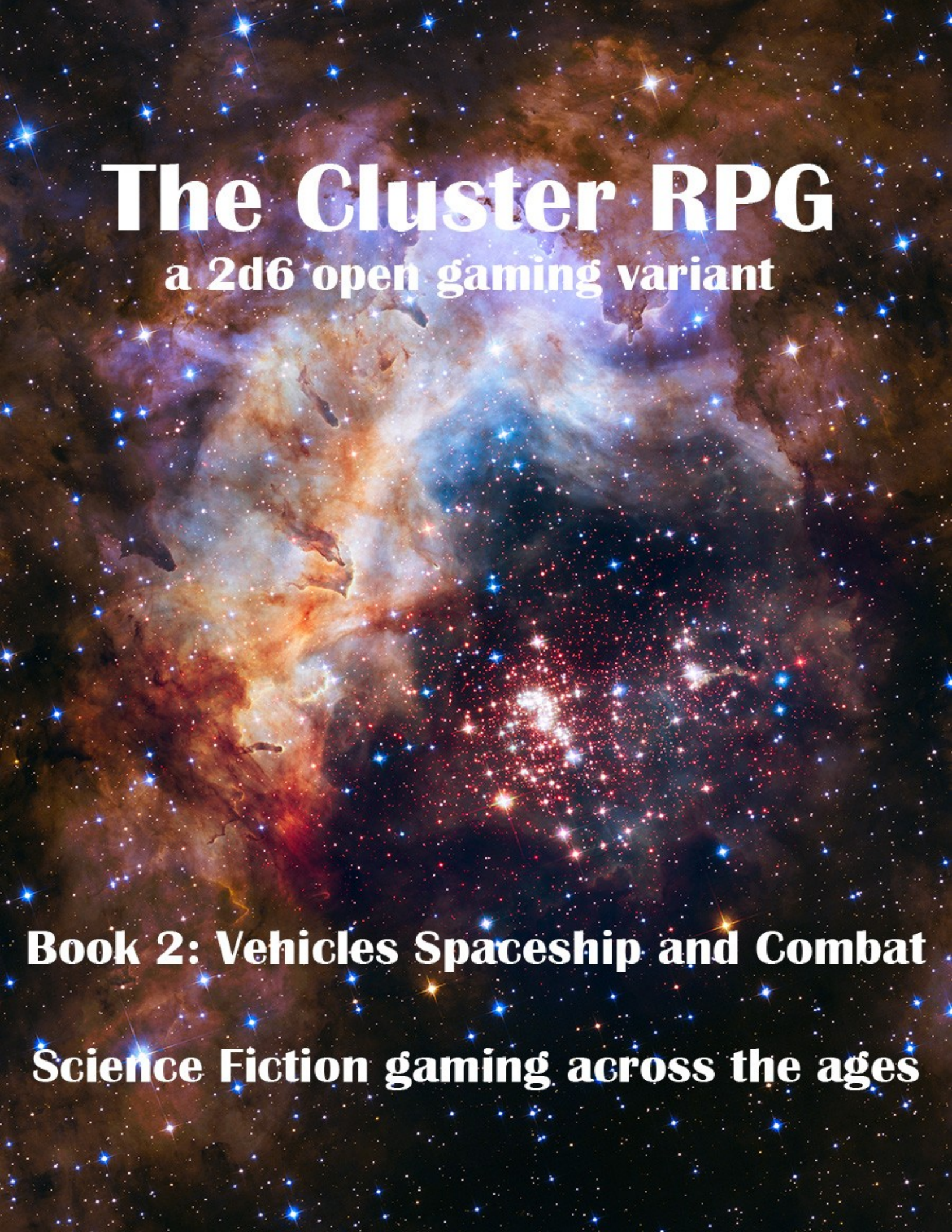
The Cluster RPG
a 2d6 open gaming variant
Book 2: Vehicles Spaceship and Combat
Science Fiction gaming across the ages

Cluster RPG Book 2

Vehicles, Spaceships and Combat

A modified version of the Cepheus Engine SRD

by

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Version 1.0.10

Chapter 5- Vehicles

Chapter 6- Spaceship Design and Construction

Chapter 7- Personal and Vehicular Combat

Chapter 8- Space Combat

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 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 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

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 twice the 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.

Gatling guns were the first machine gun, much heavier than later models but a great improvement over single firing rifles of the time. They use the same damage and cost as LMG slugs.

Repeating cannon are essentially small black powder cannons that can fire more frequently. They use the same ammo as small black powder cannon.

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
revolving cannon	4	rocket	4	7	1	2500
gatling gun	4	rifle	4	2	4	500
mortar	4	catapult	2	0.5	1	3000
medium mortar	4	catapult	3	4	1	8000
heavy mortar	4	catapult	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
med. mortar bomb	5	200	180	8d6	cluster ordninance
20mm autocannon	.2	5000	45	5d6	ordinance
55mm AT round	.5	2000	90	6d6	ordinance
heavy mortar bomb	12.5	80	240	10d6	cluster ordinance
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 works 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	4d6 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.

Chapter 6: Ship Design and Construction

General Rules for Construction/ Repair Times and Costs

Ships take approximately 1 day per MCr to build at an orbital or planetary shipyard. This assumes that the ship is being built in a Class A or Class B starport and has a hangar at least twice as large as the ship being built. Use of makeshift facilities to build or repair spacecraft takes twice as long if not being performed at an appropriate starport. Class C starports are capable of building small craft, but it takes them twice as long so it is not nearly as efficient as having a Class A or B starport. Note that a repair craft or spaceport servicing a damaged vessel must be within one tech level or higher of the ship's system in order to service a system aboard the damaged vessel. Jump-5 engines, for example, require a TL 13 (D) or better spaceport and as such it can be hard to find an appropriate repair yard. A TL 9 tramp freighter, on the other hand, can be repaired in almost any facility.

Craft repairing other ships in space must meet a number of characteristics. First, they must have 1 ton of repair drones per 50 tons of ship being repaired. Secondly, they must have at least twice the cargo capacity of any system they are trying to replace. A ship repairing a 100 ton jump drive in space would thus need to have at least 200 tons of cargo space available. Finally, repair craft working on the damaged ship must be able to provide at least 1 grappling arm per 20 tons of equipment being installed. Note that the arms may be provided by more than 1 vessel so small craft may work together to provide sufficient grappling arms.

Ships are limited in size by their abililty to enter jump space. As jump technology improves, larger ships are able to enter jump space. At TL9, ships up to 2000 tons can enter jump space. By TL10 this increases to 3000 tons, and at TL11 the limit becomes 4000 tons. The displacement maxes out by TL13 and 5000 tons. It is not currently possible to maintain a stable jump bubble for ships larger than 5000 tons, although there is a lot of active research going on in this area.

Non-jump spacecraft are not limited by size limits of Jump capable starships. Dispersed hull stations may be constructed in sections and assembled in place, but they are very limited in acceptable thrust. The standard module size of 2000 tons allows them to be efficiently moved between star systems and therefore makes mass production more feasible. Large planetoids have often been hollowed out for bases and these bases may be extremely large. Specialty Maneuver drives may be constructed that are larger than size KK, but these are not mass produced and are therefore substantially more expensive than standard drives. Large ships must be built in the system where they will operate as there is no known way to move large vessels efficiently between systems.

Ships and stations may mount redundant systems such as two engines or power plants. Only 1 system may be functinal at a time, but redundant systems have an effective passover times of 0, meaning no effect in the game. Repairs on the main system can be implemented without shutting down critical ship systems, but ship movement and weapon fire may be limited by the capacity of the backup systems. For example, Meson weapons require a power system output of 5; backup systems cannot always meet this requirement.

Spacegoing craft are divided into several classes of ships. Starships are those that can jump between star systems, while spacecraft is more general and includes all ships able to move themselves through space at 1g or above. Spaceports, orbital stations, bases, etc. are various constructs built in space which have only minimal orbital thrust capability.

Ships are further subdivided by size. All ships under 100 tons (generally in 5-ton increments) are considered small craft and may not have jump drives. General spacecraft are ships between 100 and 1400 tons (generally designed in increments of 100-200 tons). Capital ships displace 1500 tons and above, with a hard upper limit of

5000 tons for jump capable ships. Ships may generally mount any available systems, although small craft have a selection of smaller drive units and power systems designed specifically for them as the larger units may not fit within the smaller hulls. Several other systems such as barbettes or bay weapons have minimum ship sizes and power plant requirements, which make them unsuitable for smaller hulls. Giant ships above 5000 tons are not jump capable but may operate within planetary systems able to construct them.

Hulls, Power Plants, and Drives

All spacecraft require hulls, power plants, and drives of some sort in order to function. Each type of structure provides different capabilities at different price points. The tech level of the system affects everything from the efficiency of the unit to its capabilities. These are some of the most basic requirements of any manufactured system used in space.

Hulls

Hulls provide a general covering over the ship which protects occupants and systems from normal levels of radiation, micrometeorites, vacuum, and many of the other general hazards of space. It also sets a limit on the volume of additional equipment able to be added to the ship. Different size hulls have different capacities and cost very different amounts of money depending upon its intended usage. Every 100 tons of hull provides 2 hull points (round up) and 2 structure points (round down) when engaged in space combat.

Dispersed hull only costs 50% of the normal hull but it is relatively weak. It receives a -4 DM for all operations within an atmosphere, where failures maneuvering in atmospheres causes 2d6 damage to the ship. In addition, armor may not be added to any dispersed hull ship or module. Clamped ships make the joint vessel dispersed.

Standard hull costs the normal amount and provides the usual amount of protection. It receives a -2 DM penalty on atmospheric operations with failure causing 1d6 damage. Armor may be added normally.

Streamlined hulls are 110% of normal cost, but are designed for full atmospheric operations with fuel scoops for bringing on unrefined fuel from gas giants or any other potential hydrogen source. They are designed to enter atmospheres.

Planetoid hulls are approximately spherical, and always considered standard hulls- they may not be streamlined or dispersed. They are the least expensive hull option, and only cost 0.01 MCr per ton to move and drill out. Normal planetoid hulls have 80% useable space and provide 2 free armor points (not included in the max armor). Buffered planetoid hulls have 65% useable space and provide 4 free armor points (not included in the max armor). Planetoids that move at speed <1 may be any size- these are considered asteroids or orbiting bases. The largest jump capable ship is always 5000 tons no matter the source of the hull. Standard engine sizes are limited to a maximum of KK. Larger engines may be built for larger hulls, but they must be specially designed and will cost twice as much due to their non-standard nature.

Armored bulkheads may be used to protect internal systems, giving all internal systems 1 extra damage point. Armored bulkheads use 10% of the ship's total tonnage and adds 10% to the total cost of the ship.

Psionic bulkheads use psionic shielding built into the hull and internal walls of the ship to prevent the use of psionic powers. This shielding costs MCr0.1 per ton and takes up no additional space. The shielding prevents the use of psionics that pass through shielded walls; it does not prevent internal line of sight use of psionics. Thus psionic shielding would prevent teleporting commandos from entering the ship, but would not protect crew in the same compartment once the commandos had entered the ship. Psionic bulkheads are mostly used near worlds where psionics are common, but the high cost of the shielding limits its use.

Modular hulls allow certain systems to be switched in and out to alter the purpose of the ship. Modular hulls may use up to 75% of total tonnage of the ship and increase the price of the hull by the percent that is modular. The bridge, main power plant, drives and armour may not be modular. Modules inside of a ship use the ship's power plant. Externally clamped modules have a max power level of 1 unless it has its own power plant; modules of 100+ tons require their own power plant.

Hull Size	Reinforced Structure per 5%	Reinforced Hull per 10%
10-90	1	3
100-1,000	2	5
1,000-2,000	4	10
2,500+	8	20

Reinforced structure and Reinforced hull gains extra points for those characteristics by spending a percentage of the ship's volume to improve the superstructure. Both types of reinforcement cost 0.2 MCr/ton. Reinforced hull and structure is generally restricted to ships that are designed to see combat and have already maxed out their available armor. The table above lists the number of structure and hull points provided by the reinforcements given the overall size of the hull.

Small Craft Hulls

Hull Size (tons)	MCr
10	1.1
20	1.2
30	1.3
40	1.4
50	1.5
60	1.6
70	1.7
80	1.8
90	1.9

Spacecraft Hulls

hull size (tons)	MCr
100	2
200	8
300	12
400	16
500	32
600	48
700	64
800	80
900	90
1000	100
1200	120
1400	140
1600	160
1800	180
2000	200
2500	250
3000	300
3500	350
4000	400
4500	450
5000	500

Giant hulls are only useful within a star system as the largest ship able to enter jump space (currently) is 5000 tons. Standard engines are able to move giant hulls within a system and provide a mobile base which can mount more weaponry than any jump capable ship can match. Because these hulls must be constructed within the system, only systems with class B or better spaceports are able to construct these vessels. Giant hulls also tend to be more expensive and take more time than standard vessels to construct because they cannot fit into regular space docks. While there is no physical upper limit to the size of a giant hull, any vessel that cannot be moved by standard engines (up through size KK) will require unique engines that cost twice normal.

Ship Armor and Shielding

Armor is a special type of modified hull which blocks 1 point of damage from each attack per point of armor. Armor may never be added to dispersed structure ships. Armor is always added in whole point increments so that the ship has a whole number of armor. The entire ship or module must be armored in the same material and to the same level. The base part of a station may have a different amount of armor than station modules. The entire ship must be armored in the same material at the time of construction; armor type may be changed after the ship is built but it must be designed to carry a particular amount of armor in tons. Types of armor available vary according to tech level. Thus a TL10 destroyer could receive a TL12 upgrade increasing its armor protection. Armor applied to a planetoid must encompass the full size of the planetoid (not the available space within the hull) and costs as much for a given hull size as a standard ship hull; ie. it is not cheaper to armor a planetoid than a regular ship despite the difference in hull price.

Armor Type	TL	Protection	Cost	Max Armor
titanium steel	7	2 per 5% hull volume	25% of standard hull per 5%	lesser of TL or 9
crystaliron	10	4 per 5% hull volume	100% of standard hull per 5%	lesser of TL or 13
superdense	12	5 per 5% hull volume	150% of standard hull per 5%	lesser of TL or 13
bonded superdense	14	6 per 5% hull volume	250% of standard hull per 5%	up to TL

Only 1 type of hull shielding may be added to any individual ship. ie. a ship may not be both stealthy and be reflec shielded at the same time. Nuclear dampers, Meson screens and black globes are considered internal ship systems and are not considered shielding applied to the hull of a ship. A ship may therefore have both stealth shielding and nuclear dampers.

heat shielding (TL6) protects ships against burning up during re-entry. It gives a +1 DM piloting roll for entering an atmosphere and costs 0.01 MCr per ton of hull.

reflec shielding (TL9) increases armor against lasers by +3. It costs MCr 0.1 per ton of hull.

rad shielding (TL10) provides radiation and electromagnetic hardening for the entire ship, both the hull and internal structures. It blocks 6 points of damage from any weapon system doing radiation damage which includes particle beams, nuclear weapons, and meson bays. Other radiation sources that cause damage to the crew, including internal sources such as a leaking reactor, are also reduced. Rad shielding costs 0.25 MCr per ton of hull.

stealth shielding (TL11) absorbs radar/lidar beams and disguises heat emissions, giving a -2 DM on sensor checks to lock onto ship. It costs MCr 0.1 per ton of hull.

improved stealth shielding (TL14) is even better at absorbing radar/lidar/densitometry detections and gives a -4 DM on sensor checks to lock onto a ship. It costs MCr 0.3 MCr per ton of hull

Ship Drives and Power Systems

Drives are the devices which propel ships through space. One of the most significant TL 8 accomplishments was the development of the gravitic drive system, or M-drive. These drives are the main maneuvering system of ships at most tech levels. Before the gravitic drive At TL 6-7, reaction drives are the only drive available for space travel. They are the same size as later engines and cost 50% less than M-drives but are very inefficient.

Reaction drives consume 1% of total displacement of fuel per hour of 1g thrust (10 combat turns). Ships cannot maneuver after burning all their fuel.

> Some scientists think it may be possible to capture a wormhole and enlarge it many trillions of times to make it big enough for a human or even a spaceship to enter.
>
> *Stephen Hawking*

For small craft, M-drives and power plants intended for spacecraft are too large for the needed performance. To overcome this, smaller M-drives and power plants have been developed that are less efficient overall but come in smaller sizes more appropriate for small craft. The small drives also provide more distinct levels of thrust. Small craft are permitted to use the larger drives, but the possible accelerations are more limited.

Jump drives

Jump drives are the only available way to travel to other star systems. They use refined hydrogen gas to create a bubble in extradimensional space for the ship to exist. Normally ships entering or leaving Jump Space create an easily observed ripple in space-time that can be detected easily (+2DM) even at extreme sensor range. Each jump takes 148+6D6 hours to complete regardless of the distance traveled. Early jump drives are only able to move 1 parsec at a time, while higher tech allows longer jumps to take place in that same 1 week interval. The table below relates the maximum jump distance and maximum ship size available at various tech levels.

Normal Jump drives are offline for 24 hours after re-entering normal space. It is possible to shorten this time, but only at increasing the risk of a misjump. It is impossible within 6 hours of re-entry, -6 DM within 6-12 hours, -4 DM 12-18 hours, and -2DM 19-24 hours after re-entering normal space. Captains generally only jump early when the survival of their ship is at stake as misjumps are often as dangerous as whatever situation is forcing them to leave quickly in the first place.

Navigating through Jump Space is dangerous and requires careful calculations and optimized fuel. Use of unrefined fule gives a -2 DM penalty for accurate jumping. Using drop tanks gives a -2 DM penalty for navigation during a jump. Jumping close to another space body also dangerous, as the gravity well distorts space-time. Navigating a jump takes 10-60 minutes and a successful navigation roll to get to the correct destination (within 1 million kilometers), otherwise the ship misjumps. If a ship misjumps, rolls are repeated until a jump succeeds. The more sequential failures, the farther from the intended destination the ship ends up. In addition, misjumps are hazardous for crewmembers who suffer increasingly more severe effects the worse the misjump.

Fast Cycle Jump Drives are able to jump again 1 hour after arrival. If attempted sooner, there is an increased possibility of a misjump. For 1 minute after jumping, it is a very difficult jump navigation check (-6 DM). For 2 minutes to 29 minutes it is a -4 DM, and 30-59 minutes it is a -2DM roll for a misjump. This assumes that the required amount of fuel is available. Fast cycle jump drives cost 10% more than normal jump drives, take no additional space, and are available 1 tech level above the normal jump drive.

Stealth Jump Drives are available at TL13+ and reduce the chances of observing a ship coming out of jump space. Normally a ship jumping in is automatically detected out to minimal sensor range. A stealth jump drive requires a difficult (-2 DM) sensor check within limited sensor range or a -4 DM very difficult check at minimal range. Stealth jump drives cost 5x normal but take up no additional space. Stealth jump drives may never be fast cycling.

Optional Jump Rule

Higher tech jump drives are more efficient than lower tech systems. If a jump drive can make a Jump-3 or above (available at TL 12), they only need 9 tons of hydrogen per 100 tons of ship per parsec jumped. At Jump-5 and above (available at TL 14 and 15), they only need 8 tons of hydrogen per 100 tons of ship per parsec jumped. Note that a ship must be able to make the longer jumps to take advantage of the reduced fuel requirement. It may choose to make shorter jumps at the reduced fuel level. A jump engine that can only move a ship 1 parsec requires the full amount of fuel even if the rest of the ship is TL15. This change increases the usefulness of high jump multiple engines and makes higher tech jump drives more efficient and more advantageous. The downside is that high tech engines need high tech repairs which are available in fewer systems. The drives themselves are also more expensive and, if the ship is to be able to use their drives to the full potential, a large volume of the ship will be taken up by fuel.

Tech Level	distance (parsecs)	max tonnage	tons fuel per parsec per 100 tons (optional rule amount)
9	1	2000	10
10	1	3000	10
11	2	4000	10
12	3	4000	10 (9)
13	4	5000	10 (9)
14	5	5000	10 (8)
15	6	5000	10 (8)

Space Drives

Chemical rockets known as **reaction drives** are the most primitive type of drive system used to move vessels through space. They are first developed at TL6 but are more common at TL7. They use Newtonian mechanics and accelerate by expelling gas from the engine at high speed to propel a craft forward at a max thrust of 2g. It is very expensive fuel-wise, however, and requires 1% of the vessel displacement in hydrogen per hour of 1g thrust. Oribtal change (takeoff or landing) requires 25% of vessel displacement in fuel per 1.00g of surface gravity; it is easier to achieve orbit on low grav vs high grav worlds. Space stations that generate pseudo-gravity by rotation use 1% of the vessel displacement in gasses expelled to maintain rotation and orbital position per month. They have the same cost and size as gravitic engines but use much more hydrogen.

Maneuver drives use gravitic propulsion which allows safe and easy access to space for the first time starting at TL8. M-drives work by manipulating gravitonic fields that can both thrust a ship through space and create artificial gravity aboard a vessel. Almost all ships have some type of maneuver drive for traveling within a star system as Jump drives do not function consistently within 100 diameters of a large body such as a star, planet, or moon. More powerful M-drives allow more rapid access to orbit from a planetary surface, a shorter length of time to reach the Jump limit around a planet, and an easier time out-maneuvering a ship attempting a boarding operation.

Maneuver drives manipulate gravitic forces using standard energy from fusion power plants and so do not waste precious fuel pushing ships around by passing gas. Because of this, they require a power plant of the same type or larger in order to operate. Space stations require much smaller maneuver drives than ships because they are only required to maintain orbital position and provide internal gravity.

Power Plants

Power plants are essential for providing energy for all systems on ships and stations. The power plant must be able to provide enough energy for the largest drive on the ship, either maneuver or jump drive. The power plant also limits the types of weapons able to be used by a ship or station. TL 8-10 power plants are 25% larger than more modern systems but cost the same amount due to their lower technology. TL15 power plants may be 25% smaller but cost twice as much if high tech fusion plants are used.

Chemical power plants (TL6+) are 50% larger, costs 1.25 MCr/ton, and burn hydrogen fuel at 20x the rate of a fusion power plant.

Fission power plants (TL7+) are the same size and cost as fusion plants but use radioactives to provide power. Each year the plant uses (weekly amount of hydrogen) tons in radioactives. Fuel costs 1 MCr per ton, but is not available in many locations due to the preferred use of fusion powerplants. Radioactives are only available on low tech worlds with primitive space travel or full service Type A starports.

Solar panels must be 1/20 (inner planets), 1/10 (middle planets), or 1/5 (outer planets) the size of a fusion power plant to give everything but energy weapons and engines a power of 1. Solar panels cost 0.1 MCr per ton and take 10-60 minutes to retract or extend on a successful Engineering/Power Plant roll. Ships may not maneuver faster than 0.1g while solar panels are deployed, nor may a ship with panels extended enter a hangar or be clamped to a larger ship without destroying the solar panels. Smaller ships can dock to a vessel that has deployed solar panels normally. Ships depending only on solar panels may not fire energy weapons.

Emergency power systems cost 10% tonnage and cost than the main power plant does. It is only a temporary solution, however, providing 30 minutes of full power (5 combat turns) after the 3rd hit on the power plant. The emergency power plant is destroyed on the next power plant hit.

