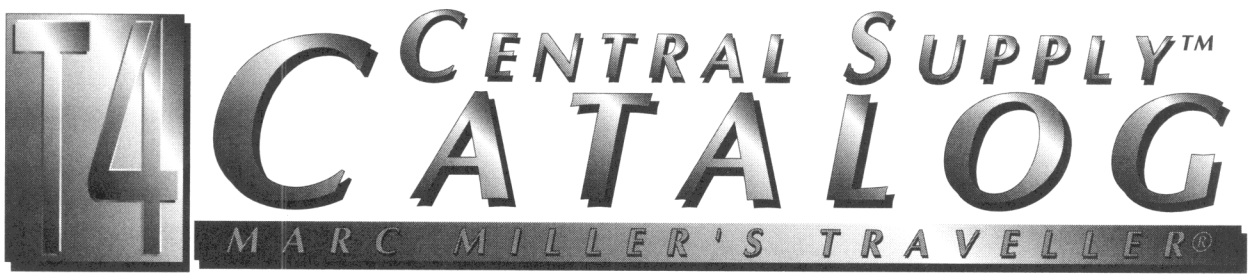
T4 Central Supply™ Catalog

Marc Miller's Traveller®



Science-Fiction Adventure in the Far Future

The Future is Around The Corner

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Thanks to everyone who ever had any equipment published for any incarnation of Traveller

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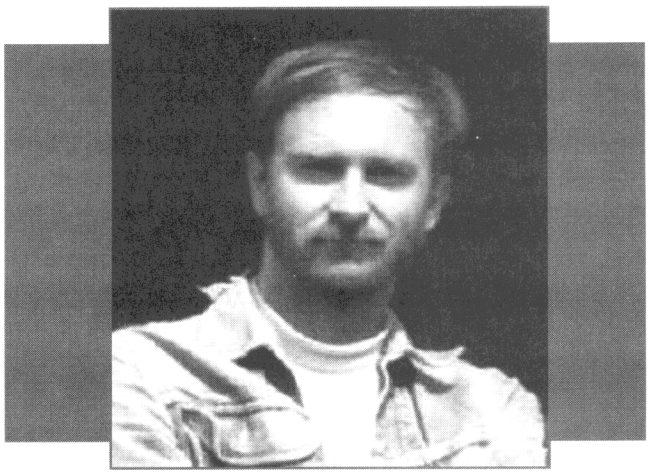

Greg Porter

Greg Porter is the technology editor for Imperium Games. He is the author of this book, as well as the Equipment and Surface Vehicle chapters for the main Traveller rulebook. Some of his previous design credits include the *3G3* weapon design and *More Guns!* sourcebooks, the *TimeLords*, *CORPS* and *Macho Women with Guns* role-playing games, and when not working on Imperium Games projects he runs BTRC games.

He has been a gamer since college, where his interest in the hobby simultaneously expanded his horizons and contributed to 1 point drop in his overall QCA. His frustration with inconsistent games and implausible technobabble eventually led him to design and publish his own systems.

If you still don't recognize him, draw a red headband and yellow horns on the above picture, because that's what he normally wears at game conventions. You can email him **btrc@aol.com**

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INTRODUCTION

Whew! What a chore! Collating virtually every item ever published for Traveller, tossing out some, adding new stuff and formatting it all for the T4 rules set has taken quite a while. But, it's done, and here it is! The Central Supply Catalog is designed for Milieu 0 characters and gamemasters, with a full selection of all the "good stuff", with background and new rules to use them with, plus a hopefully bug-free set of design rules for you to create your own small vehicles. No big secrets, no great revelations, just stuff you can use and how to use it.

Gentlemen/ladies, start your credit cards!

Greetings, Sapient!

This printed guide is an abstract of Imperial Publication 03-8462872, "Guide to Supplies, Consumables and Trade Opportunities in the Imperium". It contains information compiled from over 70 trade and survey expeditions to worlds that have been out of contact with the Imperium for over 1000 years. While each world is unique, certain technological developments have been fairly predictable. This publication lists that subset of items which explorers have found most useful to have for convenience or trade purposes, and those which have been most commonly encountered on other worlds, and which are of note either for economic potential, hazard, or curiosity's sake.

This guide is broken down into the cross-linked sections:

Imperial Surplus
Personal Protective Gear
Exploration Tools
Personal Mobility
Communications
Commercial Goods
Vehicles (plus design tools)

Full specifications, suppliers and case histories for any item can be downloaded via references in this guide for a nominal fee. Mention of an item in this abstract does not imply endorsement by an Imperial agency or any guarantee of performance, either express or implied. All comments by end users are guaranteed to be representative of the majority opinion for the relevant item, but are not guaranteed to be reliable. Individual reference locators are current at the time of download, in case personal contact is desired.

Greg Porter

(In game terms, this abstract is a single sheet of paper that can be downloaded from any general-purpose Sylean news kiosk for the cost of 5Cr. The full specifications and contact list is 50Cr, but purchasers of the abstract get a 5Cr discount.)