Spacecraft Drive Performance per Hull Volume

type	100	200	300	400	500	600	700	800	900	1000	1200	1400	1600	1800	2000	2500	3000	3500	4000	4500	5000
A	2	1																			
B	4	2	1	1																	
C	6	3	2	1	1	1															
D	6	4	2	2	1	1	1	1													
E	6	5	3	2	2	1	1	1	1	1											
F	6	6	4	3	2	2	1	1	1	1	1										
G	6	6	4	3	2	2	2	2	1	1	1	1									
H	6	6	5	4	3	2	2	2	2	2	1	1	1								
J	6	6	6	4	3	3	2	2	2	2	2	1	1	1							
K	6	6	6	5	4	3	3	3	2	2	2	2	1	1	1						
L	6	6	6	5	4	3	3	3	3	3	2	2	2	1	1						
M	6	6	6	6	4	4	3	3	3	3	2	2	2	2	1	1					
N	6	6	6	6	5	4	4	4	3	3	3	3	2	2	2	1					
P	6	6	6	6	5	4	4	4	4	4	3	3	3	2	2	1					
Q	6	6	6	6	6	5	4	4	4	4	4	3	3	3	2	2	1				
R	6	6	6	6	6	5	5	5	4	4	4	4	3	3	3	2	1				

S	6	6	6	6	6	5	5	5	5	5	4	4	4	3	3	2	1				
T	6	6	6	6	6	6	5	5	5	5	5	4	4	4	3	3	2	1			
U	6	6	6	6	6	6	6	5	5	5	5	4	4	4	4	3	2	1			
V	6	6	6	6	6	6	6	6	5	5	5	5	4	4	4	3	2	1	1		
W	6	6	6	6	6	6	6	6	6	5	5	5	4	4	4	4	3	2	1	1	
X	6	6	6	6	6	6	6	6	6	6	5	5	5	4	4	4	3	2	1	1	1
Y	6	6	6	6	6	6	6	6	6	6	6	5	5	4	4	4	3	3	2	1	1
Z	6	6	6	6	6	6	6	6	6	6	6	6	5	5	4	4	4	3	2	2	1
AA	6	6	6	6	6	6	6	6	6	6	6	6	5	5	5	4	4	3	3	2	2
BB	6	6	6	6	6	6	6	6	6	6	6	6	6	5	5	5	4	4	3	3	2
CC	6	6	6	6	6	6	6	6	6	6	6	6	6	6	5	5	5	4	4	3	3
DD	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	5	5	5	4	3	3
EE	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	5	5	4	4	3
FF	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	5	5	4	4
GG	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	5	5	4
HH	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	5	5
JJ	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	5
KK	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6

Spacecraft Drives and Power Plants Prices

	.Jump Drives.			.Maneuver Drives.			.Power Plants.			....Fuel....
Type	tons	MCr		tons	MCr		tons	MCr		tons/wk
A	10	10		2	4		4	8		1
B	15	20		3	8		7	16		2
C	20	30		5	12		10	24		3
D	25	40		7	16		13	32		4
E	30	50		9	20		16	40		5
F	35	60		11	24		19	48		6
G	40	70		13	28		22	56		7
H	45	80		15	32		25	64		8
J	50	90		17	36		28	72		9
K	55	100		19	40		31	80		10
L	60	110		21	44		34	88		11
M	65	120		23	48		37	96		12
N	70	130		25	52		40	104		13
P	75	140		27	56		43	112		14
Q	80	150		29	60		46	120		15
R	85	160		31	64		49	128		16
S	90	170		33	68		52	136		17

T		95	180		35	72		55	144		18
U		100	190		37	76		58	152		19
V		105	200		39	80		61	160		20
W		110	210		41	84		64	168		21
X		115	220		43	88		67	176		22
Y		120	230		45	92		70	184		23
Z		125	240		47	96		73	192		24
AA		135	260		51	104		79	206		26
BB		145	280		55	112		85	222		28
CC		155	300		59	120		91	238		30
DD		165	320		63	128		97	254		32
EE		175	340		67	136		103	280		34
FF		185	360		71	144		109	296		36
GG		200	390		77	156		118	320		39
HH		215	420		83	168		127	344		42
JJ		230	450		89	180		136	368		45
KK		245	480		95	192		145	392		48

Giant Hull Acceleration Table

Ships larger than 5000 tons may only travel in normal space, but are otherwise just like other spacecraft. Using standard engines and powerplants, they may travel at maximum speeds as determined by their size. Ships that have clamped modules may also increase their apparent size for purposes of jump and maneuver drive function. Thus a 2000 ton ship with 4 20 ton clamps may tug 4x 2000 ton modules giving it an apparent size of 10k tons. This ship would be unable to enter jump space while clamped to 4 modules because it exceeds the 5000 ton limit. If attached to a single 2000 ton module, it would only mass 4000 tons and be able to jump.

Engine	7k	10k	13k	16k	19k	22k	26k	30k
Y	1							
Z	1							
AA	1	1						
BB	2	1						
CC	2	2	1					
DD	3	2	1	1				
EE	3	2	1	1				
FF	3	3	2	1	1			
GG	4	3	2	2	1	1		
HH	4	3	3	2	2	1	1	
JJ	5	4	3	3	2	2	1	
KK	5	4	4	3	3	2	2	1

Small Craft

For many craft smaller than 100 tons, the full size spacecraft drives provide more thrust and more power than these vessels require. Because small craft are so useful, engines and powerplants have been standardized to meet the needs of even tiny vessels. Small craft may use larger ship-scale engines, and thrust scales accordingly. A 50 ton small craft with a Type A ship engine would accelerate at 4g; a 25 ton craft would be capable of 8g acceleration, but are limited to 6g's so much of their capability would be wasted. Larger engines and powerplants also typically cost more and take up more space, again wasting precious resources and making the ships less efficient. Smaller engines and powerplants are best suited for lower thrust, general purpose vessels that are common in most civilized systems.

Small Craft Drives

	.....Maneuver Drive.....			.....Power Plant.....		
drive type	size(tons)	price(MCr)		size(tons)	price(MCr)	weekly fuel (tons)
sA	0.5	1		1.2	3	.4
sB	0.7	1.5		1.5	3.5	.5
sC	0.9	2		1.8	4	.6
sD	1.2	2.5		2.1	4.5	0.7
sE	1.5	3		2.4	5	0.8
sF	1.8	3.5		2.7	5.5	0.9
sG	2.1	4		3	6	1.0
sH	2.4	4.5		3.3	6.5	1.1
sJ	2.7	5		3.6	7	1.2
sK	3	5.5		3.9	7.5	1.3
sL	3.3	6		4.5	8	1.5
sM	3.6	7		5.1	9	1.7
sN	3.9	8		5.7	10	1.9
sP	4.2	9		6.3	12	2.1
sQ	4.5	10		6.9	14	2.3
sR	4.8	11		7.5	16	2.5
sS	5.1	12		8.1	18	2.7
sT	5.5	13		8.7	20	2.9
sU	5.7	14		9.3	22	3.1

Small Craft Drive Performance by Hull Volume

drive	10	20	30	40	50	60	70	80	90
sA	2	1							
sB	4	2	1	1					
sC	6	3	2	1	1	1			
sD		4	2	2	1	1	1	1	
sE		5	3	2	2	1	1	1	1
sF		6	4	3	2	2	1	1	1

sG		6	4	3	2	2	2	1	1
sH			5	4	3	2	2	2	1
sJ			6	4	3	3	2	2	2
sK			6	5	4	3	3	2	2
sL				6	4	4	3	3	2
sM					5	4	4	3	3
sN					6	5	4	4	3
sP						6	5	4	4
sQ						6	5	5	4
sR							6	5	4
sS							6	6	5
sT								6	5
sU									6

Fuel Usage and Fuel Tanks

Power plants burn fuel when active, and systems such as life support and gravity require an active power source. While solar panels can power any systems other than the drive or weapons, most of the time power plants will be consuming fuel. Without a power plant, M-drives cannot function and the ship will be under zero-G conditions. The larger the power plant, the more fuel is consumed. Listed in the tables above are fuel consumption rates for small craft and spacecraft power plants.

Ship fuel tanks are contiguous, so fuel may be used for jumping, fueling other ships, or providing power. Ships that do not have enough fuel to make a given jump (either through leaked fuel, inabilty to refine enough fuel, or using it to extend their operations) may not jump until enough fuel is present.

M-drives and P-plants can use nearly any hydrogen. Jump engines, however, require a purer form of hydrogen than the other engines. Refined fuel is available at all Class C or better Starports. Some ships are also equipped with their own fuel processors that will purify acquired hydrogen. Jumping using unrefined hydrogen gives a -2 DM to any Jump made with contaminated fuel.

Drop Tanks (TL9) are disposable, collapseable structures designed to provide fuel for an initial jump without consuming the limited amount of fuel carried by a jump capable ship. Developed at TL9 to expand the range of the jump-1 ships available at the time, ships must be equipped with drop tank clamps in order to use drop tanks. Clamps are generally able to be added on after the initial construction of a ship. When used below TL14, drop tanks are damaged and rendered useless if an 8+ piloting roll is failed (separate from the jump roll). Above TL14, technology has made drop tank use routine. Drop tanks below TL14 give a -2 DM penalty for jump navigation due technical challenges, which decreases to -1 DM at TL14 and above.

If maneuvering with a drop tank attached, adjust the speed of the vessel to account for the drop tank+ ship combination. For anyone crazy enough to take a drop tank into combat, it has 1 hull and 1 structure point per 50 tons. The drop tank size is compared to the ship size, and the tank:ship ratio is the percentage chance of hitting the tank. Every hit will cause hull/structure damage as normal, with every hit causing a fuel hit (with resultant fuel loss) as well. If a destroyed jump tank is not jettisoned immediately it reduces the movement rate by 50% due to drive interference. Drop tank clamps cost 1 MCr and use 2 tons per 50 tons of drop tank to be added and must be a part of the ship. Drop tanks themselves cost 0.1 MCr and weigh 1 ton per 50 tons fuel.

Command/Control Units

Standard Bridges are required for all ships 100 tons displacement or above. These give normal control and tactics checks. The larger the ship the larger the required bridge size. Standard Bridges cost 0.5 MCr per 100 tons of ship.

Command Bridges (TL12) are meant to coordinate fleet actions and give +1 DM to naval tactics checks. They cost 50% more than standard bridges and displace 80 tons, and may be used in place of standard bridges.

ship size	bridge size
100-200 tons	10 tons
300-1000 tons	20 tons
1200-2000 tons	40 tons
2500-5000 tons	60 tons

Compact Bridges (TL8) cram everything into a smaller space. They take up 25% less tonnage and cost the same as a standard bridge, but all actions on the bridge are at -1 DM due to the tight conditions.

Detachable Bridges (TL10) serve as emergency life rafts with re-entry capabilities and 2 weeks of life support.

Hardened Bridges (TL10) protects the bridge occupants and ships computer from 200 rads of radiation and EMP. Hardened bridges cost 25% more than standard and take up the same space. Rad shielding on ships also gives this advantage and is an additive protection.

Holographic Bridges (TL13) use advanced displays and controls which give +2 to ship initiative rolls. These cost 25% more than standard bridges and take up no additional space.

	Type 1	Type 2	Type 3	Type 4
Ship size	200 tons or less	201-1,000 tons	1,001-2,000 tons	More than 2,000 tons
Tonnage	15	30	60	90
Cost per ton of ship	MCr 0.8	MCr 0.8	MCr 0.8	MCr 0.8
Hull	0	0	1	1
Structure	1	1	1	1
Thrust	0.1g	0.1g	0.1g	0.1g

Small Craft Command Requirements

Small Craft require 1 cabin or cockpit if 50 tons or less and small craft larger than 50 tons requires 2 cabins or cockpits. Cockpits take up 1.5 tons/person and are intended for relatively short duration missions. They do not provide sleeping areas or even room to stretch out. Cabins take up 3 tons per person, but can hold 1 extra passenger per 2 people (ie. 6 tons of cabin can carry 3 people) and can serve as a combined command/living area for moderate duration missions. Long and short are relative, but if the pilot will require sleep, assume a cabin is the necessary accomodation. Both cost 0.1 MCr per ton. Cockpits and cabins may be hardened against radiation for 25% of their cost starting at TL12. In addition, unlike larger craft, small craft do not come with an airlock as default. An airlock displaces 1 ton and costs 0.2 MCr.

Robotic, Drone, and Cyborg Ships

Small Craft may be operated as drones using the remote operations skill combined with the appropriate spacecraft skill. A remote operations check is used to control the drone, with a penalty of 2*effect for failed checks. Note that the remote operations check cannot increase the following skill roll. Remote operations work

using radio/laser communications up to tech level 12, then use meson communications at higher tech levels. Remote operations using radio are subject to jamming as are other comm checks. Drone controllers are generally very close to the ship itself as radio/laser controls are limited to the speed of light.

All unmanned operations require 2 tons of electronics per standard crew, and ships must be fully crewed or suffer operational penalties. Each ton of control circuits costs 0.5 MCr. Damage to living quarters is transferred to cyborg brains or control circuits which reduce the effective functionality of the ship.

The minimum tech level of a robot is determined by 9+ 2*robot skill level, so a skill 2 robot ship must be at least TL 13. All skills of the robotic ship are assumed to be the same for simplicity. For robotic control, a ship's computer must be equal to the same tech level as the minimum robot skill. For the skill 2 robotic ship above, a TL13 robot requires a Model 5 computer. Redundant computer hardware is highly suggested for all robotic ships as a single lucky hit on the computer would render the entire ship inoperable. Software for controlling the ship costs 0.2MCr/crew for skill 0, 0.6MCr/crew for skill 1, 1.2MCr/crew for skill 2, and 2MCr/crew for skill 3.

Cyborg ships use sophont brains as their control units, and as such the brains have the same skills they acquired during their organic life. Due to specialization, each brain is able to replace 2 crew members as long as it has all of the necessary skills. Each brain requires 1 ton of interface equipment and costs MCr0.1 each. This includes 1 month of nutrients for the cyborg brain. Additional nutrients cost MCr0.1 per brain-year and consumes 1 ton. The neural interface which allows brain to electronic communication is TL12 technology.

Computers and Computer Software

Computer	TL	Rating	MCr
Model 1	7	5	0.03
Model 2	9	10	0.16
Model 3	11	15	2
Model 4	12	20	5
Model 5	13	25	10
Model 6	14	30	20
Model 7	15	35	30

Jump control specialization (bis) increases rating by +5 for jump control only and increases costs by 50%.

Hardened computer systems (fib) are immune to EMP weapons and cost 50% more. Hardening only protects ship electronics and computers including drone or autonomous control electronics, not any passengers or crew. The hardened option may be taken simultaneously with jump specialization.

Ship Programs

program type	TL	Rating	Cost (MCr)	Notes
Maneuvre/0	6	0	included	allows basic control and piloting of ship
Library/0	6	0	included	basic data and stellar information
Intellect	11	10	1	allows verbal and independent control of ship functions

Security/0	8	0	included	protects against hacking and intrusion
Security/n	8+2*n	10*n	n	-2 DM vs hacking and intrusion per level
Jump/n	8+n	5*n	0.1*n	required for jumps up to n parsecs
Autopilot/n	6+2*n	5+5*n	n+1	can make 1 dodge or +1 pilot per level
Fire Control/n	8+n	5*n	2*n	make n attacks or add +n to 1+ attacks
Science/n	8+3n	15*n	3*n	adds +n for laboratory and probe research
Auto Repair/n	8+2*n	10*n	5*n	make n repair attempts or +n to 1+ attempts

Electronics, Sensors and Communications

Standard sensors are the basic sensors every spacecraft will have and are included in the price of other systems. They are not removed when upgraded sensors are installed so they become essentially a backup sensors if the primary system is destroyed. Standard sensors may not have any backups (as they cost nothing and have no weight).

Civilian sensors are upgraded versions of the standard sensors which improve the ability to lock onto targets and collect more detailed information about nearby objects.

Military sensors or better are required for jamming enemy probes, missiles, or communications. They also have more sophisticated tracking and interrogation modes to collect additional information..

At TL11, **advanced sensors** add densitometers to the suite of sensors available making it easier to target particular systems and giving sensors a positive DM for the first time.

System	TL	DM	Tons	MCr	Includes
standard	6	-4	0	0	radar, lidar
civilian	8	-2	1	0.05	radar, lidar
military	10	0	2	1	radar, lidar, jammers
advanced	11	+1	3	2	radar, lidar, jammers, densitometers
very advanced	12	+2	5	4	radar, lidar, jammers, densitometers, NAS
survey	12	+1	10	10	rapid planetary scans using probe drones
countermeasures	13	+1	7	6	advanced sensors +2 for jamming
military countermeasures	15	+1	20	25	advanced sensors +4 for jamming
distributed arrays	11		x3	x3	extends all ranges 1 band, min ship size 2000+ tons
improved processing	11	+1	1	4	improved range bands, easily jammed
enhanced processing	13	+2	2	8	improved range bands, jamming normal

Improved processing upgrades the ability of sensors to interpret confusing or weak signals. This improves the information obtained from any of the sensors by 1 range band, but the analysis is very noise dependent and may be easily jammed, thus making the sensors less useful in combat situations.

Very advanced sensors bring neural activity sensors (NAS) to ships for the first time, improving the type of information regarding crew on nearby ships.

Survey sensors for larger vessels or primarily exploration ships allow a ship to combine the use of probe drones and ship based sensors to more quickly evaluate planetary bodies. While less useful in combat, survey sensors excel at mapping and scanning planetary systems.

Enhanced processing dramatically improves how sensors handle confusing or weak signals. These improvements expand range bands by 1 space and, while still susceptible to jamming, are not easier to jam than normal sensors.

Countermeasures are electronic generators designed to deceive and mislead sensor electronics. They are commonly used to foil missile and torpedo locks as well as disrupt sensor lock-on during combat.

Military countermeasures employ state of the art jamming technology which is extremely effective and masking sensor data and confusing attacking missiles and torpedoes.

Ships without functioning sensors have a -6 DM for all sensor and communication attempts. Stealth technology, particularly stealth coatings, are designed to minimize sensor signals. Ships may not use active countermeasures without negating the effectiveness of their stealth coating.

Crew Requirements

position	salary	minimal	standard	full
officer	7000	none	15	1 per 10 crew
pilot	5000	1	1	3+ backups
navigator	4000	1	1	1+backups
engineer (power engines fuel)	4000	1	1 per 100 tons	1 per 50 tons
sensors/comms	3000	none	1 per system	1 per system + backups
medic	2500	none	1 per sickbay	2 per sickbay
turret gunner	1000	none	1 per turret	1 per turret+ backups
bay gunner	1000	none	2 per bay	3 per bay+ backups
screen operator	1500	none	2 per screen	3 per screen + backups
steward	2000	none	1 per 2 high, 5 passengers	1 per 2 high, 5 passengers
flight crew	1500	none	1 per 30 dock/hangar tons	1 per 20 dock/hangar tons
small craft pilot	3000	none	1 per 30 dock/hangar tons	1 per 20 dock/hangar tons
scientist	2500	none	1 per lab	2 per lab
service crew	1000	none	1 per 15 crew	1 per 10 crew
marine	1000	none	boarding defense	assault troops
general crew	1000	none	1 per 300 hull	1 per 200 hull
agricultural	1000	none	1 per 100	1 per 60
manufacturing	1000	none	1 per 6	1 per 4
storefronts	1000	none	1 per 3	1 per 2
establishments	1000	none	1 per 30	1 per 20

Crew Stations

Officers live one per stateroom and typically can man one or more positions in an emergency. They often have naval or ground assault tactics plus leadership to improve the operations of their unit. Captains receive 50% more salary than the next highest paid person. For smaller vessels, captains will typically assume one of the standard positions aboard ship. For ships with 8 or more crew, a dedicated captain who is an officer is required (although often present with smaller crew). Command vessels have 1 or more additional Flag officers above the captain. The highest ranked flag officer receives 1.5x the pay of the captain and any other flag staff officers receive pay equal to the captain.

Most spacecraft have an absolute minimum crew of 2- one pilot/navigator and one engineer who double as navigator and sensor/comms. This allows no room for error, and any crew casualties are a major problem. In these cases the pilot is usually the captain and earns 1.5x as much as the engineer. Most crewmembers share a stateroom like middle passage passengers.

Many freighter crews work on minimal level of staffing to save money. Military vessels prefer a full crew, plus backups. Assault troops are always in addition to normal ships crews. Many larger official vessels have a frozen watch, crew members who are in low berths who can take over for battle casualties. Crew salaries can make up a large fraction of operational expenses for any vessel, particularly fully staffed ones.

Passengers may be either high or low pasage passengers and have access to the ship's facilities. High passage implies substantial luxuries available, while middle passage is basic access and typical food. Stewards are required to look after both high and middle passage passengers. Low passage passengers occupy low berths and are only revived once the destination is reached. They may carry 20 kg in a locker below the unit.

Small craft often have only a single pilot running the entire ship. This is typical for short-haul piloting such as orbital shuttles or planet-moon transports. Cockpits are only useful for short-haul flights. Control cabins have more ammenities than cockpits and have facilities for longer duration missions such as interplanetary travel or extended patrols in system. Passenger cabins are for used only for shorter (less than a week) trips, while cramped seating is only used for trips less than 24 hours.

> Our three big emergencies are fire, loss of pressurization or contaminated atmosphere. Any of those things in a spaceship are very deadly and time critical. Everybody's trained, but I'm the commander of the ship, and it's up to me to decide.
>
> *Chris Hadfield*

Barracks are typically only used by military organizations; other purposes such as colonization or prisoner transport are more efficiently carried out using low berths. Sophonts may be crammed into tight quarters during emergencies, but life support systems are not designed to handle higher densities of people and conditions deteriorate quickly. Barracks are only suitable for the lowest ranking individuals- skilled workers generally will not put up with these cramped conditions for very long.

For ships intended to carry more people than staterooms/barracks would normally support, **life support** units can be included to maintain a healthy environment. They are most commonly used on stations, but a lifeboat cutter might be able to squeeze in dozens of people in an emergency.

Low berths are essentially cryofreezers for sophonts. This minimizes life support and space requirements for sophonts travelling between systems and is, by far, the cheapest mode of travel.

Escape pods are designed to provide short term support for one sophont leaving one environment and going to another. They are capable of independent atmospheric reentry but cannot take off under their own power. In the military landing capsules, etc are essentially the same as escape pods that are intended to get troops down to the surface as quickly as possible.

Luxuries are amenities that can provide one level of steward for supporting passengers at an appropriate level. They are usually present on ships intended to carry passengers in style and comfort.

Armories are found on military ships or larger ships which wish to restrict the distribution of weapons. Armories are legally required for weapons that might penetrate the hull, such as fusion weapons or high end missiles, although pirate vessels generally don't care if they fail safety inspections.

Briefing rooms are general use meeting rooms which have displays and screens to help describe a situation or make plans. They provide +1DM tactics or repair operations when planned there.

Detention cells are basically intended for short term restraint of a prisoner or rowdy passenger. Longer term restraint is easier and cheaper in low berths, greatly restricting the need for such facilities.

Laboratories are specialized sections of the ship designed to investigate various phenomena. General labs give allow science investigators to work on any area of research in these labs. Specific labs give a +1 DM for science investigations in their specific area but no benefit in any other. At TL 12, advanced laboratories can provide +1 DM for general labs and +2 DM for specific lab investigations.

Sickbays are intended to treat injured passengers and crew. A sickbay gives a +1 DM to medics working there, or they may have an autodoc which can provide automated care for up to 2 individuals.

Improved Sickbays provide a +2 DM for medics working there.

Libraries are useful for collecting information on trade, people, or cultural information. Searches conducted in a library give +1 DM for cultural or artistic information.

The **ship's locker** is a convenience area for storing general items required aboard a ship. It is meant for things like vacc suits, toolkits, and the like which are assumed to be available but are not specifically stated.

Workshops are areas for constructing or repairing various items found aboard ship. They can give a +1 DM to manufacture or repair small, simple items (with the appropriate skill rolls) and using spare parts that are purchased for exactly these purposes.

Vaults are highly protected areas of the ship which are difficult to access or destroy. It is an internal structure that has 4 hull and 4 structure points independent of the ship itself, meaning the vault can usually be recovered even when the ship itself is destroyed. Vaults typically have a complicated (-6 DM) locking mechanism that may only be opened by certain people or under certain conditions determined when the vault is closed.

Crew Table

Location	TL	tons	MCr	function
stateroom		4	.5	houses 1 officer or 2 crew
low berth	7	.5	.05	one low passenger or frozen watch
escape pod		.5	.1	one sophont or assault soldier
barracks		1.5	0.15	sleeping and living area for 1 soldier
cockpit		1.5	0.15	short-haul piloting region to control a small craft
control cabin		3	0.3	mid- haul small craft control system. 1 extra person per 2 cabins
passenger cabin		1.5	0.15	mid-haul quarters for 1 average size sophont
cramped cabin		.5	.2	short-haul uncomfortable seating for average size sophont
luxuries		1	.1	adds +1 steward to ship
armory		2	.5	provides limited access to weapons/armor for crew
detention cell		2	.25	houses 1 prisoner in secure, cramped quarters
briefing room	8	4	.5	give +1 tactics/repair for operations planned there
laboratory	9	4	1	science general, +1 specific, additional +1 at TL 12, +100% cost
sickbay	9	4	1	+1 medic, or has autodoc for treating 2 sophonts
improved sickbay	12	4	3	+2 medic, or has autodoc for treating 2 sophonts
library	8	4	4	improves searches and arts/humanities research by +1 DM
workshop	8	4	0.3	allows part fabrication and repair bonus
vault	14	12	6	interior emergency unit with 4 hull and 4 structure

Craft and Drone Storage

Mining drones are used to extract ores and minerals from planetary bodies and asteroids. Each set of mining drones are able to process their own displacement of ore per day. Results of the extraction operations are generally checked weekly for each shift using the mining equipment.

Probe drones are 150-200kg drone or robotic sensor systems deployed from a ship to increase the range and amount of information gathered. Different tech levels and types of drones are useful for different purposes and are detailed under drones and robots. Typical tech levels are TL8, TL11, and TL14.

Repair drones are automated units that may be controlled by the ship's computer to repair systems under combat situations or used to fix a disabled ship nearby. A ship requires 1 ton of repair drones per 100 tons of ship to be able to service its own needs or 1 ton of drones per 50 tons of adjacent ship being repaired.

Hangars are full service bays for repairing and storing other craft. They require 130% of the size of craft being stored for the servicing and access. Large hangars may service any amount of ships up to the given total displacement size. They are designed to allow entry, exit, and access while ships are in space.

Docks are minimal storage bays for small craft. They require only the size of the ship being stored and includes no space for servicing craft. They are form fitting and are designed to only handle that size vessel and none other. Larger vessels or stations often include a combination of hangars and docks to maximize the number of craft they can carry but still be able to service them during a voyage. Air rafts and ATV storage docks may be in

cargo bays without access to space, in which case they may only be deployed on planets. An empty cargo bay may be used as a work area in these cases.

ship type	dock (tons)	MCr		hangar (tons)	MCr
air raft	4	0		5	1
ATV/ATF	10	0		13	2.6
launch	20	0		26	5.2
boat	30	0		39	7.8
pinnace	40	0		52	10.4
cutter	50	0		65	13
shuttle	95	0		122.5	24.5

Launch tubes are designed for the rapid deployment and recovery of smaller ships. Ships still require hangar space for storage internally. In surprise combat situations launch tubes can allow ships to deploy anti-missile fighters quickly to provide point defense. They may also be used to rapidly recover fighters for an escape.

Grappling arms are essentially cranes used to move larger items and units around during construction, cargo transfer, or recovery operations. They are often found in mining, construction, or repair areas to safely maneuver heavy loads. They provide a +2 to operations switching 30 ton modular cutters and are required when moving modular bays from external clamps to hangars for unloading or reloading.

Docking clamps are devices used to attach ships externally to another vessel. Larger structures require larger docking clamps to hold them. Docking clamps are typically used to shuttle modules or system defense craft from one system to another. 30 ton modules for cutters are able to be stored externally on stations using 1 ton clamps while 2000 ton station modules rely on 20 ton clamps. Modules and craft clamped onto another vessel add their mass to the tug or station for purposes of acceleration and jump travel and may not expand the 5000 ton limit for maximum jump bubble size. Destroying the docking clamp allows 2 ships to drift apart. Ships with modules clamped on are considered dispersed structure ships and lose streamlining.

Clamp Size	Ship Tonnage	MCr
1	10-30	0.5
3	40-90	1.0
10	100-400	2.0
20	500-2,000	4.0
50	15,000	8.0

Drone and Hangar Table

ship system	tons	MCr	description
mining drone	10	2	includes ore handling equipment and drones
probe drones (5)	1	varies	external units deployed to increase rate and type of information
repair drones	1/100	0.2/ton	allows ship auto-repair program to make repair attempts
hangar	varies	0.2/ton	+30% space for access, repair, and diagnostics
dock	varies	0	form fitting spot for a small craft, no room for repairs
launch tube	25X	0.5/ton	25x larger than the largest craft using tube for fast recovery
docking clamp	varies	varies	attaches ships or modules for transport or extended connection
grappling arm (TL8)	2	1	aids in repair, mining, construction, module exchange, etc

Other Ship Components

Cargo spaces are basically storage areas for whatever the ship needs. They usually have access to hangars or outside the ship and carry cargo from one system to another.

Cargo scoops (adapted from the Pirates of Drinax) are typically used by pirates to acquire cargo spaced by terrified freighters. It uses magnets and mesh to capture materials in space and deposit them in a cargo bay. They may be used to capture space junk, EVA sophonts, destroyed ship fragments, etc. Cargo scoops are also used to collect debris near construction or mining areas or after space combat.

Drop tank mounts are primarily used by jump capable starships to fuel their initial jump out of a system. Hydrogen from the drop tanks are used to inflate the mini universe used by jump engines, and then are discarded just prior to jumping. This can increase the effective range of a jump ship and is often used by Jump-1 ships to leave a local group but increases the navigational difficulty. Extra time for plotting jumps involving drop tanks is therefore typical. The external tank itself is jettisoned and may often be reused. When the drop tank is used, an astrogation roll is made; on an 8+ the tank survives, although this roll is not modified by taking extra time. By TL14 drop tank technology is perfected and this roll is no longer necessary. Polities which support drop tank use typically charge a fee for recycling used tanks as the leaving ship is in no position to recycle them. Ships using M-Drives while the drop tank is attached must include that mass for determining their thrust level (ie. a drop tank of 100 tons of fuel would increase the mass of a 400 ton freighter to 500 tons for M-Drive purposes). 2 tons of drop tank mounts are needed per 50 tons of drop tank capacity.

Collapsible drop tanks are used to hold the fuel temporarily before making a jump. They are left behind in system while the fuel is used to inflate the jump bubble. Tanks cost 0.1 MCr per 50 ton capacity and mass 1 ton when carried as cargo.

Fuel scoops are mechanical intakes for collecting hydrogen sources from planetary bodies. They are included in the price of streamlined hulls so they tend not to be purchased separately.

Fuel processors are used to purify hydrogen fuels for use in jump drives. Jumping with impure fuel gives a -2 DM to jump accuracy and eventually will lead to a misjump. 1 ton of fuel processor is able to purify 20 tons of hydrogen per day.

component	TL	tons	MCr
cargo	6	1	0
airlock	6	1	0.05
cargo scoops	8	2	0.5
fuel scoops	6	0	1
fuel processor	6	1	0.05
drop tank mount	9	2/50 ton capacity	1/50 ton
collapsing drop tank	9	50 fuel	0.1
aerofins	7	5% of ship	0.1/ton
breaching tube	10	3	3

Aerofins are used to increase the aerodynamics of small craft or spacecraft in an atmosphere by +2. It works in any atmosphere including gas giant atmospheres when skimming fuel, dodging missiles whie trying to land, or when attempting to set down on an unimproved landing site.

Breaching tubes are used to allow soldiers to transfer from one ship to another without the use of an airlock. Using plasma cutters arranged around an air-tight flexible bridge, breaching tubes may cut through an airlock in 1 minute and cuts through armor at 1 point per minute. They are commonly used by military assault vessels and privateers.

Station Components

Because stations are habitats where people live rather than ships designed for a purpose, there are several components found primarily on stations that are not common in ships. Ships intended to be permanent habitats may have these components just like stations may have any components designed for ships.

Cargo lift airlocks are large, fast cycling airlocks designed for use with grav lifts transferring cargo and people around the station. Intended to function safely even if the transport tubes are pierced, they are an integral part of how modules interact with the base station.

Cargo docks are places for lifts to discharge sophonts and cargo. Modules often have several cargo docks to allow several lifts to be docked at once. This allows a faster flow of material from one place to another and can speed transport out of an area if one dock is reserved for particular use.

Lift tubes are vacuum sealed tubes within base stations that link the various modules together. They are required to take up 25% of the station volume and cost 0.1 MCr per ton. This price includes grav lifts to move around the station and control circuitry to prevent collisions and such. Lifts typically reside in module docks until needed, and autopilot controls work to predict where the heaviest use of lifts will occur to have enough lifts available. The bridge has the ability to comandeer lifts when necessary, and enterprising hackers have been known to tap into this ability.

Life support is used on ships or stations where there are more people than quarters available. When the number of people present exceed the capacity of staterooms, barracks, etc to handle them, additional air and water purifiers, waste systems, etc can be added to keep them alive and healthy. 1 ton of life support is sufficient to support 20 average sized sophonts.

The **command center** of a module is the central area where key module functions are controlled. It must take up 1% of the total tonnage of the module itself, and every module 100 tons or greater must have a command center. Decentralized controls are critical in emergencies for space stations.

Base station Command Centers are responsible not only for controlling key functions of the base station but also for integrating all module command centers and often for controlling base access from space. As they have more requirements, they make up 2% of the tonnage of any base station.

Manufacturing plants are intended primarily for stations where mechanical, chemical and/or technical goods are produced. Often intended for export, it is a way for stations to help support themselves. Often manufacturing plants take raw materials produced by mining nearby planets and convert them into more valuable materials. Manufacturing requires both raw materials as well as storage space for finished products and so often includes cargo space associated with the manufacturing plants. Manufacturing plants require a minimum of 1 worker per 15 units to operate and maintain them.

Agricultural greenhouses are used to provide sophonts with waste recycling and food for extended stays in deep space. At TL8, 30 tons of greenhouse are sufficient to support 1 normal sophont for 1 year. This is reduced to 25 tons of greenhouse space at TL11 and further reduced to 20 tons at TL14. Space reductions are enabled by using genetically engineered crops and better nutrient control. Partial greenhouse support may not be enough to fully support a crew, but the availability of fresh food or luxury items improves morale. Greenhouses require a minimum of 1 worker per 200 tons to operate and maintain them. Large independent bases require extensive greenhouse facilities or regular supply deliveries from planetary bases.

Storefronts are intended to facilitate commerce on board stations. Typical stores are either a mish-mash of items that a particular shopkeeper has collected or it is a specialty shop that caters to a very particular clientele. Shops often cluster together to attract additional shoppers. For many items, stores are the middlemen between producers and consumers and occupy an important position in any economy. They may be fastidious or grungy, reliable or shoddy, legal or semi-legal. Storefronts require a minimum of 1 worker per 3 storefronts to operate and maintain them.

Establishments are places where sophonts congregate for entertainment or other activities. Some are private intimate affairs where only a few are welcome, while a dance club might actively desire the most possible people to enhance their reputation. Modules or stations with many establishments typically have additional life support units associated with them to deal with the dense population, or may have some areas containing specialized environments for taint breathers. Establishments may be high class or crass, discrete or public, honest or crooked. Establishments require a minimum of 1 worker per 30 tons to operate and maintain them.

Station Component Table

component	TL	tons	MCr
cargo lift airlock	8	10	2
cargo dock	8	6	0.5
cargo lift tube	8	25% of hull	0.1/ton
life support	6	1	0.5
command center	6	1% of hull	0.5/ton
base station command	6	2% of hull	0.5/ton
agricultural greenhouse	6	1	0.1/ton
manufacturing plant	6	6	2
storefront	6	10	1
establishment	6	.5/sophont	0.2/ton

Turret Mounts

Turrets are the most common weapon system found on spacecraft of all sizes. Each turret or barbette requires 1 ton of fire control equipment in addition to the turret costs. Ships have 1 hardpoint for every 100 tons of craft, with a minimum of 1 hardpoint for small craft. Small craft are restricted by the size of the turret that they may mount based on the vessel size. Each turret or barbette occupies one hardpoint on the ship. Barbettes are essentially oversized 5 ton turrets designed to support a larger, more powerful weapon system and may not be mounted on ships smaller than 50 tons. Note that some weapon systems also have minimum power requirements in order to operate the weapon systems. The higher tech level needed to operate higher

occupancy turrets represents the required miniaturization to fit that many weapon systems into the same displacement tons.

When there is more than one direct fire weapon in a turret, each weapon may be fired at the same target without any penalties. Changing targets for any reason incurs a -1 DM per target change, so if a triple beam laser turret fires at missile #1 and hits, fires at missile #2 and hits (after the -1 DM), a shot at a third missile will be at -2 DM. If the first 2 shots had missed, taking a third shot at the same missile would have no penalty.

When considering upgrades to a weapon system, the upgrade starts at the higher tech level of the turret or the weapon system. Upgrading a triple pulse laser turret, for example, would require TL13 technology (TL11 for the turret, and +2 for the upgrade even though pulse lasers are TL7 technology).

Mount	TL	min size	tons	MCr
single turret	7	20	1	0.2
double turret	9	40	1	0.5
triple turret	11	60	1	1
pop-up turret	+1	+10	2	+1
fixed mounting	6	10	0	0.1

Pop-up turrets are designed as stealth type weapons for pirates or Q-ships who wish to hide their true function. Sensor scans of medium range or longer will not reveal the presence of pop-up turrets, and even minimal range scans require a separate sensors check to identify the pop-up turret. They appear 1 tech level after the visible type of turret is available. Barbettes are not eligible for popup status.

Fixed Mounts are only usually found on small, primitive fighters and only fire in one direction. Barbettes are not eligible for fixed status.

Turret and Barbette Weapon Systems

Pulse lasers are the earliest lasers designed for use in space. They fire a brief, high intensity laser pulse which could cause severe damage when it hits the target. Unfortunately, the short duration of the pulse is difficult to target effectively, giving these weapons a -2 DM for hitting their target. Pulse lasers are common for low-tech anti-ship weapons and can also be used against missiles or torpedoes.

Beam lasers shoot a longer intensity energy pulse that does not suffer the same targeting problems that pulse lasers do. The longer pulse, however, generates a significantly lower beam intensity that only does 1d6 of damage which is relatively easy to block using enough armor. Beam lasers are a common anti-missile or anti-torpedo weapon as they hit more frequently than pulse lasers.

Particle beams are one of the deadliest lower-tech direct fire weapons available. They fire a stream of charged particles that interacts destructively with matter and causes 3d6 damage to the ship and an additional 3d6 radiation damage to the crew of the targeted ship. They do not make good anti-missile or anti-torpedo weapons due to targeting issues. They are relatively expensive, high power weapons and require at least a power level of 2 from the power plant in order to be used in combat. Particle beam barbettes require even more power and need at least a power level of 3 from the power plant.

Particle beams are further restricted as a percentage of turrets that may include particle beams. At a power level of 2 or 3, only 25% of the turrets may have particle beams, rounded down. At power levels 4 or 5, up to 50% of turret weapons may be particle beams. Particle beam barbettes count double in terms of percentages of turret weapons due to their significant power demands. A ship (such as a fighter) that has more than 50% particle beams must have a power level of 6 in order to support such a heavy weapons load.

Missile racks are some of the earliest weapons designed for use in space. Missiles depend upon guidance systems to direct them to their target, but unless the guidance systems are fooled or misdirected they can be exceptionally deadly weapons when fired in salvos. Missile barbettes may fire up to 5 missiles at a time at a single target. Different types of missiles have different effects and can cause different amounts of damage on a successful hit.

Sandcasters are the premier defensive system for lower tech ships. Successfully firing sand reduces the effectiveness of laser weapons from the 'targeted' ship for the combat round by 1d. If a sandcaster fires pebbles at incoming missiles or a ship, a successful hit does 1 point of damage to ships but destroys the incoming missile. Torpedoes, unfortunately, are larger than missiles and are not affected by pebbles or sand. Pebbles may also be directed against attackers trying to board a ship from space, causing 8d6 of personal damage to all individuals in the direction fired.

Railguns are only available in barbette or larger weapon formats and basically accelerate a solid mass at the target ship at very high speeds using kinetic energy to knock out ships. They work best at shorter ranges, but when they hit they do 3d6 damage which can only be reduced by armor.

Torpedoes are the most powerful ship killing weapons available to low tech spacecraft. They are essentially oversized, 1 ton missiles which are impervious to pebbles and can carry a larger warhead than missiles which can penetrate even very tough armor. Torpedoes can miss or be confused, however, or they may be destroyed by a successful laser attack against them. Each torpedo barbette may fire only 1 torpedo at a time.

turret weapon	TL	best range	damage	MCr
pulse laser	6	short	2d6	0.5
beam laser	9	medium	1d6	1
particle beam	8	long	3d6+crew	4
missile rack	6	by missile	by missile	0.75
sandcaster	6	close	special	0.25

barbette type	TL	best range	damage	MCr
particle beam	8	long	4d6+crew	8
missile rack	6	by missile	by missile	2
railgun	9	short	3d6	4
torpedo	7	by torpedo	by torpedo	3

Heavy Weapons

Bay weapons are the heaviest weapons available in space and take up 50 or 100 tons and one hardpoint per emplacement. They also require 1 ton of fire control equipment per bay. Ships over 100 tons may be fitted with 1 bay weapon per 1000 tons of displacement times the power output of a ship, rounded down, with a

minimum of one. For example, a 2000 ton cruiser with a power output of 3 could have a maximum of 6 bay weapons. Large bays count as 2 standard bays. Small craft of any size are unable to mount bay weapons.

Ortillery Railguns are designed to bombard immobile targets such as stations and planets. They fire large masses at high velocity that can cause truely massive damage. Like other railguns, they are most effective at short range. They are quite difficult to target, however, and there is a -2 DM penalty for hitting any target that can get out of the way. Ortillery masses are also quite large and may be targeted by lasers to reduce the damage to the target by the amount of damage done to the incoming mass. Large ortillery railguns are known as mass drivers and are illegal on many worlds. When used against planetary targets they are devastating weapons and can throw up dust clouds that may cause long term climate changes akin to large nuclear weapons.

Railgun bays accellerate multiple small masses at the target vessel. The firing vessel rolls 12d6 and then arranges those dice into 4 sets of 3 dice as they wish before determining if the ship was hit or not. This greatly increases the amount of damage done on average per hit. Dice must be arranged before the success of the attack is determined. Large bays go through the same process with 18d6 in 6 groups of 3 instead of only 12d6.

Torpedo bays fire 3 torpedoes instead of 1, increasing the size of the salvo and trying to overwhelm enemy point defense. A large torpedo bay can fire 6 torpedos at once against a single or multiple targets.

Particle beam bays are powerful weapons even at medium tech levels. They require a minimum power level of 3 for small bays or 4 for large bays.

Missile bays fire 12 missiles at a single target. Each missile warhead has a limited damage potential, but a volley of missiles (which may include different types) is very difficult to stop entirely. A large bay fires 24 missiles at once and only capital warships are likely able to completely stop a full volley.

Meson Gun bays are one of the most devastating weapon developments in history. Meson weapons bypass armor and only become destructive once they have penetrated the ship. Combined with the high damage potential of the bay weapons and the radiation damage, a meson armed ship greatly outclasses any lower tech warship in terms of destructive effectiveness. Because of their extreme energy requirements, meson bays require a power level of 5 or better for small bays and 6 for large bays.

Fusion gun bays use fusing hydrogen atoms to target vessels with essentially a directed energy burst. They are quite effective at medium ranges and are not blocked by meson or nuclear shields present on larger warships. Small fusion bays require a power level of 2 or better while large bays require 3 or better to function.

bay weapon	TL	tons	range	damage	MCr
Torpedo Bay	8	50	by torpedo	by torpedo	12
Railgun Bay	10	50	short	3d6 x4	30
Ortillery Bay	9	50	short	8d6	15
Missile Bay	7	50	by missile	by missile	12
Particle Beam Bay	8	50	long	6d6+crew	20
Fusion Gun Bay	12	50	medium	5d6	8
Meson Gun Bay	11	50	long	5d6 +crew	50

Large bay weapons all displace 100 tons and take up 2 hardpoints, and also require 1 ton for fire control circuitry. They count as two bays when determining the number of bays which will fit aboard a ship or module.

large bay	TL	tons	range	damage	MCr
missile flight	8	100	by missile	by missile	24
torpedo flight	9	100	by torpedo	by torpedo	24
Particle Beam Blast	9	100	long	9d6 +crew	40
Fusion Blast	13	100	medium	8d6	16
Meson Blast	12	100	long	8d6 +crew	100
Railgun Blast	11	100	short	3d6 x6	60
Mass Driver	10	100	short	12d6	30

Ammunition

Railgun ammo costs 1000 Cr per ton, with 40 shots per ton. Barbettes fire one shot at a time, small bays use 4, and large railgun bays use 6 shots at once.

Ortillery rounds cost 1000 Cr per ton and give 10 shots per ton. **Mass Driver rounds** cost the same but are twice as large, with only 5 rounds per ton.

Sandcasters are flexible weapons with a variety of possible payloads. All sandcaster ammo consists of a payload in a 50 kg barrel which is broken open when the round is fired. 20 rounds are available per ton of ammunition storage, and any type of accessible round may be loaded, but the load decision must be made before firing. **Sand** is the namesake ammunition load and is good for reducing the effects of laser fire by 1d per successful 'shot'. **Pebbles** are also useful for repelling boarders or destroying incoming missiles (but not torpedoes). One canister of pebbles may target no more than 3 incoming missiles and all missiles must have been fired from the same origin at nearly the same time. **Chaff** rounds are useful for disorienting sensors and communications, but primarily attempting to redirect missile or torpedo guidance systems to target the false reflections instead of the real ship. **Sandcutter** rounds are basically polarizing particles which cause the aggregation of sand and prevent its effective use nearby. It is mostly useful for an attacking ship to prevent the defender from deploying sand and disrupting laser fire, but is only useful at very short range.

Missiles come in any of several varieties, all of which are launched by the same type of launcher and are generally purchased in a 1 ton block of 12 missiles. **Basic missiles** rely upon the sensor lock of the firing vessel and use that to home in on the target vessel. ECM and jamming can distract basic missiles. **Smart missiles** have internal guidance cues which may not be jammed but which are simpler and easier to fool than the more sophisticated sensors on ships. Chaff can be effective against any type of missile by creating an alternative target on an 8 +/- TL difference between ships. **Nuclear missiles** are highly restricted, but can be developed at low tech levels and are extremely effective. They do far more damage to ships compared to normal missiles and also deliver the same amount of radiation damage to unshielded crew. Their use near habitable planets is restricted and may be considered an illegal act of barbarism by other worlds. **Long range missiles** sacrifice warhead yield for longer range. **Shockwave missiles** are designed to counter sandcasters by exploding prior to reaching the target but when successful give a -2 DM penalty to sand, pebbles, and chaff that might be launched to counter an incoming barrage. A turret or bay which launches multiple missiles may fire a mixture of missile types, but the type of missile must be declared at the time of loading.

round	TL	tons	MCr	effect
sand	5	1	.01	reduces laser damage by 1d6
pebbles	5	1	.02	1 damage to ships and missiles
chaff	9	1	.05	-1 DM on sensors and remote operations
sandcutter	9	1	.05	blocks effects of sand

Note that neither missiles nor torpedoes may be made resilient but may have their yield increased as normal. Torpedo and missile launchers may be made resilient.

missile type	TL	speed	duration	damage	MCr (ton)
basic	6	10	10	2d6	.06
smart	8	10	10	2d6	.12
nuclear	6	10	10	4d6 + crew	.18
smart nuclear	8	10	10	4d6 + crew	.30
long range	8	7	20	2d6-1	.18
shockwave	7	10	10	cuts defenses	.18

Torpedoes are more powerful missiles that are not destroyed by pebbles but may be distracted by chaff, ECM, or other things. Each must be loaded before being fired, with the type of torpedo determined at the time of loading. Torpedoes each weigh 1 ton, which is enough that even warships will limit how many they carry. The larger volume does allow a substantially larger warhead, however. Standard torpedoes do 4d6 damage, while nuclear torpedoes do 9d6 damage plus crew radiation hits. Smart torpedoes, like smart missiles, have an internal guidance system which does not require sensor lock-on for targetting. Ortillery torpedoes have a larger warhead specifically for use against immobile targets such as planets and stations. Firing ortillery torpedoes at ships gives a -2 DM to hit. Long range torpedoes sacrifice warhead strength for extended range.

torpedo	TL	tons	speed	duration	damage	MCr
standard	7	1	10	10	4d6	0.3
smart	9	1	10	10	4d6	0.6
nuclear	7	1	10	10	9d6 +crew	0.6
bomb pumped laser	9	1	10	10	6d6 + crew	0.6
smart nuclear	10	1	10	10	9d6 + crew	0.9
smart bomb pumped	10	1	10	10	6d6 + crew	0.9
ortillery	8	1	7	10	7d6	0.6
long range	8	1	10	20	3D6	0.6
long range nuclear	9	1	10	20	7d6 + crew	0.9
decoy	9	1	10	10	misdirection	0.6

Bomb pumped torpedoes are a late modification to standard torpedoes. In order to make torpedo attacks harder to predict and counter, a small nuclear device is used to power an X-ray laser which targets the ship before the torpedo reaches its target. The laser is extremely powerful (6d6) and may be reduced by sand as

normal. Because bomb pumped torpedoes explode prior to impact, lasers attempting to destroy them receive a -2 DM for attacks against them.