IMPERIAL SURPLUS SERVICES

Imperium military bases are less geographically common than Earth's TL8 bases, since the Imperium is a single political entity and only needs a handful of strategically located deployment/storage sites. These are massive complexes, taking up large amounts of real estate, sometimes with areas open to the public such as museums and personnel housing, and access-controlled areas of different levels. Some of the more lightly controlled areas are surplus warehouses, where material no longer deemed suitable for second-line units is kept. Under Cleon I, material that would have otherwise been recycled is being sorted for export under the auspices of the recently created Imperial Surplus Service. Citizens of the Imperium with the proper authorizations or export permits can arrange purchase of large quantities of surplus materiel, which is usually moved from a warehouse to a controlled-access airfield, or for unrestricted goods, may be picked up at the appropriate warehouse. The same procedure is used off-world, and unadvertised trade opportunities may exist in unlikely places, such as deep space sensor arrays, bases on airless moons, orbiting spacedocks, etc.

During any given month, availability for an item will range from a 2D roll of 3– to 5–, depending on how many of the item were originally produced. Missing availability by 1 usually means that the item is available, just somewhere inconvenient for the characters looking for it (at least a week's travel time). A roll of 12 is always failure, and permanently decreases the die roll needed to acquire the item (it's surplus, and will eventually run out).

Most ISS goods (and all other goods in the Central Supply Catalog) will have short names or acronyms, followed almost always by the tech level number of manufacture — it's just an artifact added to make it easier for the GM and players to figure out how old or out of date an item might be.

Individual worlds within the Imperium are self-governing units, and will not adhere to ISS policies, but they too will probably be upgrading equipment and may have surplus opportunities. These would-be valuable trade leads and friendly contacts in the appropriate off-world governments could be extremely lucrative.

Imperial Surplus Notice

All ISS goods are "as is", and no warranty of performance is expressed or implied beyond those listed with the item description. Sales are "as available" and "first come, first served." Buyer is allowed visual inspection of goods before sale, duration and detail of which is determined by depot officer at time of sale. All export and permits must be in order at time of sale, and full payment is due at time of sale. Other specific conditions may apply to sale of specific items, and will be so noted in full description of the item. Imperial Surplus Services reserves the right to alter sale, conditions of sale, base access or availability of any item without prior notice, but due diligence will be made to contact all parties in transit to purchase items, if such transit is made known to ISS at least one standard day in advance.

AGIS-11

Inquiries may be made at ISS depots as to availability of Antigrav Insertion System units for component recycling or export. These may be new or used units, and full inspection is recommended before use. Each unit comes with at least one thermal battery, and replacements may be locally available. Price per unit is 200Cr where available, with extra power units costing 50Cr. Shipping mass is 7.5kg for complete units.

Notice as required by the Disclosure Edict of Year 009:

Use of these chutes by Imperium forces was discontinued in year -11 after an incident in which hostile forces successfully provided false radar signatures that compromised the chute's on-board computer, causing significant activation variance that substantially reduced the effectiveness of the Imperium assault force.

(That is, someone spoofed the on-board radar to force the units to activate so far off the ground that their batteries ran out ahead of time. Oops.)

The AGIS was an experimental contragrav "parachute" designed for low altitude use, minimizing the vulnerable period of a paratrooper's descent. A built-in radar altimeter activates a high-current battery at an altitude of 200m, rapidly decelerating (3-4G's) the wearer of the harness to a safe impact speed by not less than 50m above the ground. The harness is adjustable for most humanoid species, and can handle up to a 300kg load (a control panel allows for adjustment of total mass). Special adaptations and sacrifices were made to get a unit this small, and it was never widely accepted. In particular, its contragrav is power-hungry, and the battery pack only lasts for a about 10 seconds (two combat rounds), so proper activation altitude is a must.

Combat Boot-9

Imperial Surplus Services has a large number of unused combat footwear in a 95-percentile range of human sizes. In addition to the normal durability, ankle support and protection provided (by their flexible armor rating of 1), they have a special sole liner designed to deflect the energies of anti-personnel mines (which counts as a flexible armor rating of 3 vs. this type of specialized attack). These have been superseded by newer models and are available in lots of 1000 pairs, distributed by normal size variation per shipping container. Cost per pair is 40Cr, with a mass of 2kg per pair (40KCr, 2000kg and 2m3 per shipping container).

Field Hospital-10

Imperial Surplus Services has a very limited number of field hospital units for sale. These comprise four electro-stabilized domes, 8 meters in diameter with linking tunnels, fuel cell power supply, environmental positive pressure system and particulate filtering, diagnostic equipment, surgery theater, decontamination showers, chemical toilets, outpatient area, patient ward and 200 patient-days worth of supplies and medicines. Imperial field medical personnel are expected to have such a structure operational with 20 man-hours of work. The field hospital is equipped to work in low pressure or unbreathable atmospheres, but does not have the strength to handle vacuum conditions, nor will it tolerate insidious or corrosive atmospheres.