Decoy torpedoes emit electrical signals and chaff designed to mimic a ship to various sensors. They have a +2 DM compared to chaff due to their sophistication.

Note that torpedoes may not be made resilient, although their launchers can. Torpedoes may have their yield increased as per normal rules. As with sandcasters and missile launchers, torpedo bays may be located with different types of missiles as long as the type of missile is declared when loading the bay.

Radiation Crew Damage

Meson, nuclear, and particle beam weapons do radiation damage on a successful hit. Armor only stops the given amount of particle beam radiation; any damage which penetrates the armor also brings radiation which affects the crew..

Nuclear weapons do 1/2 radiation damage (reduced by armor) when detonated outside the ship using lasers or pebble rounds. Full radiation damage effects that penetrates the armor affects the crew when they actually hit their target.

Missiles and torpedoes distracted by chaff explode far enough away that there is no radiation damage.

Nuclear dampers and Meson screens block both normal damage and radiation damage when successfully deployed. Roll the effectiveness of the screens on each type of damage separately.

Torpedoes and missiles may **not** be made resilient but **may** have their yield increased by tech upgrades.

Torpedoes are NOT affected by pebbles as they are more protected than normal missiles but may still destroyed by laser fire.

Screen Generators

There are 3 different types of screens available to higher tech ships. They are large and expensive, but combined with armor can provide significant resistance against low tech ship killing weapons. A ship must produce 1 power unit for each generator of any type to operate the screens.

Nuclear dampers inhibit the fission reaction required to set off nuclear weapons and block 2d of damage. They reduce both the crew radiation damage as well as direct damage to the ship. Since fusion beams do not cause radiation hits and thus are not blocked by nuclear screens. Note that bomb pumped lasers damage ships with nuclear screens normally (it is laser damage), but the crew radiation hits are blocked by nuclear screens.

Meson screens prevent the decay of mesons inside of the protected area and thus prevent the damaging effects of meson based weaponry. Like nuclear screens, each meson screen block 2d of meson damage including the radiation damage. Because meson and nuclear radiation are fundamentally different forces two different types of screens must be used to protect against the different forms of radiation.

The tech level of the power plant also limits the number of simultaneous screen generators per type at any given time. For larger bases, different screen generators may be used to cover portions of the base- each screen generator can only cover 5000 tons. It is possible that only certain sections of the structure are shielded

by meson screens or nuclear dampers; black globe generators are all or nothing and no partial shielding is possible.

TL	Nuclear Damper	Meson Screen	Black Globe
12	1	1	–
13	2	2	–
14	3	3	–
15	4	4	3

Black globe generators are among the rarest and most powerful screens available. Only possible on the most advanced ships, black globes absorb all energy and mass transiting the event horizon. When black globes are on constantly, ships are essentially undetectable other than as an empty spot in space. While this does provide complete protection for as long as the power source on the inside of the sphere lasts, it does have the drawback that nothing from the outside can make it to the inside. All sensors are useless, communications and drives are useless, and no resupply and no refueling is possible.

Energy and mass absorbed by the black globe is converted into energy that is typically stored in capacitors of the jump engines. Each jump engine has capacitors equal to approximately 20% of the tonnage of the engines, and each ton of capacitor is able to absorb 36 points of energy. Additional capacitors may be purchased for 3 MCr/ton. When the capacitors are full, additional energy absorption will cause the entire ship to explode in a massive eruption. Absorbed energy is bled into the rest of the ship systems at 10 percent of the ship's capacity per space combat round allowing the black globe to essentially recharge.

shield generator	TL	tons	MCr
nuclear damper	12	50	50
meson screen	12	50	60
large nuclear damper	13	100	100
large meson screen	13	100	120
black globe generator	15	50	100
black globe capacitors	9	1	3

In order to use black globes in combat, they must be turned off part of the time and on the rest of the time in a varied pattern known as flickering. Flickering black globes will block certain weapons completely, while more extended type weapons will have their damage reduced because it will partially hit the black globes. Beam lasers, particle beams, and fusion guns have extended fire and will block damage equal to the flicker rate. Short duration weapons such as meson bays, pulse lasers, or railguns will be blocked or pass through completely based on the percentage the globe flickers.

Technical limitations make it impossible to predict exactly what instant flickering will take place and so both targeting and firing ships will have a percentage of their weapons fire absorbed by the black globe. Black globes are almost too good at what they do to be an effective screen. The ship with the black globe generator decides

Active generators	Max Flicker Rate
1	25%
2	50%
3	75%

each space combat round what the shield will be doing- on constantly, off constantly, or flickering. Higher flicker rates require more black globe generators to achieve.

Small Craft Weapon Restrictions

Small craft have 1 hardpoint maximum. Smaller ships are limited in the number and type of weapons that may be placed in their hardpoints. Ships less than 20 tons may only carry a single fixed weapon mount. Ships must mass at least 20 tons per weapon in a single turret; ie. in order for a small craft to carry a double turret it must mass at least 40 tons or 60 tons for a triple turret. Barbettes can be fitted to small craft of at least 50 tons but because of hardpoint restrictions they must be the only weapon on board. Particle beam weapons require a ship to be 50% larger than the minimum size for that type of weapon. For example, a fixed mount particle beam weapon may only be mounted on a small craft of 15 tons or greater, while a double particle beam turret would require a small craft of at least 60 tons.

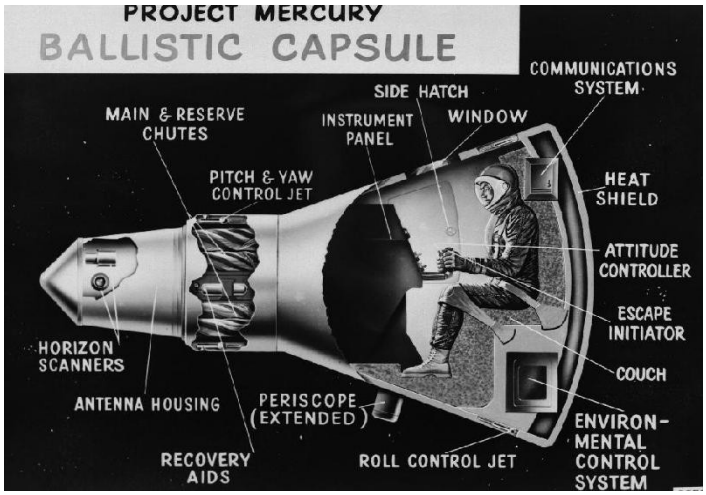
Letter code	Energy Weapons
sA-sF	0
sG-sK	1
sL-sR	2
sS-sZ	3

As small craft are frequently used in atmospheres, they may also mount vehicle scale weapons usable only against vehicles or personnel. These weapons must do less than 8d6 damage (ie. may not affect spacecraft). Small craft may mount 1 small vehicle weapon per 10 tons, and space must be provided for a mount and ammunition (if necessary).

Additionally, small craft power plants are restricted in the number of energy weapons they may support. These restrictions are in addition to the power level restrictions on the weapons themselves. If particle beams are the only weapon on a small craft, it must have a power level of 6. Projectile weapons or launchers are not restricted by the small craft power plant size but will carry a restricted amount of ammunition due to craft size.

Primitive and Advanced Spacecraft

Tech levels are a huge determinant for creating and maintaining a viable spacecraft. Low tech vessels may be repaired almost anywhere, while high tech ships require high tech bases for parts and tools. Repairs are done on a system by system basis, so that if a TL15 vessel has a destroyed fuel processing system a class C, TL9 starport can fix that even if most of the technology is beyond them.



Drive speeds are one of the most significant limitations technology places on spacecraft. Maneuvre drive technology maxes out early, but Jump engines have been advancing steadily. The minimum tech levels required for the given speed using maneuvre or jump drives are:

	1	2	3	4	5	6
Manoeuvre	6	6	8	8	9	9
Jump	9	11	12	13	14	15

Power plants also have different sizes at various TL.

	TL 8-10	TL 11-14	TL 15+
Tonnage	125%	100%	75%
Cost	100%	100%	200%

Weapon/Mount Tech Levels

System	TL		System	TL
Pulse Laser	6		Missile	6
Beam Laser	9		Nuclear Missile	6
Particle Beam	8		Smart Missile	8
Fusion Gun	12		Torpedo	9
Meson Gun	11		Railgun	9
Nuclear Damper	12		Meson Screen	12
single turret	7		double turret	9
triple turret	11		barbette/bay	7

At higher tech levels, it is possible to select upgrades for a higher-technology weapon or screen. One upgrade may be added per two Tech Levels above the minimum TL required for that particular system with a maximum improvement of +3 (ie. +6 tech levels). A +1 upgrade costs 120% of normal, +2 TL upgrade costs 150% of normal, or +3 TL upgrade costs 200% of normal. Some upgrades are double upgrades, consuming two 'slots'. An upgrade may only be taken once. Upgrades may not reduce the size of the weapon or weapon mount. Note that for some upgrades such as triple mount turrets, the turret itself is likely to be the highest tech portion of the weapon and will set the limit of what other upgrades may be applied. Upgrades do not apply to shields.

Accurate (Double Upgrade): Accurate weapons have a +1 DM to all attack rolls.

Easy to Repair: Easy to Repair armaments give a +1 DM to all repair attempts during or after space combat.

High Yield: When rolling damage for a High Yield weapon or screen, any '1's rolled on the dice are counted as '2's. For example, a roll of 1, 1, 2 on a High Yield Particle Beam attack would deal 6 damage, as the two '1's become two '2's. Missiles and torpedoes MAY have a high yield upgrade. Launchers may not.

Long Range: The optimum range for the weapon is increased by one band. For example, a Pulse Laser has an Optimum range of Short. A Long Range Pulse Laser has an Optimum range of Medium instead. Missiles and torpedoes have other options and are not eligible for this upgrade.

Resilient (Double Upgrade): The first hit on a Resilient weapon launcher is ignored. Missiles and torpedoes may not be made resilient, although their launchers may be resilient.

Variable Range (Double Upgrade): A Variable Range weapon increases its Optimum Range by one band in either direction. For example, a Pulse Laser has an Optimum range of Short. A Variable Range Pulse Laser has an Optimum Range of Close-Medium. Missiles and torpedoes do not have a range and cannot use this upgrade.

Very High Yield (Double Upgrade): When rolling damage for a Very High Yield weapon, any '1's or '2's rolled on the dice are counted as '3's. For example, a roll of 1, 1, 2 on a Very High Yield Particle Beam attack would deal 9

damage, as all the dice are below the threshold and become ‘3’s. Missiles and torpedoes MAY have very high yield upgrades. Launchers may not.

Ship Design Descriptor

The following paragraph is a universal ship description format intended to present a consistent layout for describing spacecraft capabilities.

TL: [tl] [ship class]

Using a [dtons] ton [hulltype] hull (hull [hull], structure [structure]), the [ship class] designed by [designer] is intended to [ship description]. The ship has a [jump engine type] jump engine, a [maneuver drive type] maneuver drive and [power plant type] fusion powerplant giving a jump range of [jump range], an acceleration of [acceleration]g and a power level of [power level]. The [streamlining] hull has [armor] points of [armor type] armor [coating]. [aerofins] Fuel tankage of [fuel tonnage] tons supports the powerplant for [endurance] weeks and [jump # and range]. The ship is equipped with [misc equipment]. Adjacent to the [bridge] bridge are [sensors] sensors and a [computer type and programs]. [emergency bridge] The ship has [staterooms] staterooms, [barracks] barracks, [low berths] low berths for a maximum of [occupants] long duration occupants with [low berths] low passengers. The ship has [hard points] hardpoint(s) and [fire control] tons of fire control. Installed on the hardpoints are [weapons list]. [ammunition list] There are [#] screen(s): [screen type]. There are [hangar tonnage] tons of hangar capacity to service [ship ton capacity] tons of ships and [docking tons] tons of docking bays. Cargo capacity is [cargo] tons. Crew features include [crew features]. Other equipment includes [other equipment]. The ship requires a minimum standard crew of [crew # and professions]. The ship costs [ship cost] MCr (not including discounts, ammo, customization or small craft) and takes [build time] weeks to build.

Chapter 6a: Space Stations

Types of Stations

There are 3 different types of space stations: complete, planetoid, and modular. Complete space stations are built as a single unit with no plans for expansion and no flexibility of components. They are purpose built, and that purpose is difficult to change. They are constructed exactly like regular ships.

> A self-contained world five miles long, located in neutral territory. A place of commerce and diplomacy for a quarter of a million humans and aliens. A shining beacon in space **. . .** all alone in the night.
>
> *John Sheridan, Babylon 5*

Modular stations are composed of a base station with various docking ports intended to attach to any of a number of different modules. Changing out a module allows for flexibility of purpose as well as incremental upgrades in defensive capability, for example. Each module, including the base module, is substantially independent and each has its own power generator, armor, life support, computer, etc. They are also constructed independently, allowing extensive parallel construction. The base station of a modular station is designed to facilitate connections between station modules.

Planetoid stations began as an asteroid or moon and then were hollowed out for various machinery, power plants, etc. Planetoid stations start out with a certain amount of armor due to their method of construction, but have much greater overall mass than a station constructed from scratch. Planetoid stations can include small stations on large satellites. Given the correct infrastructure, modular station elements can be incorporated onto the surface of a planetoid with the 'base' station being built underground. Planetoid stations tend to be the least expensive type for the credit, but are also least efficient in terms of space utilization and mobility.

Station Power, Movement and Construction Requirements

Stations do not generally move under their own power and therefore they may not require engines although they do require power plants. Typically power ratings on ships are determined by how fast the ship will move, and the power plant must be equal to either their jump or maneuver drive ratings. For stations, particularly stations with weapons, having enough power to use their weapons is essential.

A station's base power requirement is 1/3 that of a moving starship; ie. less than a spacecraft but more than a module. This is sufficient for life support, computers, lights, airlocks, orbital maneuvering thrusters, etc. This means that for a 3000 ton station to have a power rating of 1, it would need the same P-plant as a 1000 ton ship to move at thrust 1; ie. a Type-E fusion plant. For that same station to have a power rating of 5 (enough to fire meson gun bays) it would need a Type-S fusion plant. A larger station of 15000 tons (ie. like a 5000 ton ship) would need a Type-X fusion plant for a power rating of 1 or Type-HH for a power rating of 5.

Individual station modules 100 tons or larger must have independent power plants. These may provide more power to certain modules than is available to the station in general. Thus a station defense module may have a power 5 rating for its meson guns even though most of the station does not have that amount of power available. However, because the module is powered independently from the rest of the station, the station does not have the cabling capacity to draw upon the power available to the defense module. Engineers have been known to temporarily connect stations to modules (sometimes even module to module or ships to modules), but such experiments are not to code and prone to frequent (sometimes spectacular) failures.

Alternatively, stations can have multiple smaller power plants. The same 15000 ton station could use 5 Type-X fusion plants to provide the same power as 1 Type-HH power plant. It is space inefficient, but it does supply redundant power so that one sabouteur or lucky weapon hit could not power down the entire base station.

In addition, stations and modules may be equipped with solar panels for indefinite (and nearly free) power. The major limitation of solar power, however, is that it is insufficient to power weapon use or any technology that requires more than a power level of 1. A second redundant power plant can solve that problem, and if the station can afford a short startup time for the reactor, solar power can be a major cost savings in long term space habitats.

Station Movement

Many stations are built where they are going to remain. In some cases, though, it is sometimes necessary to move a station to a new orbit or to change their location due to new construction, other obstacles, etc. Stations may be towed by several starships or system craft working together. Because they are not really meant to be moved, stations may only move at a maximum thrust of 0.1; thus moving a station from one planet to another is going to take a long time. It takes 100x as long as a speed 1 ship to move the same distance. Thus at a speed of 0.1 it takes 63,300 seconds (17.6 hours) to move 1000 km, 200,000 seconds (55.55 hrs) to move 10,000 km, 10,500 minutes (7.3 days) to move 100,000 km, 33,000 minutes (22.9 days) to move 1 million km, 1,760 hours (~2.5 months) to move 10 million km, etc. based on a thrust of 0.1= 1 meter per second squared.

Stations must be moved by ships when in transit. Stations constructed of standard or planetary hulls may have a ship or ships push with any amount of thrust (provided all ships are using the same thrust). For example, a 2000 ton cruiser with a thrust of 3 could move a 60,000 ton station (thrust-3 x 2000 tons x 10). Distributed stations, however, are somewhat fragile; a ship can only push with a maximum of 1 thrust unit. This means in practice that for every 1000 tons of station there must be 100 tons of ship pushing. Thus for a 25,000 ton distributed station, 2,500 tons of spacecraft must be used continuously to move the station. This is not a commonly used technique, however. Modular stations must be disassembled, each separate module moved to their new position, and reassembled onto the base station.

Stations also require minimal thrusters for orbital maneuvering, although stations not orbiting a planet do not require any thrusters (but would be a zero-G station since M-drives provide the gravity for a ship or station). A station requires only enough thrust to achieve a velocity of roughly 0.02 to maintain orbit. Note that this is

barely enough to provide gravity and maintain orbit; it is NOT enough to move the station. Thus the 25,000 ton station above only requires a Type C gravitic engine. Only the base module on a station may provide orbital thrusters, so the initial construction of a station limits its maximum size if found in orbit. The base station's engines must support the station and all attached modules.

Station modules are constructed from the same materials and systems used to build spacecraft. Individual station modules are made of standard or dispersed hull material and can survive being transported by jump capable tugs provided the tug has the engine power to move the station and can stay under the 5000 ton limit for jump travel. Larger station modules cannot be moved via jump travel, so these modules must be constructed in system, often in parallel with the base station itself in the same orbit.

Starship and Station Construction

Many starships are built in stations designed for the job. Because they are required to have a fair degree of structural stability (even dispersed starships), spacecraft are always constructed as a single entity. Even modular craft, for example, have their hull value provided by the hosting ship. For construction purposes, starships require a hangar twice as large as the hull size; to build a 5000 ton freighter therefore requires a 10,000 ton hangar. Using a smaller hangar or no hangar doubles construction times making it economically impractical. Note that ship hangars normally need 30% more space just for repair, and construction is a more difficult operation. The construction of a starship or module may only take place at a planet which has the tech level to support that level of construction, so only TL14 and TL15 worlds can build TL 14 class ships. This is one reason lower TL ships are so common around the galaxy.

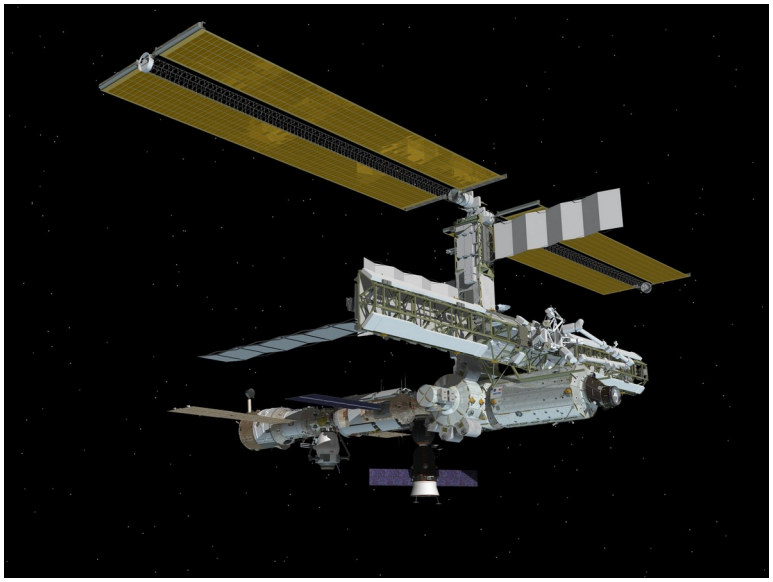
Shipyards are usually a very large dispersed cluster of construction modules that manufacture many different ships at once. Given that large vessels take years to build under the best of circumstances, a large shipyard will have many different hangars where work is under construction. Military shipyards, because they make such a tempting target, always have top notch defenses and usually have their own protecting fleet as well.

Planetoids, because they have the 'shell' of the station already present, are not constructed in a hangar. They must be hollowed out using mining procedures and zero-gravity work which requires a lot of attention and fine detail work. Many of the same techniques used in asteroid mining are used in hollowing out planetoids, allowing a fair amount of switching between these careers. Planetoids take 1 day per 1 MCr construction time; hollowing out a planetoid is faster than constructing in zero-G, but maneuvering the components into place takes more time. Modular structures may be included on planetoids bases, but only on the surface. There, they may be targeted independently, must have their own power, etc, just like other station modules. Planetoids make excellent hangars for constructing large ships or modules as they are relatively inexpensive to hollow out compared to building a hangar from scratch. Planetoids may be pushed around a system using ships the same way that stations may be moved.

Space station modules are usually constructed in hangars similar to starships. Large station modules, however, simply won't fit into most hangars. It is more time consuming to construct a station in zero-G vacuum than in a hangar. For all construction outside of a hangar, time is basically doubled; ie. 2 days per 1 MCr value. Note that ships may be constructed the same way, but the greater efficiency is almost always worth the one-time expenditure to make a hangar capable of building large ships and is assumed in their construction costs and times. Note that the increased time is to construct a station module itself; assembly of already constructed modules generally happens in a 4-24 hour timeframe and is a standard engineering (spacecraft) check.

Modular Station Construction

Some stations, particularly those made from a hollowed out planetoid, can be made as a unit. Other stations, however, have grown and expanded haphazardly over decades or even centuries. Modules within stations have a number of characteristics. First, they must contain independent power supplies and life support for all of their systems. Second, they may be armored individually such that some sections (Meson Weapon Module) can have more protection than Ore Storage. They may also be targeted independently by attacking ships. Station modules are connected by airlocks and must be clamped together using appropriately sized clamps; destroying the clamps will cause station modules to slowly drift apart and prevent movement betwen station modules. Reducing the structure of a module to 0 will cause that module to fragment and break apart similiar to reducing the structure of a ship to 0.



Clamp Tonnage	Attached Module	MCr
1	10-30	0.5
5	40-90	1.0
10	100-300	2.0
20	400-2,000	4.0
50	2,500-15,000	8.0

Life support within a module is generally provided through staterooms or barracks. If a module does not have enough staterooms or barracks, the atmosphere of the module will slowly deteriorate and people will become poisoned as long as they are in overcrowded conditions. Life support for visitors may be provided at 1 ton of life support per 20 average sophonts; this is often used in retail and/or docking areas of stations with large transient populations. 1 ton of life support costs 0.5 MCr. Note that under most circumstances this extra life support is not required; it is only critical when stations are attacked, systems fail, or modules separate from one another.

As with ships, station modules use standard designs that may be replicated across star systems. For example, an Agriculture Module is pretty much the same across worlds because it serves the same function. Because modules must be able to function somewhat independently, they are often constructed at different tech levels. This can cause problems for repair crews tasked with working on all of these different types and tech levels of modules. Stations have a well earned reputation throughout sci-fi literature for being a hodgepodge of styles and a maintenance nightmare. This same modularity, however, allows a station around a TL8 world to have a high tech battle module shipped in from outworld to give an attacking fleet a surprise.