The full field hospital is designed to fit in a standard drop pallet (shipping volume $5m^3$), or can be broken down into twenty man-portable loads of 50kg each. Cost is 30KCr per unit. ISS recommends replacement of all perishable consumables in these units, and has estimated the cost of doing so at 5KCr. In addition, some of these units have been assembled and disassembled as part of field exercises, and no guarantee is made that all components are in place or in proper working order.

This type of unit is suitable for any surgical task that does not involve reconstructive/regrowth surgery or organ transplants. These latter tasks are technically possible at a field hospital, but will incur negative DM's based on the complexity. Note that the

field hospital does not include cryostasis chambers. If a patient is alive when he gets to the field hospital, he can in all likelihood be stabilized. And if cryostasis is needed, a Medevac team with cryostasis-equipped vehicle can be called. The domes are considered to have an armor of 1, and come equipped with a pair of 25kw fuel cells (50kg each), each consuming about 10kg of refined hydrogen per hour at full output. Normal climate control and lighting requires approximately 20% of capacity.

Field Kitchen-10

Field-tested units for supplying hot meals (and thus morale boost) to long-term field personnel. These units have been rendered obsolete by the FK-11 and FK-12 units, and are available for purchase.

Specifications:

200 meals per hour

2000 meal capacity storage

Where available, these units are for sale at 10KCr each, with an approximate shipping mass of 10,000kg.

While the FK-10 is rated at 200 meals per hour, this is for pre-packaged heat-n-eat meals (glorified TV dinners). Preparation of traditional fare is at half this rate, and storage for raw foodstuffs is half the listed amount. Still, it is an excellent support item for any group requiring a large labor pool for an extended period away from civilization (mercenaries, archaeologists, etc.). On a roll of 9–, any given FK-10 is still self-mobile. Otherwise it will need to be loaded onto transport and repaired elsewhere (usually full maintenance will suffice).

Flex-9

Imperial Surplus Services has a limited quantity of sealed Flex-9 body armor units available to qualified export purchasers. These units cover the torso and shoulders of most humanoids and are available in three sizes for the majority of races that can utilize them. The Flex-9 units provide a flexible armor of 3 to the covered areas, and have a mass of 3kg, plus or minus .5kg depending on size. Rigid chest and back inserts (+1kg mass) upgrade this protection to a rating of 4, at some loss to mobility: –1DM to Endurance and Dexterity tasks without inserts, +1DM to Endurance and +2 to Dexterity tasks with inserts installed.

These units are available in unsorted lots for 50Cr each, or in sorted lots for 75Cr each, with a minimum purchase of 200 units (shipping volume 1m^3). Buyer must complete all export forms, pick up directly from ISS and deliver to bonded orbital warehousing pending transshipment outsystem.

There are mixed reports on these units. Unsorted lots may have some units that are degraded due to integrity loss on hermetic package seals. Effort is made to give even distribution of sizes within unsorted lots, but no guarantee of such is provided.

Hazard Suit-10

Designed to provide temporary protection from insidious atmospheres or chemicals, this is worn over standard helmet and fatigues. A small battery and chemical cartridge combination provides atmosphere filtering and a slight positive pressure within the suit to prevent entry of harmful chemical compounds. External straps adjust the fit of the suit for a variety of body sizes, and the suit includes elbow, knee and foot reinforcement to withstand normal use. The suit was originally rated to provide 24 hours of protection in the filtering mode and 6 hours in a full recirculation mode, and additional filter packs can be added for additional duration. Provision is made for fluid intake and output without compromising suit integrity. Hazard suits mass 4kg each, and are available in lots of 100 in varied condition for 5KCr per lot (shipping volume of 1m^3).

While the hazard suit is not officially rated as such, it can function as a short-term vac suit or underwater life support. However, it will be significantly more encumbersome due to ballooning or bunching, and is prone to catastrophic blowouts if punctured in low-pressure conditions. The hazard suit provides a flexible armor of 1 against cuts or abrasion, but has no other damage protecting properties. The wearer takes an additional –1DM on all tasks due to encumbrance and reduced visibility, increased to -3DM on physical tasks if used in vacuum or underwater.

ICOM-10

The Integrated COMmunications system, Model 10, is currently being phased out of reserve service as the ICOM-12 units

Field Kitchen (stripped)		**Volume**	**Mass**	**Area**	**Cost**
Displacement:	3.0 (USP7)	42.000m3	-	-	-
Volume:		-	-	70.08m2	-
Configuration:	Box				
Dimensions: 5.38m long x 2.80m high x 2.80m wide (approximate)					
Structural material:	Crystaliron				
Chassis: 1g rated		.078m3	.779t	-	2.808KCr
Armor: .3cm TL7	Light alloy				
Armor rating:	Overall rating of 2	.210m3	.630t	-	8.400KCr
Power plant:	TL5 Internal comb., .4Mw	1.000m3	1.000t	1.500m2	8.000KCr
Fuel consumption:	5.0m3 per 100 hours				
Fuel volume:	x1 (high grade hydrocarbons)				
Fuel carried:	20 hours	1.000m3	1.000t	-	500KCr
Propulsion:	TL8 Tracks (x.55), .4Mw	.600m3	.600t	3.600m2	48.000KCr
Adverse condition propulsion (off-road)		.120m3	.120t	.360m2	4.800KCr
Crew: Driver		1.000m3	.100t	-	-
Passenger x 5		5.000m3	.500t	-	-
Options: Kitchen		25.000m3	5.000t	-	12.500KCr
Food storage		6.000m3	3.000t	-	-
Other storage		1.000m3	.500t	-	-
Trailer hitch, up to 20 tons		.200m3	.200t	-	1.000KCr
Total		41.008m3	13.429t	5.460m2	86.008KCr
Performance(loaded):	acceleration .1G, top speed 59m/turn (35kph), maximum range 708km				
(driver only):	acceleration .2G, top speed 84m/turn (50kph), maximum range 1008km				
Agility:	+3DM to be hit				
Description: A mobile field kitchen, able to support a large force for several days off of its internal stores, and able to traverse rough terrain to reach areas inaccessible to wheeled vehicles.					

become front-line equipment and ICOM-11 units are placed in reserve. The ICOM-10 is the standard issue communications package for the modern soldier, and is previously referenced under the TFAC-10 ISS entry. These units differ from the ICOM-11 and 12 units in a lower resolution and battery life, and less subsidiary data channels for targeting information. They are compatible with all Imperium-standard sighting and tactical aids. These units will be available on an irregular basis in lots of 250 for 200Cr each and have a shipping mass of .5kg per unit (shipping volume .2m^3). Some units may be inoperable or out of specs, but all have no more than minor wear or cosmetic damage.

The ICOM-10 effectively acts as a sub-regional range (10km nominal) video communicator with a battery life of about a week of routine use. The battery can be removed and recharged in any vehicle power outlet in several minutes. The ICOM-11 and 12 units may have more advanced features such as inertial referencing, radio triangulation or computer interfaces, but otherwise fill the same role. Unlike a regular civilian Comm which looks only for base station signals to relay to, an ICOM will scan its limited frequency band for any friendly ICOM signal, so it is effectively an open channel for all units on the same scrambler code.

ICOM's will act as a heads-up display for any Imperium electronic sighting aid they are hardwired to by a standard cable. This will allow the user to see through the weapon sight, regardless of their position. This particular function is extremely well-received by Imperium forces, who routinely use it to shoot over walls and around corners without exposing themselves to hostile fire. There is a -3DM penalty to such shots due to the lower resolution and sometimes awkward firing position, but only the hands and weapon are exposed when shooting in this manner, forcing any return fire to become in effect a decreased-damage called shot (–6DM to hit, 1 point of damage per die for wound). Referees might note that this isn't very "heroic," but it is a logical extension of the technology available.

KIA-11

The Kit of Injury Abatement, model 11, is now discontinued. Large numbers of surplus units are available for export only. See your local ISS depot for details. These mass .5kg each and cost 10Cr each in lots of 1000 (shipping volume 1m^3). All units in sealed wrappers are guaranteed sterile. Random sampling shows medicines are still viable, but are past their expiration date and not warranted.

This is your basic military first aid kit. In addition to Bandage, each kit includes an oral spray dose of Fast and Fuzz (to use their generic terms). These spray units have adapters for use on the fluid replenishment ports of vac suits and rebreathers. These drugs are the reason the kits are for export use only, as there is concern they would otherwise be stripped and the drugs used on Sylea.

LAV-10

The LAV-10 is a tracked utility vehicle superseded by fusion-powered antigrav units and removed from secondary service in year -21. Its normal role was as non-combat troop transport or light weapons platform.

The Central Storage Depot at Port Sidon has a large number of LAV-10 utility vehicles for sale for export or metals reclamation. No warranty is expressed or implied as to usability except for a guaranteed recyclable mass of 3,600kg per unit. LAV-10 units are available for 2500Cr each in minimum quantities of 10, and have a shipping mass of approximately 6,000kg each.

The surplus LAV-10's may be missing tracks, engines or instrumentation. While they are sealed for use with life support, it is not currently installed, and while wiring and data paths for military electronics are intact, all sensors and communications gear has been removed. On average, five units can be disassembled to get one LAV-10 in good used condition and a lot of spare parts. This process will take about 200 man-hours in a vehicle repair shop, and this time can include retrofitting with a Fusion+ unit (see Power Plant section in Vehicle Design, page 59, for description) for an additional 1500Cr in parts and labor.

Mobile Fabrication Facility-10

The MFF-10 has been superseded by the MFF-11 retrofit and MFF-12 units, and units are available for sale by Imperial Surplus Services at their previous duty station.