Module Components

Space station modules contain a number of features which allow them to work together efficiently with the base station. Typically large modules are connected to the base station via a central lift system that allows efficient cargo and sophont movement within the station proper. A system of 2 standard airlocks are arranged diagonally across the central cargo lift. Docking clamps (20 tons for a 2000 ton or smaller module, 50 tons for up to 15,000 ton modules) are provided by the base station as attachment points for the various modules. Typically each module provides the space for cargo lifts to reside while being loaded/unloaded and not to block the base station lift tubes. Cargo lift docks, like airlocks, are provided by both the station and the module. Cargo lift airlocks take up 10 tons and cost 2 MCr. Additional cargo lift storage slots for loading and unloading take up 6 tons and cost 0.5 MCr.

Along with docking arrangements, each module greater than 100 tons requires an independent power plant 1/5 the size of an equivalent sized ship with a thrust of 1. Thus a 2000 ton module (a convenient size for construction, freight movement, and clamping) requires a power plant sufficient for a 400 ton vessel to move at thrust 1, or a Type B power plant. If the station is around a middle planet (the typical case), solar panels equal to 1/10 the size of the Type B power plant (0.7 tons) may be used to provide nearly unlimited power for daily needs. Certain modules require higher power, but since modules never have to power gravitic engines they can use smaller power plants than ships. Station modules may never have independent orbital thrusters or M-Drives; the base station is required to provide gravity and orbital maneuvering. When decoupled from the base station, modules lose gravity and zero-G skill becomes critical.

Station modules are armored independently from the base station. All modules have 2 structure and 2 hull points per 100 tons of size, the same as ships. As with ships, armored modules must be constructed with standard hull plating in order to provide sufficient support for the armor. Note that modules are never streamlined. Modules that are not armored may use dispersed structure hull materials that cost 50% of the standard hull material. If a station module loses all structure points, none of the systems present on that module function. Pieces may easily break off and drift away, but in any case the entire module must be replaced. Sophonts unlucky enough to be trapped in a destroyed module may (or may not) be trapped in staterooms which are airtight but can only survive a limited time without power.

Station modules require a certain amount of life support infrastructure to support whatever sophonts are living or working in the module. Normally these are provided by staterooms. In a station, however, people may live in a different module from which they work and they still need to breathe. For such circumstances, life support machinery (CO_2 scrubber, filters, oxygen converters, heaters, etc) may support 20 sophonts per ton of dedicated machinery. Life support for 20 sophonts weighs 1 ton and costs 0.5 MCr to buy and 2000 Cr/month to operate. Certain emergency craft might also carry life support to aid crippled vessels in urgent situations. Note that this support is meant to be temporary; it does not supply room for sleeping, eating, etc- merely the most essential aspects of life in space.

Each station module also requires independent control circuitry to control the functions of the module. Since each module is not responsible for all of the functions of an entire ship, a module's command center weighs 1/100 the total size of the module and costs 0.5 MCr/ ton. Decentralized controls mean that loss of 1 control center does not shut down every module on a station.

Computing power on a space station tends to be distributed to modules that require it. No module may have more than 1 primary computer system active at any time, and control of that module's functions are always operated only by a computer in that module. Backup computer modules that come online in case of damage to

the primary system are also allowable. Clever engineers have been known to link computers in one module to another module under emergency situations, but these are jury-rigged and prone to failure.

Screens work differently on space stations due to their modular nature and the nature of the screens. Meson and nuclear screens prevent the damaging effects of those weapons from happening within their protected areas. Thus individual modules may be protected by screeens while others are not. Either the entire module or none of the module may be screened. Screens weigh 50 tons and are sufficient for screening 5000 dtons of space. For modules larger than 5000 tons, additional screens must be used and spread out within that module. Thus a base station module of 20,000 tons would require 4 meson screens in roughly 5000 ton sections to block out 2d of meson damage on a successful screen deployment. This may be accomplished at TL12, as individual screen generators do not have to work together to shield that part of the station. For stronger screens, screen generators can be linked together at higher tech levels (see ship design) as long as power requirements are met. Thus to provide a 20,000 ton base module with 6d of meson screens, each of the 4 'sections' would have 3 screen generators linked together, become available at TL14, and require enough generators to reach power level 3. To be screen for 6d of meson AND 6d of nuclear damage, it would need to have a power level of 6 (3 for meson screening and 3 for nuclear screening) but only TL 14 since the nuclear and meson screens function independently.

Black globe generators, on the other hand, must be large enough to enclose the entire structure in an impenetrable force field. Therefore the base station module must be TL15 (minimum to use a black globe generator) and have a power level of 2 per set of black globe generators installed. For the 20,000 ton base station above, it would require only 4 black globe generators. However, base stations typically have many modules attached to it, increasing the size to cover the entire station (base module + all other modules) to perhaps, 500,000 tons total. Those 4 black globe generators have now multiplied to 100 generators spread throughout the station. Each module using a generator would have to be TL15 and have a minimum power level of 2. Only high end military stations are likely to have black globe generators in any case.

Unlike most ships, space stations are often used as manufacturing hubs for a planet or system. This is an activity related to mining, but takes refined material and creates a finished product out of it. Station manufacturing plants occupy 6 tons of space and cost 1 MCr and typically require 1 crewman (generally a technician, not a full fledged engineer) to operate. For every 60 tons of manufacturing, however, an actual engineer is required to make sure the facilities are properlay maintained and repaired.

Base Stations

Base stations are the key piece which limits the size of the entire station and serve as the structure to which all other modules attach. Independent stations require gravitic engines to work as orbital maneuvering thrusters when orbiting a planet or a star. These thrusters must be able to power 1/50 of the total mass at thrust-1. Note that a base module with an M-Drive must have power plant(s) equal to the size of the M-Drive. This also means that other power plants must also be of the same type. For example, a 1 million ton station requires a Type FF maneuvering engine. The station will then require Type FF power plant(s) or better to support it, and all of the power plants within the base module must be of the same type. Because stations require some orbital maneuvering thrusters and the maximum standard thruster size is KK, this is enough to keep a 1.5 million tons (base station plus all attached modules) in orbit.

If a base module does not have orbital thrusters, it is at the mercy of anything that changes the orbital path of the base. A large ship leaving or arriving, for example, might change the angular momentum of a small station and alter the orbital path. A station without orbital thrusters will require regular adjustment by ships to keep it

in a stable orbit. Bodies such as moons or larger asteroids generally will not change their orbital positions unless a great outside force acts upon it.

One of the primary purposes of a base station module is to provide connectivity between different station modules, perhaps a hangar to a cargo bay. The cargo lifts used in the standard module connectors need to have ways of reaching other modules. For anything other than the smallest base modules, this will require 2 paths (ie. moving in opposite directions), or a one-way circular connection to keep traffic jams from occurring. Cargo lift docks move lifts out of the central shaft for loading and unloading and to reduce congestion. The cargo lift tubes and passageways are not expensive, but take up a significant amount of space. For base stations, 25% of the total displacement tons is for lift tubes and associated structures which cost 0.1 MCr/ton.

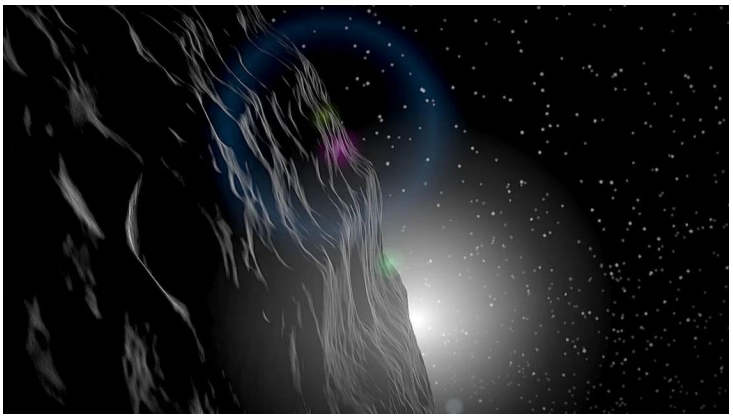
Stations also require more control circuitry than normal modules do. For base stations, the command center displaces 1/50 (2%) of the volume of the base module and costs 0.5 MCr/ton. The minimum computer rating is 5 per quarter million tons of total station. Sensors and sensor arrays are also mounted on the base station, often with redundant arrays to protect against failures. Individual modules may also have their own sensors, particularly for military purposes.

Typically the base command center (along with any defense modules) have the strongest defenses of any part of the station. Armor to reduce damage to the station is almost required for the station to survive. Stations have 2 structure and 2 hull points per 100 tons just as ships and modules. If a normal module is destroyed, that module is lost. If the station loses all structure points then the connecting struts between modules fail and all hell, or at least all modules, break loose as the station breaks apart. Destroying clamps on base stations is another technique to cause modules to be released, but because the module still has its own independent power it may function normally for a time (although transportation to other modules is impossible and communications will probably be disrupted as well).

Cutter Modules as Station Modules

Modular cutters use standardized 30 ton modules that increase the utility and range of functions vessels can carry out. While 30 ton modules would be very small for larger stations, a tiny station could be reconfigured for many different uses by substituting different cutter modules. Unlike larger modules, cutter modules do not require additional power or command center needs as their functions are relatively simple. The base module requires a dedicated airlock (1 ton) and a 1 ton docking clamp to attach each cutter module (which also requires an airlock). For cutter modules attached to a station, they may only require a power level of 1. If a station module includes a certain percentage of 'modular space' for cutter modules, the extra power requirement is not needed as the space is already accounted for using the normal rules for modular ships (just as cutters do not need extra power for modules under normal circumstances).

Planetoid Bases and Outposts



Conceptually, any body in orbit may be made into a base by hollowing out part of the structure for use. A moon such as Luna that has a small underground TL7 structure for 3 people in it is a 'planetoid base'. The difference is in degree. Mining out a planetoid is relatively inexpensive compared to constructing a complete ship of the same size. Planetoids cost 10,000 Cr (0.01 MCr) per ton to hollow out into a base (10 MCr per 1000 tons). The maximum volume which may be

hollowed out of any planetoid is 80% of the planetoid's mass, although it is very easy to hollow out smaller percentages (see the TL7 Luna moon base above). Planetoids may not function as modules, but may serve as a base stations for attached modules. They are never streamlined.

Planetoids have a certain amount of inherent armor given their nature. If a planetoid base is less than 65% hollowed out, it receives 4 points of 'free' armor. If a planetoid is less than 20% hollow, more armor to that base may be added according to how large the actual base is; ie. the small Luna base might have 4 additional points of armor added without having to armor the entire moon. These are generally referred to as asteroid bases or moon bases rather than stations. If the planetoid is more than 20% but less than 65% hollow, the entire planetoid must be armored. These are referred to as 'buffered' planetoids and are considered stations. Planetoids 65.1 to 80% hollowed out receive only 2 points of free armor. These stations have more internal room but the external shell is weaker and there is less internal reinforcement. For an old enough society "That's not a moon, it's a space station!" is actually possible.

Planetoid bases that take up less than 20% of the mass of the planetoid do not need additional thrusters to maintain their orbits. The normal changes in mass are generally too small to significantly alter the orbit of the planetoid. (Intentional orbital alterations are another matter entirely.) Buffered and unbuffered planetoids may have their orbits degraded by mass shifts and therefore require regular orbital corrections. As the mass of the station is one structure, the whole mass of the planetoid must be moved either by ships or by gravitic thrusters. As such, the mass of a planetoid station is limited the same way as other stations by the maximum standard engine size of KK (ie. 1.5 million tons) unless a sizable fleet is available to reposition the planetoid. Alternative methods of changing the orbits of planetary bodies (nuclear explosions, etc) are beyond the scope of these stations and should be carefully considered before implementation.

Planetoids can be quite massive, but unless the base is built into or on an actual planet or larger moon the gravity will be minimal at best. In order to provide gravity to the base, a gravitic drive appropriate for the size of the base must be installed. The gravitic drive is not able to move the planetoid, but it is designed to allow sophonts working on the station to be more comfortable and capable in their duties. As with gravity aboard stations, the gravity of the base can be adjusted down to the minimum supplied by the planet or planetoid.

Note that there is nothing to prevent the construction of small planetoid 'stations' that can move quickly. Type KK gravitic M-Drives can move a 5000 ton ship at thrust-6; whether that ship is built of standard hull material or composed of a 5000 ton planetoid is irrelevant. Thus a 30,000 ton planetoid station could move at thrust-1 around the system using a Type KK M-drive. Jump engines, however, have stability issues that limit the maximum size of a jump capable starship to 5000 tons. The pocket universe created by the jump engines are only so stable at TL15. Spacecraft restricted to normal space have no such restrictions. System defense planetoids maxed out on weapons can be remarkably difficult to destroy by incoming jump capable starships.

Planetoid and buffered planetoid stations have the same number of hull and structure points as completely constructed ships; ie. 2 points of hull and 2 points of structure per 100 tons. For small bases on large moons, though, things can be more complicated. A meson gun emplacement buried under 10 km of rock has nearly unlimited structure points, while a base just under the surface might have the same number of structure points as a regular planetoid station. Surface installations have fewer structure points, but a deep base might be relatively easy to completely cut off from the surface. The referee will need to determine precisely what rules apply given the situation on moon bases and base structure.

Feeding the Crew

Living out in 'The Black' is all well and good, but space is a very lonely and empty place. Where do space crews get most of their food? Clearly the bag of chips from the convenience store down the street is out. Some races may enjoy the hunt or prefer sea-based food, but in space habitats such as stations or remote outposts some sacrifices must be made.

Given the variety of sophonts found in the galaxy and their diverse origins, no single type of food is acceptable. Merfolk and avian physiologies aside, a diversified diet is essential for long term health and satisfaction of those living in space. The same is true here on Earth. In short, food must be produced somewhere and that origin has consequences for everyone concerned.

For systems without gravitic drive technology, agriculture is an essential planetary activity which could limit the maximum population on many worlds. In the United States in 2012, roughly 1 acre of arable land was required to feed 1 person for a year. Lower tech societies will generally have lower productivity per acre, and higher tech can reasonably increase efficiency somewhat. If a low tech planet cannot produce enough food, people starve until the balance stabilizes. If a stellar technology system does not have enough arable land for growing their own food, they have 2 choices: 1) import food from other systems, or 2) grow the food in space.

Most polities want control over their own food supplies for self protection, so space (ie. non-habitable regions of a system) might seem preferable. In order to grow food in space, some conversions need to be done. One acre is approximately 4050 square meters of cropland. When taking farming into space, it seems reasonable to use technology such as vertical farming, green walls, hydroponics, multi-level farming, year-round productivity, and more efficient water/fertilizer use. For lettuce in 2015, hydroponics used more water and energy but increased production per 'greenhouse unit' by slightly better than 10-fold. Using this as the average future productivity standard at TL7 suggests that about 350 square meters per person per year is probably doable.

In space, inorganic fertilizers are recyclable and solar or fusion power make light inexpensive. Lighting can be optimized to provide the correct wavelengths for maximum growth. The challenge is growing area or volume. Agricultural modules can be designed to stack atop one another and share common collecting tubes, but plants take up some volume and animals would require even more space to raise for food. Much of that volume will be air, but some will be drone harvesters, transport tubes, lighting, and such. 1 dton has a volume of approximately 14 cubic meters; converting 14 m^3 to a short 1.4m height, this is roughly 10 square meters per dton. If 350 square meters are needed per person per year, then it would take roughly 35 dtons of agricultural volume to feed one person continuously for a year.

Earth is still very much learning how to live in space. By TL8 (particularly with gravitic engines), sophonts are more familiar with the requirements of space life and how to make the most of the available volume. This suggests that about 30 dtons of dedicated agricultural space could support 1 average sophont for 1 year. Naturally smaller or larger beings would need less or more food appropriately. By TL11, genetically engineered plants and even more efficient farming techniques would likely reduce space even further to perhaps 25 dtons per sophont. By TL14, xenoengineering, nanofabrication of recycling equipment and maximization of crop yields can reduce the space required even further to 20 dtons per sophont. This volume of agricultural space would allow a mostly self-sustaining ecosystem for living on a space station or moon base assuming efficient waste and water recycling.

Put another way, a moon base supporting an average population of 10,000 sophonts at TL8 would require 0.3 million tons of agricultural space to feed that many people without food imports. At 0.01 MCr per ton for hollowing out a planetoid base, the 300,000 tons would cost 3,000 MCr just to provide the space to feed that

many people, independent of staterooms, power, harvesters, etc. Even at TL14, it would still take 2,000 MCr. For large constructed modules (assuming 1/2 price for dispersed structure), volume costs roughly 0.05 MCr per ton. (It would cost twice as much using standard hull costs.) That means 300,000 tons of module space comes to approximately 15,000 MCr (5x as expensive) to feed those same 10,000 sophonts at TL8. A trillion credit TL14 agricultural 'squadron' could only feed about 1 million people annually. That's a lot of credits!

One workaround fiction authors have used for years is to eat yeast grown in large vats, often with different additives to give various flavors or textures. In reality, yeast digest the same food we do, particularly sucrose, molasses and various other sugars. The do not photosynthesize and therefore they cannot contribute to the actual food supply. In space, the beauty of photosynthesis is that it takes human waste (not just excrement but carbon dioxide as well) and converts it back into consumable food. Since yeast consume sugars and produce their own waste (which may be rather tasty when produced from barley or grapes), they are clearly a poor choice for a primary food source.

Algae cultures might take the place of yeast vats, but the opaque nature of any algae culture (since it must, by definition, absorb light energy to photosynthesize) puts an upper limit on the density of the organisms used. Under ideal high density conditions, algae achieve only about 50% of the biomass that yeasts can. This assumes optimal nutrients, pH, atmosphere, etc. For algal species commonly cultured during the 1990's, typical conditions used produced only 250 mg (yes, milligrams!) of algae per liter according to a UN FAO Fisheries technical report from the United Nations. Besides, eating the same thing day after day, even when prepared differently, would get very boring very quickly. Try eating nothing but broccoli cooked different ways for a week, then imagine doing the same for months on end. Even one week in jump space would cause a quick mutiny!

When viewed under these conditions, habitable planets are the most efficient method to feed sophonts of all types. Inhospitable planets and asteroids could provide the raw materials and resources to protect the environment of the fertile planets and garden worlds. Given that the United States alone had over 900 million acres of farmland as of 2012, habitable planets are clearly the most important source of food in the galaxy. Semi-habitable worlds with non-toxic restrictions may also be quite productive depending upon the crops growing there. Water planets with their massive oceans of productive volume could also be important sources of various foodstuffs. In all cases, planets have significant cost advantages per ton of food production compared to anything in space.

Importing food to stations and asteroid systems is thus likely critical for their survival. When examined closely, a station such as Babylon 5 (250,000 'souls', 5 million 'tons') could not support itself. 5 million tons of just agriculture space at TL11 would feed roughly 200,000 people but allow nothing else, while 250,000 sophonts would need 6.25 million tons devoted just to agriculture. Because many stations are continuously inhabited far from homeworld support, these stations would require regular resupply runs to keep fed.

Calories come primarily from 3 sources: sugars, fats, and proteins. Fats are about twice as efficient (9 cal/g) as sugars (4 cal/g) and proteins (4 cal/g). As these are purified molecules, the tech level of a society cannot really increase these significantly short of a Star Trek replicator reassembling molecules from their component atoms. Organisms take up a fair amount of space, as do all of the molecules humans eat.

Astronauts aboard the International Space Station consume roughly 2 kilograms of food and water per day, and considering the cost of shipping anything from Earth to low orbit NASA minimizes weight everywhere they possibly can. Therefore one ton of imported, processed food will feed (approximately) 500 people well for one day, so perhaps 1000 people would eat a ton of food during an emergency. Thus Babylon 5 would have to get a minimum of 250 tons of food every day from somewhere to feed its 250,000 people. For stations near

habitable planets, these shipments might be relatively easy. For an asteroid based system, though, having reliable sources of food shipments would be essential. Disrupting even a few food or water shipments to a base (on Ceres, perhaps?) might quickly create a humanitarian disaster. "Remember the Cant!" for those of you who are fans of 'The Expanse'.

Just like medieval castles centuries ago, blockades are perhaps the most effective way of neutralizing space bases of all sorts. Stations can have deadly weapon arrays, but meson bays and nuclear torpedoes do not taste very good come dinnertime. Starving people become desperate, and this was historically how 'impregnable' castles would eventually fall. Supply lines in space are just as important as they are during any other time period. This dependence on supplies leads naturally to profitable but dangerous activities such as blockade running, privateering, profiteering, hoarding, price gouging, breaking a blockade, etc.

Another way of taking over a space station might be to contaminate or poison the station's food supply and make it unfit for consumption. In the original Star Trek series "The Trouble with Tribbles", Klingons poisoned the wheat (OK, "quadrotriticale") intended to support a remote outpost in contested space. Given the variety of engineered viruses and plagues available in the far future, a debilitating illness striking at a critical time could give the invaders a quick victory vs a protracted, expensive siege. The Klingon plan may not have been successful, but that does not make it an invalid strategy.

Starships typically do not have to worry as much about the volume of food they consume. Not only do ships have relatively small crews compared to stations, they also typically visit known planets or bases quite regularly. A 2500 ton cruiser with a crew of 100 sophonts, for example, would need less than 1.5 tons of food per week assuming the same nutritional density as planetary food. A small freighter with a crew of 5 could go for more than 3 months on 1 ton of food. Long duration missions into unknown space might be a problem, but normal deployments or trips require minimal space for food storage. A starship uses far more hydrogen fuel than food. Stations and outposts which are continuously manned and located far from home, however, may need rather extensive dedicated agricultural facilities if they are to be self sufficient.

Chapter 7: Personal Combat

Combat Schedule of Events

1) Determine Information. Who knows what, and when is it known? Usually based on a recon check with or without a die modifier, in can include remote sensors such as cameras, motion detectors, or neural activity sensors. If two groups discover each other at essentially the same time assume no advantage for anyone.

2) Determine Surprise. If one group is aware of another group and can communicate with the rest of their cohort, they may plot a surprise action. The group with information then decides on a plan and the referee decides how likely it is to succeed to give it a die modifier for a tactics check. The individual in the group with the highest tactics skill then makes a single tactics roll taking into account the referee's modifier. The effect of that roll is then applied to the entire group. The effect does 2 things: first, it is added to the initiative roll for everyone in the group; secondly, each character may (but does not have to) use the time to do one or more of several things: 1) make one movement before the enemy can react (ie. charge into battle); 2) add +1 per effect to the chance of a successful initial hit; or 3) add +2 per effect to the damage done on an initial hit. Note that a tactics roll due to surprise can also subtract from initiative- a bad tactical move that warns the enemy is never a good thing. The extra activity takes place regardless of the effectiveness of the tactics roll.

Combat Begins. Free actions may be taken any time after surprise actions are resolved. A surprised guard killed with a single aimed shot cannot shout a warning.

3) Initiatives (2d6) are rolled for each combatant and Dexterity or Agility is added to give the combat segment in which they are scheduled to act. Note that a low initiative roll with low Dexterity or delays due to recoil or reactions can result in an initiative below 1 and thus delayed into the next combat round.

4) Highest initiative acts first. Actions occurring in the same segment are simultaneous, so humans dueling with laser pistols could kill each other on their first shots. Most sophonts may take 1 significant and 1 minor action during their turn, or they may take 3 minor actions. Certain alien species are able to multitask better than humans and may take either 2 significant actions or 1 significant and 2 minor actions on their turn.

5) Move on to the next segment in the round. Certain actions or reactions may change initiatives, so the order of actions may change over the course of the combat. A character may skip an action in one segment to act first in the next segment.

Combat Range Bands

Distance from the enemy makes a big difference- it's not a good idea to bring a knife to a gunfight. How far away the enemy is limits their ability to act. The combat range band table covers essentially any distance necessary to deal with personal or vehicular combat.