LAV-10 (stripped)

		Volume	Mass	Area	Cost
Displacement:	3.0 (USP7)				
Volume:		42.000m3	-	-	-
Configuration:	Box	-	-	70.08m2	-
Dimensions: 5.38m long x 2.80m high x 2.80m wide (approximate)					
Structural material:	Crystaliron				
Chassis: 1g rated		.078m3	.779t	-	2.808KCr
Armor: .3cm TL10 Crystaliron					
Armor rating:	Overall rating of 6	.210m3	2.102t	-	18.900KCr
Power plant:	TL5 Internal combustion, .6Mw	1.500m3 1.500t	1.500m2 12.000KCr		
Fuel consumption:	7.5m3 per 100 hours				
Fuel volume:	x1 (high grade hydrocarbons)				
Fuel carried:	15 hours	1.125m3	1.125t	-	.563KCr
Propulsion:	TL8 Tracks (x.55), .6Mw	.900m3	.900t	5.400m2	72.000KCr
Adverse condition propulsion (off-road)		.180m3	.180t	.540m2	7.200KCr
Secondary propulsion (waterjets)		.180m3	.180t	.540m2	7.200KCr
Crew: Driver		1.000m3	.100t	-	-
Passenger x 5		5.000m3	.500t	-	-
Options: Turret (empty, capable of holding .5m3)		.750m3	-	-	-
Cargo compartment		30.000m3	15.000t	-	-
Trailer hitch, up to 20 tons		.200m3	.200t	-	1.000KCr
Total		41.123m3	22.560t	7.980m2	121.670KCr

Performance(loaded): acceleration .1G, top speed 66m/turn (39kph), maximum range 594km
(driver only): acceleration .2G, top speed 140m/turn (84kph), maximum range 1260km
Agility: +3DM to be hit
Description: A tracked prime mover capable of hauling a variety of loads across rough terrain, with provision for light self-defense weaponry, and sufficiently armored to stop most small arms.

In addition to the six basic "medications", there are a number of other pharmaceuticals available, some with restrictions on use, and some which only apply to certain alien races. Two of these medical items are Bandage and Fuzz.

Bandage comes in small spray tubes, wrapped with a small roll of chemically impregnated fiber tape. The Bandage foam is usually sprayed on the wound, massaged around and then rinsed off, followed by another application. It has antibiotic and coagulant properties to supply healing factors to the tissue. The fiber tape can be wrapped around a wound as a bandage, and if it is soaked in the foam first, it will set in a few minutes into a rigid cast capable of supporting a character's weight. Fuzz is an anesthetic and stimulant. It will negate 2D of damage (divide evenly among wounds, fractions to largest one) for several minutes (100 turns), and can get an unconscious or shocked person back on their feet again so they can get to proper medical attention. At best, it will restore a characteristic to 3 points less than the original score; it will wake an unconscious person, or provide some alertness to a groggy one, but won't bring either to full potential. Fuzz does 1/2D points of stun damage (divide evenly again) to a person when they wear off (mainly to reflect the accumulation of damage from the injury that prompted its use in the first place), and drops Intelligence by 1D (to a minimum of 1) until it wears off. It may get you conscious and mobile, but it also tends to disassociate you from reality in the process. Abusers of the spray will get "fuzzed" before a fight, in which case its temporary damage-negation ability is evenly divided between characteristics and just allows the person to ignore a certain number of wound points for a while.

The MFF-10 is a self-contained parts fabrication facility for reconstruction and repair of all standard-issue Imperium equipment, comprising automatic machining and finishing tools, full database of all Imperium Standard Part Numbers (ISPN) and their specifications, as well as electronic testing and diagnostic tools for all electronic sub-assemblies.

These units are warranted to have all repair equipment in working order. No warranty is provided for the stocks of raw materials or date of last software upgrade. Cost per unit is 100KCr and purchaser is responsible for immediate transport off-site. Shipping mass is approximately 20,000kg.

The software used by these units is standard with other industrial computer-aided manufacturing units. These MFF units can manufacture any part from a trigger spring to an engine block, provided you have the metal, ceramic, or plastic stock required. Many of these older units have been propped upon blocks as semi-permanent installations, and may need new tires and engine overhauls to be brought back into self-mobile condition. On average, they will require an additional 10KCr in parts and labor to get working, and ISS will not permit the purchaser to spend a few days with the MFF to use it to repair itself. The 3 metric tons of raw stocks carried will cost approximately 15KCr at current market prices. Retrofitting with Fusion+ unit will require two 1MW standard units and an interface unit which can be manufactured by the MFF. This will free up a few tons of vehicle mass, improving loaded performance to 93m/turn, or 56kph.

Note: You've probably noticed that all three of the surplus vehicles are built on the same chassis, but with differences in armor or propulsion systems. You've also noticed that they are slow. They are not combat vehicles but support vehicles, and are not expected to ever need to get anywhere fast in that role. The MFF-10's have been sitting propped up on blocks for years, for instance. The LAV-10 is the only one with "legs", and when carrying up to 35 troops or light cargo, it can still move along at a respectable clip (113m/turn, 68kph).

PAWS-10

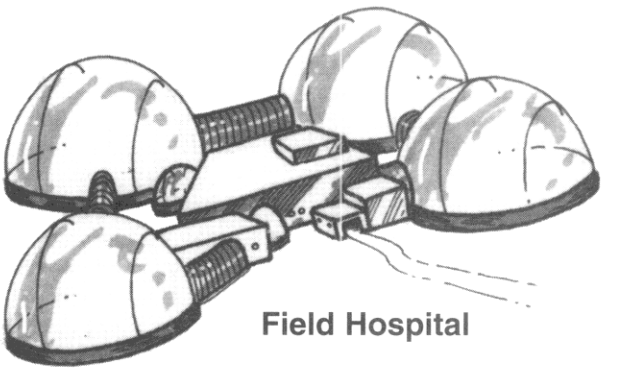
The Personal All-Weather Sight, Model 10, is available for export or civilian use, having been declassified and replaced by the PAWS-11 unit. PAWS units provide passive computer-enhanced telescopic thermal sighting for any weapon, and have the standard Imperium mounting hardware and data channels for linking to other Imperium-standard equipment like the TFAC or ICOM series units. PAWS-10 units are available for 500Cr each in lots of 100 (shipping volume $2m^3$), with a mass of .5kg per unit, plus .2kg for padded shipping case. Each lot includes one set of repair and adjustment tools. Units were taken from reserve service but are not guaranteed other than having no more than cosmetic damage or normal wear.

MFF-10 (stripped)

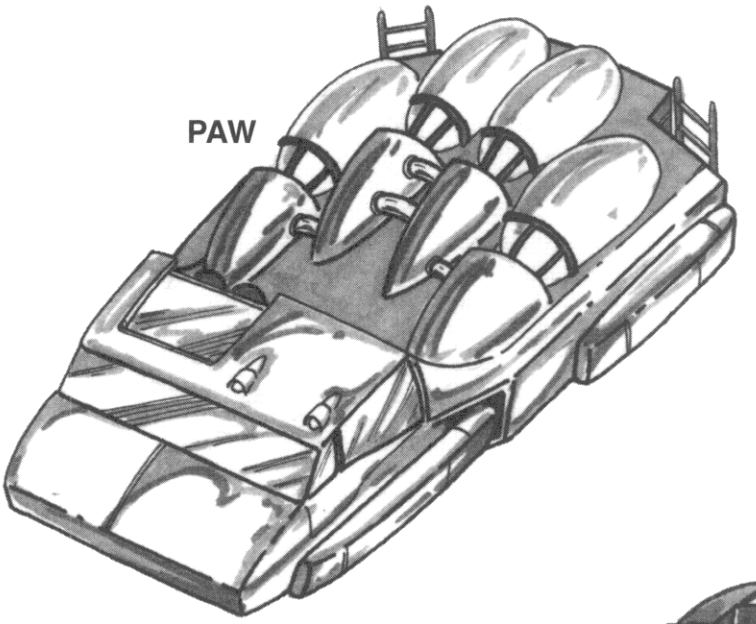
		Volume	Mass	Area	Cost
Displacement:	3.0 (USP7)				
Volume:		42.000m3	-	-	-
Configuration:	Box	-	-	70.08m2	-
Dimensions: 5.38m long x 2.80m high x 2.80m wide (approximate)					
Structural material:	Crystaliron				
Chassis: 1g rated		.078m3	.779t	-	2.808KCr
Armor: .3cm TL7	Light alloy				
Armor rating:	Overall rating of 2	.210m3	.630t	-	8.400KCr
Power plant:	TL5 Internal combustion, .6Mw x 2	3.000m3	3.000t	3.000m2	28.800KCr
Fuel consumption:	15.0m3 per 100 hours				
Fuel volume:	x1 (high grade hydrocarbons)				
Fuel carried:	20 hours (x2 if 2nd engine is unused)	3.000m3	3.000t	-	1.500KCr
Propulsion:	TL8 Wheels (x.7), .6Mw	.600m3	.600t	3.000m2	15.000KCr
Adverse condition propulsion (off-road)		.120m3	.120t	.300m2	1.500KCr
Crew: Driver		1.000m3	.100t	-	-
Passenger x 5		5.000m3	.500t	-	-
Options: Mechanical bay (uses .5Mw)		20.000m3	10.000t	-	100.000KCr
Parts storage		6.000m3	3.000t	-	-
Other storage		1.000m3	.500t	-	-
Trailer hitch, up to 20 tons		.200m3	.200t	-	1.000KCr
Total		40.208m3	22.429t	6.300m2	159.008KCr

Performance(loaded): acceleration .2G, top speed 84m/turn (51kph), maximum range 1008km
(driver only): acceleration .2G, top speed 100m/turn (60kph), maximum range 1200km
Agility: +3DM to be hit
Description: A mobile repair shop for any type of mechanical part, capable of using its on-board database or generating new specifications from scans of existing material.