Weapon systems are designed to work against targets at particular distances from the enemy. A 155mm cannon is not a good weapon against a bayonet wielder next to the crew. The closer a target is to the weapon's optimal firing range the easier they are to hit. The attack difficulty table below cross references different weapon ranges

Combat Range Band Table

range	distance
personal	to 1.5m
close	1.5 to 3m
short	3 to 12m
medium	12 to 50m
long	51 to 250m
very long	250 to 500 m
distant	0.5 to 5 km
very distant	5 to 50 km
extreme	50 to 500 km
continental	500-5000 km

with combat ranges. The same range bands are designed to cover both personal and vehicular combat. It is only an average difficulty attack (+0 DM) to shoot someone with a pistol at close range, but it is difficult (-2 DM) to do so with a rifle. It is generally a good idea to keep range information on a character's sheet next to weapons to facilitate combats.

Attack Difficulties by Weapon Type

Weapon	Personal	Close	Short	Medium	Long	Very Long	Distant	Very Distant	Extreme	Continental
close quarters	avg	diff	--	--	--	--	--	--	--	--
extended reach	diff	avg	--	--	--	--	--	--	--	--
thrown	--	avg	diff	diff	--	--	--	--	--	--
pistol	diff	avg	avg	diff	v diff	--	--	--	--	--
rifle	v diff	diff	avg	avg	avg	diff	v diff	--	--	--
shotgun	diff	avg	avg	diff	v diff	--	--	--	--	--
assault weapon	diff	avg	avg	avg	diff	v diff	form	--	--	--
catapult				v diff	avg	diff				
rocket	--	--	v diff	diff	avg	diff	v diff	--	--	--
very long	--	--	v diff	diff	avg	avg	diff	v diff	--	--
distant	--	--	--	--	v diff	diff	avg	diff	--	--
very distant	--	--	--	--	form	diff	avg	avg	v diff	--
extreme	--	--	--	--	--	form	dif	avg	diff	--
ICBM	--	--	--	--	--	--	v diff	diff	avg	diff

Character Actions

The personal combat system relies upon a series of actions taken by individuals. A **free action** takes place in the segment it is stated and may be used freely without changing a character's initiative. A **minor action** is typically something that is not applied to another individual but may aid in a future action. Aiming is a good example of a minor action. **Significant actions** directly affect another individual, so applying first aid or making an attack is a significant action. A **reaction** is taken in response to an action by another individual. The reaction takes place immediately but subtracts 2 from a character's initiative for the next round. Dodging or parrying would be examples of reactions. Every reaction a character uses also gives a -1 DM penalty to all future actions until a significant action or recovery minor action is taken. Finally some activities will take more than a single significant action and are considered **extended actions**. Each type of action (free, minor, reaction, significant, or extended) is described in more detail below.

Free Actions

These are the simplest, quickest of things. Shouting a brief warning, pushing a button, checking a mirror while driving, or peeking around a corner are examples of free actions. Free actions should always be simple enough never to require a skill check- anything else is at least a minor action. Holding action is a free action and may be ended at any time. This can allow a character to react to opponent actions without a penalty.

Minor Actions

Minor actions during a combat are usually taken by an individual without directly affecting someone else. They may require a skill check but it is not essential. A recon check to keep track of a subject during a street brawl, for example, is a minor action. Reloading a weapon or changing positions would be examples of minor actions which do not require skill checks but still take time. A variety of minor actions are listed in the table below, but players will invent many more things they wish to do as quickly as possible.

Minor Actions Table

Fighting	Driving	Other
reloading a weapon	normal controlled driving	calling in an artillery strike
changing position, like standing up	activating a targeting system	using a densitometer
aiming a shot	recon check to follow a vehicle	operating a keypad
recon check to spot a sniper	control vehicle after being hit	clearing a reaction penalty
making a feint when in melee	making a blind turn	moving to a very nearby position
changing weapons	reading a map	checking a sensor screen
blind fire with a gun	turning smoke on or off	applying a drug during combat

Blind fire with a weapon is extremely wasteful of ammo and is unlikely to hit very much, but it is commonly used to distract the enemy's attention while something else significant is happening. Blind fire receives a -3 DM penalty to hit and no dexterity or aiming bonuses are possible. Damage is done as normal. Only 1 chance to do damage is allowed per combat round and three times as much ammo is consumed. Blind fire can cause an enemy to react and take penalties to their future actions as they only know that they are taking fire- not that the fire is random. Blind fire may not be combined with any other significant attack by that individual.

Aiming a shot gives a +1 DM to hit or +2 to damage against a particular target. The target must be stated in advance; taking a reaction or firing at a different target eliminates all benefits from aiming. Up to 6 sequential aiming minor actions may be taken in order to maximize the chance to hit, damage done, or combination of both (although the damage increase is limited to +6). Snipers specialize in aiming. Note that even a weapon with low damage dice can cause serious injuries if aimed for long enough.

A **feint** in combat is used when in melee combat with another individual. It looks like a real attack, but the attacker pulls back before actually striking or otherwise engaging the enemy in melee. The goal of a feint is to force the opponent to take a reaction against the attack and hopefully allow a real attack (occurring 3 segments later) to be unopposed or more likely to succeed due to their reaction penalty. Feinting works most effectively when 2 or more individuals are fighting a single opponent who can't defend against all of the possible attacks.

In combat, several positions are possible which give various benefits during a fight. Standing is the assumed position and gives no penalties or benefits. Crouching halves the movement rate but gives a -1 DM to being hit at medium or greater range. Lying prone gives a -2 to being hit at medium or greater range but movement is delayed and anyone entering melee combat against a prone opponent has a +2 DM to hit.

Reactions

Reactions are taken in response to an action taken by someone else. These may occur at any time during a round, even if someone has just completed a significant action. Reactions typically attempt to avoid a potential result caused by someone else. Dodging a bullet, avoiding a collision, or closing a blast door might be possible reactions in different circumstances. Successfully reacting to an attack can be the difference between life and death in a particularly lethal system like the Cluster Variant rules.

When an individual takes a reaction, their initiative decreases by 2 for the next round and they have a -1 DM on all actions they take until after they complete a significant action or a recovery minor action. For example, imagine a character fires a laser pistol at a smuggler and misses. The smuggler throws a grenade at the character and the character dodges. The grenade misses, but now the character is at -1 DM on their next significant action which is delayed by 2 segments. After the character fires at -1 DM, hit or miss, the -1 DM penalty is gone.

A recovery minor action may be taken to clear one reaction penalty a character has accumulated. Going back to the previous example, two smuggler's crewmates have shown up and each is firing an autorifle at the character after the grenade. The character dodges both of them and the smuggler's pistol shot, but now has a -3 DM and a -6 initiative on their next action. The character may take a minor action to remove one penalty or, realizing that they are outnumbered, take off running around the corner. The significant move action resets the reaction penalty and unless there is a serious obstacle to the movement (maybe a locked gate) there is no skill check so the penalty is gone after the move action.

Dodging is a reaction taken in response to an attack directed against an individual. It gives the attacker a -1 DM penalty to hit in most circumstances, or a -2 DM penalty if there are obstacles that a sophont can use for cover. The obstacle must be able to deflect the attack to make dodging more effective. Ducking behind a wooden crate to avoid a PGMP blast is not effective cover, but would be effective against an autopistol.

Parrying is a way to avoid damage in melee combat. The character parrying rolls a melee attack against their attacker, and any positive effect of the parry is applied as a negative DM against the attacker to hit the parrying character. Unarmed characters may still parry, but have a -2DM penalty as it is harder to block an attack without risking injury. Shields allow a normal parry option. Aliens with multiple significant actions or characters being attacked by two (or more) foes must parry each attack separately using different reactions and increase their reaction penalty each time.

Significant Actions

Significant actions during combat almost always require a skill check of some sort. The most common significant action is firing a weapon, but actions such as applying first aid, unjamming a weapon, or performing a leadership action are also significant. Significant actions take substantially longer than a minor action and require more concentration to accomplish. The significant action does not have to be declared until the initiative segment in which it will take place, so a character can choose to shoot at an enemy that may have only just made an appearance.

The most common significant action during combat is an attack. The attacker declares a target and the target then has the opportunity to react. Depending upon the weapon and difficulty level, the attacker makes a skill check. If the skill check is higher than the difficulty, the attack succeeds and damage is dealt, otherwise the attack fails. There are 3 different types of attacks:

- Melee Attack= 2d6 + melee skill + Str or Dex modifier + all other modifiers
- Shooting Attack= 2d6 + gun combat skill + Dex modifier + all other modifiers

- Thrown Attack= 2d6 + athletics skill + Dex modifier + all other modifiers

Damage from the attack is determined by the weapon plus the effect score of the attack, and is reduced by the armor of the target, then changed by other modifiers such as aiming. Melee and Thrown attacks which depend upon the momentum of the weapon for damage also add their Str modifier to the damage done. Excellent hits (those with a +6 effect or better) do at least 1 point of damage regardless of the amount of armor present. A club might not be able to penetrate combat armor, but a whack to the head can still have some effect.

Several situations can modify the length of time between significant actions. Recoil for firearms or heft for melee weapons are probably the most common initiative modifiers during combat. Some weapons such as a broadsword are naturally unwieldy compared to small weapons such as a stiletto. A character's Str modifier may increase or decrease a heft or recoil modifier. The strength modifier is only applied to cancel out the heft or recoil effect: a high strength will allow a sophont to fire a heavy gun without a penalty but not allow them to fire earlier in the next round. Weapons with a negative recoil or heft may be fired more quickly (unless canceled out by having low strength), but only to the limit of the given modifier.

Coup-de-Grace

A coup-de-grace is a significant combat action where an individual finishes off a fallen or helpless opponent at close range or shorter. In a coup-de-grace, the helpless character is automatically hit and dies. For the mental balance of the players, referees are encouraged NOT to use this option against players. It is particularly useful against robots, however, as they may fall due to lost stability but may become active again in the not too distant future.

Hurrying

In combat situations time is of the essence. After someone completes a significant action, an individual may declare that they are going to hurry their next action. For every segment of initiative they gain by hurrying, their next significant or extended action will have a -1 DM penalty attached to it with a maximum hurry penalty of -4 DM. This penalty exists until after they complete their next significant or extended action.

Leadership Action

I know of no single formula for success. But over the years I have observed that some attributes of leadership are universal and are often about finding ways of encouraging people to combine their efforts, their talents, their insights, their enthusiasm and their inspiration to work together.

Queen Elizabeth II

The leadership skill is used during personal combat to help direct others and can speed their actions during combat. Leadership actions require communication between the leader and the person being led and may only be applied at medium or longer ranges. Leadership doesn't help when the enemy is up close and personal. The individual using the leadership skill makes a skill check (usually 8, but may be modified by the referee) and increases the initiative of their team by the effect of the roll. Initiative may be increased to the current segment but not earlier- leadership is not a time machine. Note that poor leadership will confuse and slow down another's actions so it can also be a bad thing. A sophont is under no obligation to listen to leadership, but whether or not they choose to listen must be stated before the result of the leadership roll is known.

A good example of leadership would be a soldier acting as a spotter for a sniper. The spotter can use their recon skill to find a target and use leadership to direct the fire toward that target as quickly as possible. Another example might be a tank commander ordering a driver in a particular direction or to avoid a minefield ahead. A person may only apply one leadership roll to their initiative in any given combat period, but a leader may lead any number of followers with whom they communicate. The specifics of how leadership is applied to

an individual are a bit arbitrary, but the more effective use of available time due to active instruction is a key outcome of having good leadership. Leadership also allows those without combat skills to participate effectively in combat. It may be considered as a sort of task chain for combat.

Grappling

Wrestling, judo, or other forms of unarmed combat are all resolved using the natural weapons skill. Both the attacker and defender roll 2d6+ natural weapons skill + Str modifier + 2x size damage modifier (see below). Highest combined check wins. The winner chooses what they wish to do to their opponent, which may include:

- continuing the grapple
- disarm the losing opponent. If successful by 6 or more the victor takes the weapon.
- drag the loser 3 meters in whatever direction the winner chooses
- escape the grapple and move away from the loser as a normal move action
- cause 2 + effect damage to the loser
- knock the opponent prone
- throw the opponent to the ground and inflict 1d6 damage

Natural Weapons

Some alien species have natural weapons which are far more effective than human hands and feet for causing damage. Unarmed combat for these species is treated like a normal attack but have bonus damage associated with their weapon(s) added. Thus while a human unarmed strike does 1d6 damage, an alien with claws might do 2d6 damage with the same attack. Either Str or Dex may be used to increase their attack roll and a successful hit does the indicated amount of damage plus the effect of their attack roll. Most aliens with natural weapons will have at least a 0 in their unarmed combat skill.

Size in combat is also going to affect the use of natural weapons in combat. Tiny or small creatures are harder to hit, and therefore any attack aimed at them has a -1 DM. Further, because their arms are shorter any melee weapons they can use must also be shorter. Their extended reach weapons only reach as far as a normal human sized character's normal reach. Normal reach weapons strike before weapons used by small creatures. Smaller sophonts also do less damage than a normal person in combat. Both do a minimum of 1 point of damage (which may still be blocked by armor). If tiny or small creatures have natural weapons, they do their base damage +1d6 additional damage.

Large or huge races have exactly the opposite situation. Due to their size, they are easier to hit; any attack directed against them has a +1 DM to hit. Their reach, however, is much longer than a normal humans and they are already considered to have extended reach. An extended reach weapon used by a large or huge sophont strikes before an extended reach normal size weapon. They also cause more damage whenever they hit with a natural weapon, which can be increased even further if they have weapons such as claws or a thrasher.

Size	Str	Dex	End	base height cm	height mod	base weight kg	weight mod	# per stateroom	base damage	reach
tiny	1d6	3d6	1d6	28+2d6	2d6	5+2d6	1d6	6	1	0.5 m
small	2d6-2	2d6+2	2d6-2	45+10d6	4d6	6+6d6	3d6	4	1d6-2	1 m
average	2d6	2d6	2d6	90+16d6	6d6	30+16d6	6d6	2	1d6	1.5 m
large	2d6+2	2d6-2	2d6+2	170+20d6	8d6	105+30d6	10d6	1	1d6+2	3 m
huge	3d6	1d6	3d6	270+20d6	10d6	260+40d6	15d6	0.5	2d6	4.5 m

Automatic Weapons

Some weapons have an optional high rate of fire which can release many projectiles quickly but will burn through the ammo supply in short order. When firing single shots the weapon behaves normally and reduces the recoil by 1 (but no lower than 0). Burst fire is when a number of slugs are fired at a single individual up to the auto rating of the weapon. The attack is carried out with no additional attack modifiers but 1 point of extra damage per die per 4 auto rating is done on a successful hit. When fully automatic fire is used, the weapon sprays out projectiles in an area around the target using three times the number of slugs and increasing recoil by +2. The shooter may either add +1 DM to hit a single target per 4 auto rating OR have a normal chance to hit an additional nearby target per 4 auto rating. High auto ratings can allow many enemies to fall in the same segment, but the increased recoil delays firing the weapon next round.

Extended Actions

Some activities take more time to complete than a significant action in combat allows. For these tasks, they may take any number of rounds determined by the referee. A sophont working on an extended task needs to stay concentrated or lose the thread of what they are doing. Any interruption increases the time required to complete a task by 10x the length of the interruption, with a maximum penalty of resetting to zero. For example, an engineer might be trying to quickly fix a damaged jump drive while a boarding party is trying to kill her. She's already pushing to get the job done in 1-6 minutes instead of 1-6 hours but now has to contend with being shot at as well. She uses a reaction to dodge a bullet, and that 2 second interruption (reaction penalty) causes 20 seconds of lost time fixing the engine AND a -1 DM to her engineering roll to fix the engine.

Damage

Damage is caused by many factors. Weapon hits and explosions cause injuries starting with Endurance and progressing through the other physical characteristics Strength and Dexterity. Characters may also be injured by falls (depending upon the gravity of the planet or ship), exposure to heat, cold, or vacuum, poisons, diseases, psionics... the list goes on. Most damage is taken from the physical characteristics, but there are a few drugs or special weapons that target Int, Edu or Psi as well.

> The object of war is not to die for your country but to make the other bastard die for his.
>
> *George S. Paton*

If the damage done is greater than zero after accounting for armor, the target was **injured**. Damage is initially applied to Endurance, but after the first attack the target chooses which physical characteristic is affected by the damage. When all 3 physical characteristics are reduced or any single characteristic is reduced to zero, the target, is knocked down and is **wounded**. Wounded individuals have a -1 DM to all activities due to pain and physical impairment. If a second characteristic is reduced to 0, the remaining damage must be taken from the last characteristic, they must make an immediate endurance check to see if they fall unconscious, and they are considered **seriously wounded**. Seriously wounded characters are very impaired and require substantial medical care to heal. They have -3 DM to all activities and should retire from combat if at all possible. Every 10 minutes seriously wounded players must make an Easy Endurance roll to be conscious (don't forget the -3 penalty for all actions!) for the next 10 minutes. Note that people may fall in and out of consciousness when they are seriously wounded. Attacks which bring all 3 physical characteristics to zero die.

Many players and referees do not like to lose a character who has been developed over many sessions of play. Clearly the referee has the final say in how 'deaths' in the campaign should be handled or whether some other penalty is sufficient. There should be a significant penalty associated with near death, however, particularly if the player acted stupidly. The referee may decide that the PGMP blast which should have killed the character vaporizes an arm or a leg instead. Biologic and cybernetic augments are available in many systems after all, and

a few weeks or months waiting (plus the cost of the augment) may deter them from taking on a superior opponent in the future.

Characters may also be knocked **unconscious** by any of several types of stun weapons. **Stun weapons** are reduced by armor as normal, and any damage that gets through is compared to the current End characteristic. The value (End - stun) is used as a modifier against an Endurance roll. Any result less than 8 causes the character to fall unconscious for 2d6 minutes. Unconsciousness for 2d6 minutes is also caused by mental attacks which bring the Int stat to 0. In addition, every time a characteristic is reduced to 0 a character falls unconscious for 1 round.

Explosions are caused by weapons that do damage to an area and not just an individual. Common battlefield examples include grenades, rockets, and artillery. For these types of weapons, proximity to the source and amount of exposure determines the amount of damage taken. Characters dodging an explosion reduce the damage by 2d (or 1.5m distance). If a character dives for cover they may reduce the damage by 1/2 with a successful dodge roll but will incur a changing position initiative penalty of -3 along with their reaction penalty of -2. If they wish to do something that cannot be done while prone, they will have to use another minor action to change position again (or take another -2 initiative reaction).

Healing

Healing depends upon the severity of the injury and when medical attention is applied. More seriously wounded or unconscious characters are harder to heal than minor injuries.

Natural healing replaces d6+ End modifier points per day of full rest. Normal physical activity allows only 1+ End modifier points of physical damage to be healed. Note that a character who has few End points left may actually lose points if they rely on natural healing. Some races have special healing abilities that greatly exceed the norm and a few can even replace lost limbs given time. Mental characteristics may also heal but heal at a standard 1 point per day (or higher if they have special healing abilities due to their race).

First aid given to a recently injured character can quickly replace lost points of damage. If applied within 5 minutes, first aid replaces 3x the effect of a medicine roll (-2 DM if applying first aid to yourself). First aid is less effective if applied after 5 minutes but within 1 hour of taking the injury as it only heals 1x the effect of a medicine roll. First aid is able to take a character from wounded back to unwounded and remove the -1 DM penalty. While first aid may stabilize the characteristics of a sophont who becomes seriously wounded, first aid is NOT able to reduce the -3 DM penalty. Full medical care is required to remove the penalty from a seriously wounded individual.

Medical Care at a hospital or medical bay under a trained sophont (medicine skill 1 or better) also replace characteristic points. This requires nearly full bed rest to be effective and brings back 2+ End modifier + effect based on the doctor's medical skill. This is able to help a wounded character recover even after 1 hour but is not enough to heal a seriously wounded character.

If a character became seriously wounded. the situation is more grave. They may still benefit from first aid, but unless an individual has an improved healing rate they cannot benefit from natural healing or simple medical care. They will require at least one round of surgery to repair the worst of the damage and allow natural healing to begin. Surgery takes 2d6 x 10 minutes and heals 2x effect of a medicine roll. If the effect is negative, the character takes additional damage and cannot heal until a successful surgery is performed. A character must wait at least one day between surgeries. Surgery requires a Sickbay, autodoc, hospital, high-tech medicines, or some other medical center and the patient must have full bed rest to benefit from surgery.

Regenergel is an advanced medicine developed from organisms that naturally regenerate and can heal even seriously wounded sophonts. Unfortunately if it used incorrectly it can cause damage just like an unsuccessful surgery and requires 1 week between applications as the drug depletes a character's metabolic reserves. If an application of regenergel does not bring a patient back from seriously wounded status surgery may still be needed.

When surgery is not an option, characters will often resort to low berths or certain drugs as an alternative. A low berth will put a character into suspended animation until surgery facilities are available, and no time is considered to elapse from entering the low berth. When low berths are not available, 'fast drug' can induce a deep sleep, slowing the metabolism so that 1 day appears to pass over the course of 1 month.

If a character has gengineered augments, all medical care beyond first aid must be provided with equipment and sources at least equal to the tech level of the augment. If equipment of a lower tech level is used, roll a medicine check with a - (TL of patient augment- TL of treatment) DM. A failure will cause an allergic reaction that causes effect points of damage. Worse, once the allergic reaction occurs, all future lower tech treatments will cause 1d6 points of additional damage due to the allergic reaction. Note that this rule is for augmented individuals who gained augments later in life. Gengineered races such as merfolk or other uplifted species that have abilities inherent at birth do not suffer allergic reactions due to low tech levels.

Combat Conditions

Not all combats take place in the middle of an empty field in bright sunlight. There are conditions which can influence almost everyone in a combat. **Darkness** prevents aiming and reduces combat ranges by -2 DM for all non-blind fighting individuals. Those with vibration sense (short range or closer) or night vision (natural or technological) may fight at normal difficulty chances. **Smoke** is often used to obscure targets giving -2 DM on recon or attack rolls and decreasing the effectiveness of laser weapons by scattering the light. If a character is not adjusted to the **local gravity** whether too high or too low, gives a -1 DM penalty for all combat actions. **Bad weather** (wind and rain) may also give -1 DM for ranged attacks, although sensors that penetrate the weather can negate the penalties if properly used.

In space, **zero gravity** provides the most common adverse combat conditions for many people. Zero gravity is an alien environment and all skills are limited to 1 better than the character's zero gravity skill. Characters untrained in a zero-G environment have a -2 DM to all combat actions. Even for skilled characters, however, weapons with recoil are difficult to use in zero gravity and give a -2 DM for all attack rolls. Melee weapons with heft are impossible to use in zero-G.

Cover is any sort of construction or obstacle which is able to obstruct detection or weapons fire. Note that cover may differ based on the opponent: an opponent with IR vision will see a heat signature even behind tall grasses, while a marine with a FGMP will not have any trouble hitting a character hiding behind a fence. Better cover gives more protection from being hit, but a general rule of thumb is if they can't hit you then you can't hit them.

Chases

Every action movie has at least one chase scene, whether it be police running after the villain on catwalks, or two cars careening down conveniently empty streets in the big city. Both speed and agility affect a chase. Faster sophonts will close a distance based on their speed, while a more dexterous or agile individual can avoid obstacles more effectively. Each round players should make an opposed agility roll where the difference determines how much ground is gained or lost depending upon the environment. The faster individual always

moves closer or falls behind as they wish. Catastrophic failure on the agility roll means that individual lost control and has stumbled or crashed into something. A second agility roll is needed to avoid falling or stopping abruptly.

Fatigue

Organic beings cannot function at their highest intensity indefinitely. When a character exceeds their natural limit (End rounds) of continuous fighting, they become fatigued and receive -1 DM on all skills, tasks, or efforts they put forth until they can rest for at least 1d6 minutes. Fatigue may also be caused by various drugs wearing off or longer term efforts. For these deeper types of fatigue it requires 1d6-(End modifier) hours of rest (minimum of 1 hour) in order to regain normal skill levels. Note that injured characters with low End remaining are easily tired and cannot be pushed. If a fatigued individual becomes further fatigued they receive a -3 DM penalty, and if even further fatigued fall unconscious for 2d6 minutes and must rest for 1d6 days to recover normal function. Robots and machines never suffer from fatigue.