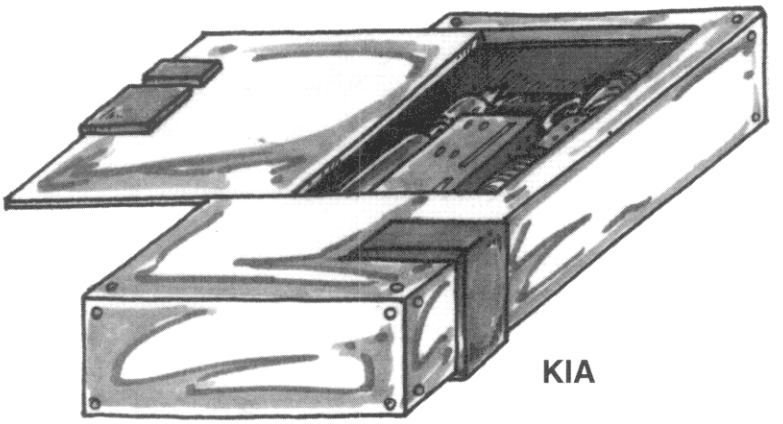
ICOM



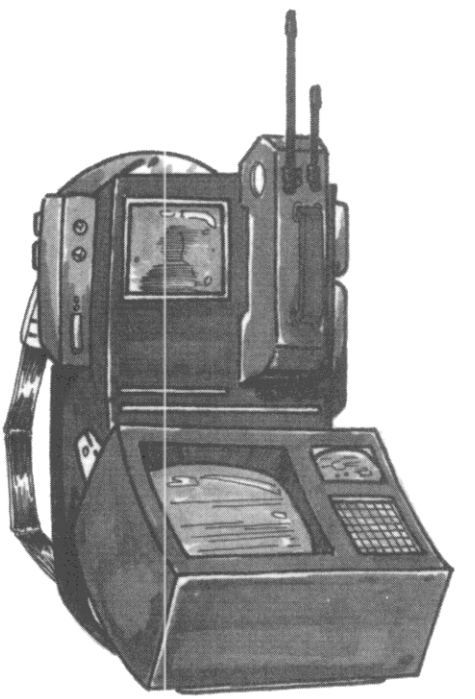
Field Hospital



PAW



KIA



TFAC

The classified part of the PAWS-10 unit is its ASOP (Application-Specific Optical Processor), which was custom-tailored to enhance human/alien silhouettes and body temperature ranges, making it very effective in penetrating visual camouflage. The sight can be used day or night, and provides a "normal" color image based on computer analysis of the image it receives, along with range and bearing. For instance, it will color green the things it thinks are grass or leaves, while things it thinks are people will be outlined in flashing red. This works very well against TL10-or-less forces, but TL11+ soldiers generally have camouflage and countermeasures to "spoof" lower-tech units. PAWS-11 units have their own still-classified algorithms that provide parity with TL11 countermeasures. In game terms, a computer-enhanced night sight will counter some or all of the DM's for camouflage of the same or lower TL's, especially if the persons being observed are unaware of the vulnerabilities of their countermeasures. The battery of a PAWS unit is good for several hundred hours of operation, and is recharged by a built-in solar panel on the upper surface of the unit. Degradation of the solar panel and wear on switches are the most likely source of malfunctions on these units, but note that they were produced for a long period of time, and any given lot will have units ranging from new in wrapper to units that look like they were used in the Vilani war.

TFAC-10

The Tactical Force Analysis Computer, Model 10, was declassified in year 23 after issuance of the TFAC-12 computer and algorithms. These personal units are available for export or industrial use where a ruggedized computer and communication system is needed. Upgraded mounting will be required for any headgear other than Imperium-issue helmets, but otherwise all units are guaranteed to have been functional as of their last diagnostic check. These units are available in lots of 200 for 1,000Cr each, and have a shipping mass of 1.0kg per unit (volume .3m^3).

The TFAC unit allows a squad or platoon to have integrated communications capability. Each soldier has a unit with a low-light capable camera, microphone, and heads-up display unit mounted to their helmet. This passes short-range, level 1 encrypted spread-spectrum information back to the command unit (difficult to detect or pinpoint), so that the officer in charge can see everything that each soldier sees, or route this information to any one of his group. This includes such ancillary information as range to target in viewfinder and position, allowing any soldier to act as eyes for a forward observer check. More modern units do the same, but are harder to detect, decrypt, or jam, and in addition may be able to do real-time map generation, predict movement for targets lost to sight, etc. TFAC-10 units can exchange level 2 encrypted information with each other, and higher tech models have more secure links. The TFAC-10 gives a +2DM to any tactics task by the "commander" as well as providing a relatively secure communications link.

Training/Technical Manuals

The entire MT-10, MF-10 and MT-11, MF-11 series of manuals are available for personal reference for download cost from any ISS office. The full set of manuals cost 200Cr and the training computer and accessories are 500Cr (where available).