Armor

Armor is the material that serves as protection for a person during combat. It may be technological or natural in origin, but it protects vital areas of the character from damage. Most armor does not stack, but organisms that have natural armor (including the subdermal armor augmentation) and wear additional armor add those armor values together. While armor can be quite efficient at blocking most damage, whenever an armored individual is hit by an attack with an effect of +6 or better at least 1 point of damage will penetrate the armor.

Vehicle Combat

Vehicle combat takes place on the same scale as personal combat, with personal weapons being able to damage vehicles and vehicles or vehicular weapons able to harm individuals. Note that because vehicles are larger, military vehicles in particular can mount rather devastating weapons intended to take out other heavily armed vehicles. Individuals without a tank of their own should avoid facing military vehicle weapons if they wish to live a long life.

Unlike people, vehicles have a difficult time turning around. Vehicles therefore have a facing, and weapons mounted on a vehicle have a limited field of fire depending upon where they are mounted. Vehicles with an autocannon facing left cannot use that autocannon to shoot the vehicle approaching on the right.

Vehicles are considered to move on the driver's initiative. Driving is an active process; the driver must take a minor action every combat round to keep a vehicle under control. In more difficult circumstances where there are a lot of obstacles (off road) or incoming fire the driver is required to make a significant action every round to keep the vehicle under control. Chases use the vehicle agility and the vehicle speed similar to sophont chases.

Because vehicles are larger and less maneuverable than people, any person firing a handheld weapon at a vehicle 1 ton or larger receives a +1 DM to hit due to size. Vehicles 20 tons or larger are shot at with a +2 DM, and vehicles over 500 tons give a +3 DM. Hitting a precise target on a vehicle is possible (such as a tire on a car or window on a ship), but any bonuses due to vehicle size are lost.

Speed Modifier Table

difference (kph)	DM modifier
20-99	-1 DM
100-399	-2 DM
400-1199	-3 DM
1200+	-4 DM

Relative speed differences can make targets harder to hit as well. When targets are moving at different velocities, direct fire unguided weapons must take into account the relative motion which can be challenging. Guided weapons such as missiles do not have this handicap. Use the Speed Modifier Table to identify the DM penalty.

Ground vehicles using contact based drives (legs, wheels and tracks) shift positions when hitting even small obstacles. (Imagine shooting at another car while hitting a speed bump at high speed.) Because of this inherent instability, firing weapons from a moving vehicle has an additional penalty of -1 per 2 speed bands (round up) as well as subtracting terrain modifiers from the attack roll. Tracked vehicles provide a more stable platform and negate 3 points of penalties, and each extra pair of wheels also remove 1 point of firing penalties due to vehicle movement. Note that tracks and extra wheels can only remove penalties and can never provide an attack bonus.

Vehicle Structure and Weapon Facing

Closed vehicles have walls on all sides to protect the vehicle occupants. Civilian vehicles have a less robust structure than military vehicles, so civilian vehicles offer 1/2 cover unless reinforced or having at least 1 point of armor added. Military vehicles offer full hard cover to all occupants. Because civilian vehicles offer less cover, 2 individuals may shoot out from each facing in civilian vehicles while military vehicles allow only 1 person inside to fire out from each facing unless otherwise designed.

Open vehicles do not have sides protecting the occupants. This means that there is no cover in any direction but any individual in the vehicle may fire in any direction.

Weapons mounts on vehicles have a facing and may only fire in that given direction. Smart weapons or guided weapons that are striking at long range or more distant targets do not depend on facing and may be fired in any direction. Weapons in turrets may rotate to fire in several possible directions. Large vehicles, however, may only have a limited number of unrestricted access turrets; other turrets must have a facing.

Vehicular Driving Actions

Because vehicles are not as maneuverable as a person, dodging as a reaction is not available to vehicles. Instead, vehicles may take evasive action if the driver has spent a significant action to **drive evasively**. The driver makes a vehicle driving skill check + vehicle agility and apply the effect of the check against all attacks on the vehicle or its occupants. This must be stated prior to the actual attack.

Maneuvering is a minor driving action which allows it to move safely around large obstacles, stay under control, or to change the vehicle firing arc for 1 target by 1 direction. For example, a maneuver might be to put a target in the front of the vehicle temporarily into the left firing arc.

Ramming is directly piloting a vehicle into someone or something. It is a significant action and is affected by evasive actions (vehicles) or dodging (people). Ramming causes damage to both the vehicle and whatever the vehicle hits, with the smaller object taking more damage. Armor reduces damage caused by ramming.

A **stunt** is a significant driving action which pushes the capabilities of the vehicle or is an attempt to aid another individual as part of a task chain. A stunt might be to skim a powerboat over a low sandbar, for example, or to give a gunner a bonus DM modifier to attack the speeder bike giving chase. The driver makes a driving check + vehicle agility roll, and the effect of the check (good or bad) is applied to the attack roll. Negatives effects depend upon the nature of the stunt and may be catastrophic (ie. crashing into a wall).

Weaving is a significant action taken when driving through an area with may obstacles. It may be racing along a freeway crowded with cars or flying through the partially completed superstructure of a giant space station, but generally involves some risk of collision between the vehicle and something else. The driver makes a skill check based on their skill + agility of the vehicle and compares it to a target number determined by the referee and based on the vehicle's speed and difficulty of the obstacles. Any number greater than the target is a success, a number slightly lower than the target results in a minor collision, and a substantially lower result causes a crash.

Vehicle Damage Table

damage	effect
0 or less	no damage
1-3	single hit
4-6	two single hits
7-9	double hit
10-12	three single hits
13-15	two single, 1 double hit
16-18	two double hits
19-21	triple hit
22-24	single and triple hit
25-27	double and triple hit
28-30	single, double, and triple hit
31-33	two triple hits
per 3 extra	+1 single hit
per 6 extra	+1 double hit

Collisions

When a vehicle fails a driving check it collides with an object. In a minor collision (sideswiping a pedestrian or scraping against an obstacle), the pilot must make a vehicle driving check to maintain control (skill+agility) otherwise suffer a major collision. Minor collisions may include things such as scraped paint, dents, lost antennae, or other peripheral objects attached to the vehicle and the referee may roll a hit on an external portion of the vehicle causing some actual damage.

Major collisions, on the other hand, are severe. For every 20 kph of relative vehicle speed, 1d6 damage is done to each

object in the collision. Unsecured passengers each take full damage from the collision and may be thrown 1.5m from the vehicle per 20 kph; seat belts reduce damage by 75%. Depending upon what was struck (a building, a vehicle moving in the same direction), the referee may require a driving skill check to maintain control of the vehicle if it is still moving. No check is needed for a vehicle which is stopped by the collision.

Vehicle Damage

Vehicles have two values referring to the integrity of the frame holding various parts of the vehicle together. Hull refers to an outer covering that protects internal components while the Structure of the vehicle is the internal supports which hold the rest of the machine together. A vehicle is destroyed when the structure drops to 0. Other parts of the vehicle may be found externally or internally depending upon the nature of the system.

When a vehicle takes damage from any external source, damage is first reduced by any armor on the vehicle. If any damage gets through, consult the Vehicle Damage Table to determine which systems are affected. Note that vehicle hits are more serious than personal damage as most systems take no more than 3 hits before they are completely destroyed. Double or Triple hits do 2 or 3 points of damage to the same system immediately which can quickly disable a vehicle. Each hit must be rolled separately so two single hits require 2 rolls for 1 damage to a system per roll, while a double hit requires 1 roll and does 2 hits to the system struck. Internal explosions from weapons fire or planted bombs will be based on where those explosions take place. Sabotage can be very specific and should not be random compared to external weapon fire.

The system hit on a vehicle is determined by rolling 2d6 on the Vehicle Hit Location table. Most damage will be coming from the outside of a vehicle and so will first be taken from the External Hit chart. Depending on the system hit, if the external system is already gone the damage may become internal damage. Damage that surpasses the internal system goes into structure hits.

Vehicle Hit Location

2d6	External hit	Internal hit
2	hull	structure
3	sensors	power plant
4	drive	power plant
5	weapon	hold
6	hull	hold
7	armor	crew
8	hull	structure
9	weapon	hold
10	drive	computer
11	sensors	crew
12	hull	cockpit/bridge

Hull hits reduce the vehicle structure by 1. If the vehicle runs out of hull, move to the internal hit column on the same row.

Structure hits each reduce the vehicle structure by 1. If a vehicle structure goes to 0 it is destroyed and if the structure goes negative the vehicle explodes. Exploding causes 4d6 damage to all passengers and 2d6 damage to everyone outside the vehicle within 12 meters. Passengers in open vehicles may dive for cover to reduce the damage; people in a closed vehicle take full damage.

Drives take 3 hits to be destroyed. On the first hit, the maximum vehicle move is reduced by 10% and all vehicle control checks are at -1 DM. On the second hit, the movement is reduced by 25% and all vehicle control checks are at -2 DM. Further drive hits count as hull (then structure) hits.

Weapons take 2 hits to be destroyed. On the first hit the weapon has a -2 DM for all operations and is destroyed on a second hit.

Sensors take 2 hits to be destroyed. On the first hit the vehicle suffers -2 DM to all comm and recon checks (or any other operation) using the system. On the second hit the sensors are destroyed and the vehicle is blinded unless alternative sensors are present.

Power plants take 3 hits to be destroyed. The first hit reduces the maximum power output by 1 (with a minimum of 1) and degrades the maximum speed or weapons capability appropriately. The second hit reduces the maximum speed and power output to 50% (disabling energy weapons fire if power level 1 or 1/2), and the third hit not only disables the vehicle but causes 1d6 hull hits as well (transfers to structure).

Crew hits cause full damage from the initial roll to d6 passengers or crew. If it is a cyborg, robotic or drone vehicle, 1 hit gives -1 to all vehicle rolls and injures 1d6 organic brains, a second hit gives -3 DM to all vehicle rolls and kills half of the organic brains (round down), and a 3rd hit disables the vehicle and kills all of the organic brains aboard. Excess crew hits become structure hits.

Hold hits destroy non-combat related systems on the vehicle, whatever they may be. This is a broad category of items from scientific equipment to airlocks to hangars. GM should choose the effect(s) based on the items present.

Cockpit/Bridge hits cause a crew hit as above and gives a -1to vehicle control rolls. A second hit gives a -3DM for vehicle control rolls, and a 3rd hit makes the vehicle uncontrolled.

Computers take 2 hits to destroy. The first hit disables the computer system and causes it to enter a recycle loop for 1d6 rounds and reboot. Robot or drone vehicles are disabled for this length of time. A second hit will destroy the computer and will completely disable a drone or vehicle AI.

Pressurized Vehicle Hits

Pressurized Vehicle Table

# hits	result
1	self-sealing (no affect)
2-3	minor breach
4	serious breach
5+	catastrophic breach

In addition to the normal damage, pressurized or sealed vehicles may become breached when damage penetrates the armor. Vessels that float on water are considered pressurized if hit at or below the waterline; ie. superstructure hits on a frigate will not cause a breach, but hits on the bow will. The referee will decide where a hit has taken place based on chance and the method of attack; ie. torpedoes will not hit the superstructure. If a vehicle is hit, count up the total number of hits done to the vehicle, then compare those hits to the Pressurized Vehicle Table. A self sealing hull doubles the number of hits required to reach a particular damage level.

A **minor breach** causes a small leak in containment and allows some water into a compartment or some air to escape. it may be sealed using a small adhesive patch and may be repaired later and has no affect on the handling of the vehicle. A **serious breach** causes substantial turbulence as air is sucked out or a large amount of water to flow in. It requires a solidfoam plug or large patch that must be stabilized to block the leak, and causes a -1 DM agility modifier which is not cumulative. It will not cause a complete failure unless ignored for several hours. A **catastrophic breach** is a massive hole and cannot be repaired while underway- a vehicle requires an equal pressure environment (hangar or dry dock) for repairs. Vehicles that can seal off pressure doors must do so to prevent complete flooding or depressurization. A vehicle must do everything possible to equalize the pressure or the vessel is at risk of complete loss; a jet must descend to lower altitude, a submarine must surface, etc. A cumulative -2 DM agility modifier is applied until at least temporary repairs are made. Even after

the worst of the damage is localized, the vehicle has a cumulative -1 DM agility modifier until full repairs are made for each catastrophic breach suffered.

Large vessels such as warships may have armored bulkheads which reduce the effect of breaches by confining their effects. Each 100 tons of vehicle allows the vessel to absorb one more serious breach. Note that this still requires significant efforts to control the leaking. Ships which do not or cannot halt the leak can still be lost entirely. Large does not mean invulnerable.

Repairs

Damage falls into 3 major categories, structure, hull, and system damage.

Structure damage is only repaired using a fully stocked workshop and takes 10-60 hours per point to repair. It costs 20% of the base vehicle chassis cost per point to repair where the base cost includes environmental seals. This consumes 1 space of spare parts.

Hull damage may be repaired with a successful mechanic or vehicle engineer check at 1d6 hours per point. It takes 1 space of spare parts per attempt.

Repairing system damage depends upon how badly the system was hit. Systems damaged but not destroyed may be temporarily jury-rigged to function using a successful mechanics or otherwise appropriate skill roll with only 10-60 seconds of work. It will fail again in 1-6 hours, though. To fully repair a damaged system, a successful skill check with a workshop, 1d6 hours of effort, and spare parts must be available. Spare parts may come from stores, a scrapyard, or even components from other vehicles or other vehicle systems (other than cockpit or passenger regions).

A system which is destroyed requires either a replacement system which may be purchased directly and installed in 1d6 hours in an easy mechanics or other skill check. A destroyed system may be fixed by spending 2d6x10% of the cost of the system and a successful difficult mechanic or other skill check. A failure here with effect of -6 or worse completely ruins the system so that it MUST be replaced. The spare parts are consumed whether or not a repair check succeeds.

Fighting Spaceships

Spacecraft and starships are built on a different scale than planetary vehicles. Spacecraft are tougher and weapon systems have substantially more power available to them. To convert vehicle scale damage to spacecraft scale, divide by 12 dice. Vehicle weapons must do at least 8 dice of damage to even scratch the surface of spacecraft and will do only 1d6-1 points of damage. For every +4 dice above 12, give a +1 damage or another full die for 12 dice. Thus a TL-15 FGMP, the nastiest personal scale marine weapon available, does a bit more damage than a beam laser found on many barely spaceworthy tramp freighters.

Fighting spacecraft using vehicle or personal scale weaponry is hard, but it should not be impossible. Missiles designed to take out spacecraft are less than 100 kg total weight and if even non-nuclear missiles were super deadly every ground vehicle would mount those instead of other weaponry. A conversion factor of 12 vehicle dice per 1 starship die still makes starship scale weapons insanely powerful. A low end TL7 pulse laser, for example, does 24 dice of vehicular damage that is equivalent to a 400mm (16 inch) shell from a World War II battleship. It only makes sense for high end military vehicle weapons to be able to hurt transports and other weakly armored targets.

Chapter 8: Space Combat

Space combat is a staple in classic science fiction, and the 2d6 Cluster Variant has rules to cover it. This chapter details the basics for space combat. These rules for vehicle and starship combat presented here are designed to allow for more roleplaying and involvement of the characters as opposed to ship systems vs ship systems. Movement and maneuvering are abstracted to allow for cinematic battles as vessels attempt to maneuver into a position of pursuit and advantage against their opponents, or frantically try to shake pursuit. Range is similarly abstracted, needing only to note whether the range for all vessels involved for each round is Close, Short, Medium, Long, Very Long, or Extreme. Other systems, particularly wargames, can provide more realistic ship on ship battles without individual characters making a difference.

Space Combat Checklist

Space combat in the 2d6 Cluster Variant is cyclical. Everybody acts in turn in a regular cycle called a turn. Each turn in space combat lasts one kilosecond giving individuals plenty of time to carry out somewhat complicated activities such as repairing damage or breaking into the enemy's communications. Generally, space combat runs in the following way:

1. The Referee determines the range at which the encounter begins.
2. All crew members are assigned to a position on board their vessel.
3. The Referee determines which characters are aware of their opponents at the start of the battle. If some but not all vessels are aware of their opponents, the vessels that are aware of their opponents are considered to get an automatic 12 on their initiative roll, giving them an Initiative of 12 + Pilot Dexterity DM.
4. Any remaining vessels roll initiative. All vessels are now ready to begin their first turn of combat.
5. All vessels act in initiative order.

a. At the start of each combat turn, a Captain may declare that their crew is acting hastily.

b. The crew members of the vessel resolve their actions.

c. After every crew member has completed their actions, any damage is resolved if the vessel’s weapon systems hit enemy ships.

6. When every vessel has had a turn, the combatant with the highest initiative total acts again, and Step 5 repeats until combat ends.

Range in Space Combat

If two vessels randomly encounter each other while travelling through the depths of space, far from any other objects or vessels, the encounter will begin at Very Long range. More often, ships engage near a planet, where the range is Short or Medium. Scanning a particular target with a ship's sensors allows one closer range band of information to be determined on a successful Sensors check but the target vessel will notice the scan on a successful sensors check of their own.

Different types of weapons are optimized for combat at different ranges. One common tech upgrade for weapons systems is to improve the average range band of the system. Such improvements should be noted in the ship's description and will override the difficulty table below.

Table: Space Combat Range Bands

Range	Distance	Sensor Details Detected
Adjacent	<1 km	Individual sources of neural activity (Very Advanced sensors only)
Close	1 to 10 km	Individual ship systems, level of neural activity (Very Advanced sensors only)
Short	10 to 1250 km	Fine visual details, individual heat sources, internal structure (Advanced and Very Advanced sensors only), presence of neural activity (Very Advanced sensors only)

Medium	1250- 10,000km	Source of EM emissions, external structure (Advanced and Very Advanced sensors only)
Long	10,000- 25,000km	Ship configuration and shape, thermal activity, external structure (Advanced and Very Advanced sensors only)
Very Long	25,000- 50,000 km	Ship's presence and level of activity, basic object silhouette
Distant	50,000 km+	Object's presence

Table: Space Combat Attack Difficulties by Weapon Type

Weapon	Adjacent	Close	Short	Medium	Long	Very Long	Distant
pulse laser	-2	-2	0	-2	-2	-4	impossible
beam laser	-2	-2	-2	0	-2	-2	-2
particle beam	-4	-2	-2	-2	0	-2	-4
railgun/mass driver	-2	0	-2	-2	-4	impossible	impossible
fusion bay	-2	-2	-2	0	-2	-2	-2
meson bay	-4	-4	-2	-2	0	-2	-2
sandcaster	0	-2	-4	impossible	impossible	impossible	impossible

Crew Positions

At the start of an engagement, all crew must be assigned to a position on board ship. There can be only one pilot, but other than that, any number of people can occupy the same position if the system is available.

Table: Crew Positions

Position	Responsibility
Bay Gunner	Each bay weapon has two gunners.
Captain	Commands the ship, and can use Leadership and Tactics skills.
Marine Officer	Commands marines, and can use Leadership and Tactics skills in boarding actions.
Medic	Provides health care to injured crew during and after battles
Damage Control	A character assigned to free-floating damage control can repair any system.
Engineer	An engineer can be assigned to each of the M-drive and the J-drive.
Marine	Prepares to repel boarders, or to board enemy ships.
Passenger	Passengers are all people aboard ship who are not assigned a position and are assumed to be waiting in staterooms unless otherwise assigned for an emergency.
Pilot	Flies the ship, responsible for changing course and for evasive maneuvers.
Sensors Operator	A character assigned to communications and sensors.
Steward/Purser	Watches over passengers and inventory, assist in damage control
Service Crew	Provides assistance and routine chores for the rest of the ship
Flight Crew	Responsible for launching, recovering, and repairing small craft
Scientist	Collecting research information from instruments and probes to solve problems
Screen Operator	Each screen has 2 operators who coordinate activity
Turret Gunner	Each turret and barbette has its own gunner. A character must choose which turret he is manning at the start of the combat.

Automated Positions

The ship's computer can cover several positions if it is running the appropriate software:

- Fire Control programs can either act as **gunners** or aid existing gunners.
- A ship equipped with repair drones and Auto-Repair software acts as **damage control**.
- A ship running an Intellect program and Expert Pilot can be the **pilot**.

• A ship equipped with repair drones and running an Intellect program and Expert Engineer can be a **drive engineer.**

Initiative

Each ship in an engagement rolls 2D6 to determine their starting Initiative score. The ship with a greater Thrust score gains a +1 DM to its roll. The Captain of each vessel (or each fleet, if more than one ship is involved on a side) may make a Tactics check. The Effect is added to the Initiative of the vessel (or fleet).

The Space Combat Turn

Each turn in space combat lasts around one kilosecond (1,000 seconds) of game time. In a combat turn, vessels have individual Initiatives. Actions are taken in descending order of Initiative. If two vessels have the same Initiative, the vessel with the highest Thrust goes first. If they are still tied, then vessels act simultaneously. When a vessel acts, the crew members of the vessel take all of their actions at once. Each crew member gets a minor action and a significant action. Once everyone has acted a combat turn is over and a new turn begins. Initiative is not re-rolled but is dynamic, and may be adjusted up and down by actions taken during a turn.

Note on Personal Actions

As a space combat turn represents over 150 personal combat rounds, it stands to reason that crew members may engage in a lot of personal actions over the course of a single combat turn. Much of this is abstracted into the various space combat actions. Most personal actions have minimal impact on space combat. For crew members that do want to pursue a personal action during space combat, such as use a psionic ability, these actions count as minor actions on the space combat scale. This glosses over the remainder of the character's time during the combat turn, and highlights the primary acts that a character might want to pursue without taking away from the rest of the space combat.

Table: Space Combat Action Summary

Description	Type	Crew Member
Change Positions	Minor	Anyone
Personal Action	Minor	Anyone
Reload Weapons System	Significant	Anyone
Miscellaneous	Varies	Anyone
Coordinate Crew	Significant	Captain
Increase Initiative	Significant	Captain
Boarding Action	Significant	Chief Security Officer, Marine
Repair Damaged System	Significant	Damage Control
Fire Sand	Reaction	Gunner
Point Defense	Reaction	Gunner
Trigger Screens	Reaction	Gunner
Attack	Significant	Gunner
Calculate Jump Plot	Significant	Navigator
Range Check	Significant	Navigator
Adjust Speed	Minor	Pilot
Maintain Course	Minor	Pilot
Dodge Incoming Fire	Reaction	Pilot
Avoid Collision	Significant	Pilot
Break Pursuit	Significant	Pilot
Dock With Another Vessel	Significant	Pilot
Evasive Manuevers	Significant	Pilot

Line Up The Shot	Significant	Pilot
Pursuit	Significant	Pilot
Ram	Significant	Pilot
Electronic Warfare	Significant	Sensors Operator
Intercept Enemy Communications	Significant	Sensors Operator
Maintain Communications	Significant	Sensors Operator
Sensor Targeting	Significant	Sensors Operator

Minor Actions

As in personal combat, minor actions are actions intended to perform tasks that do not require significant focus and concentration. Each crew member has one minor action per turn but may take up to three minor actions at the loss of their significant action for that turn. Sophonts with the multitasking ability receive an extra minor action each turn.

Adjust Speed

The pilot may increase or decrease the vessel's speed up to an amount equal to its Thrust. This requires no skill check.

Change Positions

Crew members changes crew positions, and are now considered to be manning their new position rather than their previous one.

Maintain Course

The pilot keeps the vessel on its current course and heading, remaining at the current speed. This requires no skill check.

Personal Action

A crew member may pursue any personal action that generally takes less than two minutes.

Miscellaneous

The Referee may permit a character to perform a skill check or other action as a minor action if the use of the skill does not require the character's full attention or complex physical actions.

Significant Actions

Significant actions are intended to do something within about 10 minutes (600 seconds). You can perform a single significant action per turn, or forego it to perform a total of three minor actions.

Take Minor Actions

A character can take two minor actions instead of a significant action.

Attack

A gunner may attack any target within the range of the weapon system they are manning. The gunner attacks by making a Turret Weapons or Bay Weapons skill check roll at a Difficulty determined by range, adding any Computer Targeting, Sensor Targeting, or other modifiers in effect this round for his vessel. The enemy ship may react by dodging, point defense or triggering screens (see Reactions). A gunner may fire any or all of the weapons in his turret or bay, but once that turret has fired during a combat turn it is unavailable until the next combat turn. If a turret weapon makes an attack roll it may not fire in reaction to missiles or boarding attacks. If the attack is successful it will inflict damage. Damage is resolved after all attacks have been made in a vessel’s

turn. Missiles do not impact in the same round they are launched; their damage is resolved in the combat turn that they impact their target.

Avoid Collision

When a vessel is moving at Short or Close range through a debris field, traffic, an asteroid belt, a planetary ring, or similar situation where there is a reasonable chance of collision with another object, the pilot must make an Avoid Collision check each turn. A collision inflicts 1D6 damage for every point of the vessel's current speed. Missiles traveling through a debris field may also collide, while smart missiles have a +2 DM. A collision will destroy a missile or a torpedo, so these obstacles may be used by a desperate pilot to avoid an incoming attack by placing the ship at additional risk

Table: Collision Avoidance

Situation	Difficulty
Traffic (5 or more vessels within Short range), debris	Average (+0)
Asteroid field, light density	Average (+0)
Asteroid field, average density	Difficult (-2)
Asteroid field, heavy density	Very Difficult (-4)
Significant speed difference between ship and debris	DM -2

Boarding Action

If two ships are Adjacent or docked, then a boarding action can be attempted. If the ships are docked, then the attackers may cross over safely via airlocks. If the ships are merely adjacent, then the attackers must use thruster packs or small craft to cross over. While crossing, the attackers may be attacked with point defense weapons or by firing sand. Once across, boarding actions can be resolved using the personal combat rules or the abstract boarding rules.

Break Pursuit

If a vessel is being pursued (as per the Pursuit action) the pilot may break the pursuit with a successful opposed Pilot skill check against his opponent. Once the pursuit has broken and the pursuing vessel loses all accumulated attack bonuses against that target.

Calculate Jump Plot

The navigator can hastily calculate a Jump Plot as a significant action in space combat. Normally an Easy (+4) Education-based Navigation skill check, hastening it to fit within one space combat turn imposes a DM-1 on the skill check.

Dock with Another Vessel

The pilot must make a successful Average(+0) Pilot check. If the other ship does not wish to be docked with then make opposed Pilot checks; the ship trying to dock suffers a –2 DM. When docked, boarding actions can take place.

Coordinate Crew

The Captain makes an Average(+0) Leadership skill check. The Captain gains a pool of points equal to the Effect of the skill check (minimum of 1), which they can distribute to individual crew members as DMs (granting a +1 DM per point) on skill or ability checks during the combat turn.

Electronic Warfare

A sensors operator may attempt to jam radio communications and sensor locks by making an opposed Intelligence-based Comms check against the Sensors skill of the sensors operator of the opposing vessel.

Electronic warfare can be used to break sensor locks. Alternatively, electronic warfare can be used to attack smart missiles that are targeting the ship. The operator makes a Difficult (–2) Comms check and, if successful, a single attacking smart missile ceases attacking. The sensors operator may continue making checks to disable smart missiles until the skill check is failed, with a cumulative –1 DM each time. Note that the Comms skill is used to jam the enemy while the Sensors skill is used for one's own detection abilities.

Evasive Manuevers

The pilot operates the vessel in an erratic manner in an attempt to avoid being hit by opposing weapons fire. The Pilot makes an Average(+0) Pilot skill. If successful, any attack rolls targeting the pilot's vessel suffer a DM-1 penalty, or DM-2 with an Exceptional Success.

Increase Initiative

The Captain of a vessel may make a Leadership check and increase the Initiative of his vessel by the Effect of the check. This increase only applies for the following turn.

Intercept Enemy Communications

The sensors operator may attempt to intercept enemy communications. This requires a Difficult(-2) Comms skill check. Encryption (if any) must also be broken. Knowledge of enemy intentions can be valuable to a Captain, if they know how to use it. The Captain may make an Easy (+4) Tactics check to gain an advantage from intercepted communications. If successful, the Captain gains knowledge of the enemy's dispositions or intentions. This translates to a one-time DM+4 bonus to any skill check affecting the enemy (e.g. a pilot's attempt to evade a sudden attack, or a gunner's precise shot just as the enemy vessel turns to present a better target.) Of course, the enemy must have communications for them to be intercepted.

Line Up the Shot

A pilot may attempt to aid his gunners by providing a stable firing platform along an optimum attack vector. The pilot makes a Pilot check to aid his gunners, granting a DM+1 on all attacks rolls this turn with a success, or a DM+2 with an Exceptional Success.

Maintain Communications

The sensors operator can establish and maintain communications between allied vessels with a Routine (+2) Sensors skill check. If there is significant interference or a lot of communications going on (e.g. due to bad comm. discipline among a fleet), treat as Considerable Noise (DM-2). Deliberate comms jamming requires a Sensors vs Comms skill check with the jammer. If reliable communications are not established, vessels cannot act in concert, and Tactics skill cannot be applied.

Pursuit

If a pilot makes a successful opposed Pilot skill check against another vessel within Short or Close range travelling at the same speed as the pilot's vessel, the successful pilot has placed his vessel in pursuit of his target maintaining the current range and matching the target ship move for move. Once a pursuit has been established, it must be maintained each turn to take advantage of the position. Maintaining a pursuit is a significant action that does not require a skill check. It is automatically maintained unless the target succeeds at the Break Pursuit action, manages to extend the range between the vessels to Medium or greater, or succeeds in outpacing the speed of the pursuing vessel by 7+ points. For each turn (after the first) that a vessel maintains pursuit of another vessel, it gains a cumulative DM+1 to hit when attacking the vessel being pursued, up to a maximum of DM+4.

Ram
Ramming is a potentially suicidal maneuver in which a pilot intentionally crashes his vessel into the hull of another vessel. This action may only be attempted at Close range, and if the ramming vessel is moving faster than the target. To successfully ram another vessel requires an opposed Pilot skill check between both vessels. A collision inflicts 1D6 damage for every point of difference in speed between the two vessels.

Range Check
The Navigator makes an opposed Navigation skill check with another vessel. The vessel with the highest result may elect to increase, decrease, or maintain the range between the vessels for the round.

Reload Weapons System
A crew member (usually the gunner) may spend the round reloading one spent missile rack, one spent sandcaster or other individual weapon system.

Repair Damaged System
A character on damage control may attempt to repair a damaged system by making an Education-based Mechanics check. If the check is successful, determine how many hits are repaired:

Table: Damage Repair Results

Mechanics Check Effect	Hits Repaired
0	1
1–5	2
6+	3

A ship with repair drones and the Auto-Repair software also makes one or two repair checks on the vessel's turn (unless it is being used to assist other repair attempts). The standard Auto-Repair software makes the check with a +1 DM. These are battlefield repairs only and will break down as soon as the battle is over unless repaired properly.

Sensor Targeting
The sensors operator may attempt to spend the turn providing improved fire control and targeting data to the gunners, hopefully increasing their chances of hitting their targets. The sensors operator should make a Education-based Sensors skill check against the target's Jamming rating, for each vessel that is to targeted. If successful, all gunners on the vessel gain a DM+1 bonus to their attacks this turn, or a DM+2 on an Exceptional Success. When using missiles the initial attack gets this bonus – the individual missile to hit rolls do not benefit directly. Smart missiles are unaffected.

Miscellaneous
A character may make a skill check or do something else as a significant action when such an action requires the character's full attention, concentration, complicated physical actions or some combination thereof. Any skill check with a time interval of 1-6 minutes is simply considered a significant action during space combat.

Reactions
As in Personal Combat, reactions are actions taken immediately in response to the action of another. A ship may react to incoming attacks. The following situations allow reactions:
- Targeted by a beam attack
- Incoming missile or torpedo
- Attempted boarding

Each time a ship reacts to the actions of another ship its initiative is decreased by 1. If a ship's initiative is reduced to zero, the ship has forfeitted its actions for that combat turn and may act at 1 higher initiative than the next highest vessel in the next turn. A ship that constantly reacts to attacks forefeits its initiative and will be unable to initiate actions. Fleet attacks where different enemy ships fire on the same target vessel have an advantage because they can maintain the initiative.

Dodge Incoming Fire

To dodge, the pilot must make a Dex based Pilot check. If successful, the attack suffers a –2 DM.

Fire Sandcaster

Turrets equipped with sandcasters can launch different defensive barrels depending upon the attack. Any given sandcaster makes 1 launch per turn as a reaction, but any given turret may respond only once during a combat turn. The particular loadout of a sandcaster (sand, pebble, or chaff) must be stated in advance and 1, 2, or 3 weapons may be discharged from the same turret at the same time. Changing the load of a sandcaster is a minor action during combat. Any given turret may fire each caster independently or trigger them at the same time as part of 1 reaction. Thus a triple sandcaster might expend 2 barrels of sand to potentially intercept 2d6 laser damage, but then the third caster will not be able to fire until the next combat turn.

Sandcasters may fire sand at incoming beam attacks. Each reaction spent on firing sand allows the gunner to make a Turret Weapons roll. If successful the damage of each beam in the incoming attack is reduced by 1D6. Resolve each beam separately. Each firing of sand costs one canister of sand.

Pebbles may be directed against incoming missiles or boarding parties. If the pebble attack using a turret weapons roll is successful, each target in the boarding party takes 8D6 damage or the missile is destroyed. Attacks against boarders are at -2 DM. Resolve each missile or boarder separately. Each pebble attack uses one canister of pebbles.

Chaff may be used to attempt to confuse missile or torpedo attacks. If a turret weapons roll is successful, the missile or torpedo must make a successful targeting check or explode harmlessly in the chaff. Roll separately for each torpedo or missile. Each chaff attack uses one canister of chaff. Chaff must be used just before the missile or torpedo strikes the ship.

Point Defense

Turret lasers can be used to destroy incoming missiles or torpedoes. The missiles can only be destroyed in the moments before they strike the spacecraft as they are too small and fast-moving to effectively target at greater ranges. The gunner must make a Turret Weapons check against the missile. If successful, the missile is destroyed. A gunner may keep making Turret Weapons checks against missiles until he misses an attack; each attack suffers a cumulative –1 penalty. Attacks may be directed against different incoming missiles. Point defense can also be used to attack incoming boarders in the same way. Targets against individual people are at -2 DM but do 12 personal dice of damage per 1 die of ship damage.

In point defense modes, turrets with more than 1 beam laser are all triggered at once. If a particular laser misses, it may no longer fire that turn even if the missile was destroyed. Thus if a triple laser turret scores 2 hits on one missile it is destroyed, but only those two lasers may fire at another incoming missile at a -1 penalty. Once all lasers have missed missiles, that turret may not fire until the next combat turn.

Screening Vessels
Capital ships often travel with smaller vessels known as screening vessels. One of the primary functions of a screening vessel is to use point defense and sandcasters to shoot down incoming missiles and torpedoes. Any ship may target missiles and torpedoes that are adjacent to the ship whether or not the ship is the actual target of the attack. The screening craft must be prepositioned in between the launching vessel and the target before the missiles reach their target.

Although fighters may be the typical screening vessel in space combat scenarios, any ship may 'screen' any other ship by using point defense and sandcasters against missiles or torpedoes adjacent to the ship. Because fighters are small and fast, they provide more screening firepower per ton than an equivalent spacecraft can mount. Fighters are very commonly used as a screen for large ships or stations due to this firepower/ton advantage.

Trigger Screens
Screens can be activated as long as there are 2 people manning a screen generator and the ship has the required screen type (nuclear against nuclear missiles and fusion guns; meson against meson guns). Screens reduce the damage from the attack by 2D6+the operator's Screens skill. Successfully blocking the attack also reduces the radiation damage by the same amount.

Other Actions
Other types of action can take place during space combat.

Free Actions
Some actions are so fast on the scale of space combat that they do not even qualify as a minor action. A character can perform as many of these free actions as he likes in a turn, although if he performs several the Referee may require him to spend a minor or even a significant action on his various tasks.

Extended Actions
Some skill checks will take longer than a single combat turn to complete. Make a Timing roll for the task and then work out how many 1000 second combat turns it will take to complete. A character engaging in an extended action cannot do anything else but can abandon their action at any time and return to the normal Initiative order. A character who is hit by an attack while undertaking an extended action must make an 8+ roll using the skill in question with a negative DM equal to the amount of damage the attack causes (after armor). Failure indicates that this turn's work does not count towards the completion of the task. Failure by six or more (an Exceptional Failure) ruins the task and the character must start over from the beginning.

Delay
A vessel does not have to act when its turn comes up in the Initiative order. The Captain may decide to act at any later point during the turn, even interrupting another's actions to do so. When he acts, his Initiative is set to the count on which he acted. If the character has not acted by the end of the turn he may choose to act first in the next turn, effectively giving up his actions in the previous turn in exchange for an Initiative advantage. His new Initiative is set to one higher than that of the current first person in the order. When multiple characters are delaying and all wish to act first in the following turn, their Initiatives are all set to the same score and they act in order of Thrust as normal.

Special Considerations
The following are special considerations in space combat.

Missiles and Torpedoes

Unlike beam weapons, which travel at the speed of light and so hit the enemy vessel almost instantly, missile weapons take time to cross the gulf of space. Missiles generally travel at Thrust 10 towards their designated target and their positions can either be tracked as additional craft in the battle or, for the sake of simplicity, they can be assumed to strike after a number of turns dependent on launch range, as shown in the Missile Launch Range table. Missiles cannot be used at Adjacent or Close range as there is not sufficient time for their sensors to lock onto the target vessel.

Table: Missile Launch Range

Range	Turns to Impact
Adjacent	-
Close	-
Short	1
Medium	1
Long	1
Very Long	2
Distant	2

When the missile is launched, the gunner must make a Turret Weapons or Bay Weapons skill check to determine the accuracy of the launch. The effect of the skill check determines the chance that the missile will strike its target when it hits. A target may react to incoming missiles by dodging, jamming (if smart missiles are used) or point defense. This reaction does not take place until the turn the missiles arrive at their destination, so any target response must wait until then.

Table: Missile To-Hit By Skill Check Effect

Turret Weapons/Bay Weapons check	Missile to-hit roll
Failed With Effect –6 or less	11+
Failed With Effect –1 to –5	10+
Succeeded With Effect 0	8+
Succeeded With Effect 1–5	7+
Succeeded With Effect 6+	6+

Smart Missiles

The missile to-hit roll for smart missiles is always 8+ and if they miss they make another attack every turn until they are destroyed with point defense, jammed with ECM, confused by chaff, run out of fuel or otherwise dissuaded.

Planetary Maneuvers

Within close range of a planet, certain planetary maneuvers become possible. Atmospheres scatter energy from particle beam and fusion weapons which reduce the amount of damage they do. Clouds and atmospheric effects that block visible light reduce the amount of damage that lasers do. Meson weapons are not affected by atmospheric conditions at all. Black globes are suicidal to activate in an atmosphere as the gas molecules striking the globe are converted to energy and quickly overwhelm the ship's capacitors causing the ship to explode.

Orbital Insertion: The pilot may attempt to insert the ship into orbit around a planet. If an orbital insertion fails, the ship fails to enter the proper orbit, and the orbit will steadily begin to decay drawing the ship towards the planet's atmosphere in an uncontrolled reentry (see Atmospheric Reentry below). This is a significant action requiring a Routine(+2) Pilot skill check.

Atmospheric Entry: The pilot may attempt to transition the ship out of orbit and into the atmosphere of a planet. This is a significant action with an Average (+0) Pilot skill check, with any applicable DMs from the Atmospheric Entry table. Exotic, Corrosive, or Insidious atmospheres should be treated as Standard unless specified otherwise.

Table: Atmospheric Entry

World Values	DM
World Size 9+	-2
World Size 4 or less	+2
World Atmosphere 1 or less	Auto Success
World Atmosphere 2-5, 14(E)	+2
World Atmosphere 8-9, 13(D)	-2

Special Weapon Rules

Several types of weapons have their own rules.

• **Meson Guns**: Meson guns ignore armor and always roll on the Internal Damage table. Furthermore, they also automatically inflict a radiation crew hit in addition to any other damage. They may be blocked by meson screens.

• **Fusion Guns**: Fusion guns inflict a radiation crew hit in addition to any other damage. The bonus radiation hit suffers a –DM equal to the ship's armor. They may be blocked by nuclear screens.

• **Particle Beams**: Particle beams inflict a radiation crew hit in addition to any other damage. The bonus radiation hit suffers a –DM equal to the ship's armor.

• **Nuclear Missiles**: Nuclear missile hits inflict a radiation crew hit in addition to their normal damage. The bonus radiation hit suffers a –DM equal to the ship's armor. They may be blocked by nuclear screens.

• **Sandcasters**: While the primary purpose of a sandcaster is to block incoming beam attacks, they can also be used as an attack. A sandcaster has a range of Close and inflicts 1 point of damage. This is sufficient to destroy missiles but not torpedoes (also known as heavy missiles) as they have more protection.

• **Rad Shielding**: Rad shielding reduces all radiation hits by 6 points and also reduces Meson, particle beam, and nuclear damage by 6 points. Rad shielding is a passive property of the hull and is effective against any hit.

Damage

Systems can take a variable number of hits before being destroyed, depending on the system in question. A ship can endure one point of Hull damage per fifty tons, rounding down. A ship that runs out of Hull Damage will rapidly be incapacitated. A ship can endure one point of Structure damage per fifty tons, rounding down to a minimum of one. A ship that runs out of Structure breaks up and is completely destroyed.

The effects of damage are determined by subtracting the ship's armor from the damage rolled by the weapon, then consulting the Space Combat Damage table to determine the number of hits inflicted. Then roll on the Space Combat Hit Location table for each hit. Small craft receiving damage use the Small craft column. Vessels of 100 tons or larger use the External Hit (Vessel) column until a ship has suffered enough damage to degrade

its Hull, and then uses the Internal Hit (Vessel) column. A double hit applies two hits to the same location. A triple hit applies three hits to the same location.

Some ships are equipped with backup systems for critical components such as sensors or power plants. Only one of these systems may be active, but the ship is able to switch automatically between them so that the most capable system is active at any given time. Thus if a ship's advanced sensors are damaged (-2 for targeting), its backup military sensors would immediately take over. The operator of the ship may choose which system is active manually if there are conflicting advantages.

Table: Space Combat Damage

Damage	Effect
0 or less	No damage
1–4	Single Hit
5–8	Two Single Hits
9–12	Double Hit
12–16	Three Single Hits
16–20	Two Single Hits, Double Hit
21–24	Two Double Hits
24–28	Triple Hit
29–32	Triple Hit, Single Hit
33–36	Triple Hit, Double Hit
37–40	Triple Hit, Double Hit, Single Hit
41–44	Two Triple Hits

For every extra three points +1 Single Hit
For every extra six points +1 Double Hit

Table: Space Combat Hit Location

2D6	External Hit (Vessel)	Internal Hit (Vessel)	Small Craft
2	Hull	Structure	Hull
3	Sensors	Power Plant	Power Plant
4	M-Drive	J-Drive	Hold
5	Turret	Bay	Fuel
6	Hull	Hold	Hull
7	Armor	Crew	Armor
8	Hull	Structure	Hull
9	Fuel	Hold	Turret
10	M-Drive	J-Drive	M-Drive
11	Sensors	Power Plant	Crew
12	Hull	Bridge	Bridge

Hull

Reduce the ship's Hull by one per hit sustained. If a ship's Hull is 0, then apply the hits to the location in the same row of the Internal Damage column.

Structure
Reduce the ship's Structure by one per hit sustained. If a ship's Structure is reduced to 0, the ship is destroyed.

Armor
Reduce the ship's armor by one per hit sustained. If the ship's armor is already 0, then this counts as a Crew hit.

Turret
A random turret is hit.
First Hit: The turret's tracking mechanism is damaged. It can still be used, but all attacks suffer a –2 DM.
Second Hit: The turret and all weapons in it are disabled.
Third Hit: The turret and all weapons in it are destroyed.
Subsequent Hits: Count as Hull hits.

Bay
A random bay is hit.
First Hit: The bay's targeting mechanism is damaged. It can still be used, but all attacks suffer a –2 DM.
Second Hit: The bay weapon is disabled.
Third Hit: The bay weapon is destroyed.
Subsequent Hits: Count as Structure hits.

J-Drive
The Jump drive is hit.
First Hit: All attempts at Jump suffer a –2 DM to Engineering checks.
Second Hit: The jump drive is disabled.
Third Hit: The jump drive is destroyed.
Subsequent Hits: Count as Structure hits.

M-Drive
The maneuver drive is hit.
First Hit: Reduce the ship's thrust by one.
Second Hit: Reduce the ship's thrust by 50%, rounding down.
Third Hit: The drive is disabled.
Subsequent Hits: Count as Hull hits.

Power Plant
The power plant is hit.
First Hit: Damaged.
Second Hit: The crew suffers a Crew Hit, rolling on the Radiation Damage column.
Third Hit: The Power Plant is destroyed and the ship is disabled.
Subsequent Hits: Count as Structure Hits.

Sensors
The sensors are hit.
First Hit: –2 DM to all Sensors and Comms checks. This affects all jamming and detection rolls.
Second Hit: Sensors are disabled preventing the ship from making any jamming or sensor scans, plus it prevents making attacks on any targets beyond Adjacent range.
Third Hit: Sensors are destroyed. The ship is essentially blind.
Subsequent Hits: Count as Hull hits.

Bridge
The bridge is hit.
First Hit: The crew suffers a Crew Hit, rolling on the Normal Damage column.
Second Hit: The bridge is disabled. Until the bridge is repaired, the ship cannot take any Pilot, Sensor, or Comms actions, it cannot jump, and any attacks suffer a –2 DM.
Third Hit: The bridge is destroyed.
Subsequent Hits: Count as Structure Hits.

Fuel
The fuel is hit. Ships with insufficient fuel are unable to inflate a jump bubble to enter jump space. Ships with small fuel tanks may be incapacitated after a single fuel hit.
First Hit: Causes a minor fuel leak of 1/2 d6 -1 (ie. 0-2) tons of fuel per combat turn including the current turn. Ships with small fuel tanks may be incapacitated by a single fuel hit.
Second Hit: Destroys 1D6x10% of stored fuel.
Third Hit: Destroys fuel tank.
Subsequent Hits: Count as Hold Hits.

Hold
This 'system' includes everything not directly combat related. Components such as laboratories, armories, briefing rooms, etc come under this heading. It does not affect the combat capacity of the vessel, but will significantly change the ship's non-combat functions for later. As ships are quite variable in what constitutes the 'hold', the referee must use their discretion for these hits.
First Hit: Destroys a non-combat system or 4d6 spaces of cargo or hangar capacity.
Second Hit: Destroys a non-combat system or 4d6 spaces of cargo or hangar capacity.
Third Hit: Destroys a non-combat system or 4d6 spaces of cargo or hangar capacity.
Subsequent Hits: Count as Structure Hits.

Crew
Each hit on the crew indicates that one stateroom (or equivalent) has been destroyed and radiation or flying debris has injured one or more crew. Roll 2D6 on the appropriate column on the Crew Damage table.

Table: Crew Damage

Roll	Normal Damage	Radiation Damage
4 or less	Lucky escape – no damage	Lucky escape – no radiation
5–8	One random crew suffers 2D6 damage	One random crew suffers 2D6x10 rads
9–10	One random crew suffers 4D6 damage	One random crew suffers 4D6x10 rads
11	All crew suffer 1D6 damage	Lucky escape – no radiation
12	All crew suffer 2D6 damage	all crew suffer 2D6x10 rads

Scaling Damage: Ship Weapons Against Personal-Scale Targets
Ship weapons are 12x more powerful than personal or vehicle scale weapons. Multiply ship weapon dice by 12 for personal damage so that a 1d6 beam laser does 12d6 personal damage. Divide vehicle or personal scale weapons by 12 when attacking a spacecraft, rounding every 4 dice to one pip. Thus it takes at least 8 dice of personal damage to do 1d6-1 spacecraft damage, while 18d6 personal damage would round to 1d6+1. Because

spacecraft are designed to fight larger scale ships, their weapons receive -2 DM when attacking people or vehicles. Some small craft may mount vehicle scale weapons, negating these penalties.

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