A character who wants to acquire level-0 skill with a military-related field can do so by spending time, rather than experience points, to study these training manuals. They are designed in a progressively difficult sequence and each session or lesson can be handled in half-day chunks. Completion of the 100 hour course will provide a level-0 formal knowledge of the skill that can be improved normally. The interactive computers that play the manuals are very sophisticated, and may include fold-out screens and cameras to analyze trainee performance. In addition, a character can use a field manual to get default use of a skill that does not normally allow it, provided that it is a non-pressure situation that permits repeated querying and cross-referencing of the manual. For instance, a character with no mechanical skills could use a field manual to strip and clean a rifle, or get step-by-step instructions (install a transmission in a LAV-10).

PROTECTIVE GEAR

The broad category used to include only worn items such as environment suits, but has been reorganized to encompass all equipment designed to protect, monitor or abate the adverse effects of the environment. Within this, items will be classified according to type and function. Links to related items elsewhere will be noted. Protection from the hostile energies of combat is a subset of this section, and notes on available and encountered technologies will be listed at the end of this section.

Artificial Gill-8
Extracts oxygen from water to allow indefinite submerging. Functions only on worlds with thin, standard, or dense atmospheres (types 4 through 9). Pulling oxygen from the water is tiring (all Endurance tasks get a -2DM), so the gill is not normally used for more than a few hours at a time. An artificial gill also pulls other dissolved gases from the water, and cannot be used on worlds with poisonous atmospheres. It suffers the same limitations as SCABU gear regarding the bends and nitrogen narcosis.

Artificial Gill, Powered-9
Identical in theory to the TL8 model, but includes a power supply to pull water through the gill rather than the muscle power of the wearer. It uses a replaceable or rechargeable battery good for about 12 hours of normal operation. A pulse sensor in the mask adjusts oxygen extraction to match the exertion of the user.

Cold Weather Clothing-1
This is the most primitive of gear to protect against the elements. It is made of organic, locally available materials — usually cloth, leather, and fur — with the sophistication and degree of tailoring depending on culture and TL. A full set of cold weather gear includes boots, mittens, two layers of leggings, an outer and inner coat, and head protection (the set listed in the Traveller rulebook consists of only the heavy undergarments, suitable for normal cold weather use under other clothing). If kept in good condition and worn by a healthy individual, cold weather gear will protect against any outside air temperature that can be inhaled without damaging the lungs. While water-resistant, it will lose most of its insulating properties if soaked. It is also quite heavy, and while it provides some protection in combat (rating 1 vs. melee weapons), it is also encumbering (-2DM to Dexterity tasks).

Cold weather gear at TL6 takes advantage of synthetic fabrics to significantly lessen the weight, bulk and lack of flexibility, and has no significant encumbrance in marginal conditions (but is a -1DM to Dexterity tasks if bundled up for extreme conditions). TL10 cold weather gear is very lightweight, less bulky and made from smart fabrics to automatically compensate for most conditions. It loses none of its effectiveness if wet.

Combination Mask-7
A combination filter mask and respirator to allow breathing of very thin, tainted atmospheres (type 2). It relies on chemical filter cartridges which need to be replaced after every 10 hours of use at a cost of 50Cr and mass of .2kg.

Desert Clothing-1
Rugged, lightweight clothing for use in hot, bright environments. Includes white, long-sleeved robe or shirt and loose pants, well-ventilated lightweight footgear and hood or broad brimmed hat. It provides maximum heat reflection with low tech materials, plus efficient absorption and evaporation of sweat for cooling (+1DM to desert survival tasks or +1DM to counter heat-based Endurance penalties).

Desert Survival Suit-9
The DSS-9 is one-piece garment with shiny outer surface which prevents major water loss in the desert. Normally worn as the only garment or the innermost garment under another heat-reflective layer, the wearer sweats normally, but a series of traps, pumps and chemical filters condenses and purifies lost body liquid and stores most of it as pure water in pouches within the suit. The small amount of water that cannot be purified is evaporated off in an efficient manner, cooling the suit. A hood, goggles, and breathing mask (which traps moisture exhaled through the nose and mouth) are included. The chemical filters must be changed once a month, at a cost of Cr50. Fitting the suit to oneself is an Average Survival task. Failure will result in blisters and chafing (-1DM on Endurance tasks) and double the normal water loss from the suit.

Besides keeping the wearer alive, if not comfortable, in hot and dry conditions, the suit supplies one liter of water every three daytime hours, and one liter every night. All this water must normally be consumed by the wearer, and an extra liter in addition. A +1kg and 500Cr option provides solar power (50 watts), used to power a small thermionic cooler and fan to increase the comfort of the suit.

The suit has certain disadvantages. At TL9, the bulkiness of the suit causes some clumsiness (-1DM to Dexterity tasks). Also, the suit is extremely shiny, making it almost impossible for the wearer to sneak up on anyone, even in rocky terrain — though this could be an advantage for characters lost in the desert who are hoping to be spotted by aircraft. Desert vehicles equipped with DSS usually have them with a full load (5 liters) of water already in the pouches, adding 5kg to their initial mass.

Note that EVA suits will also, by their very nature, provide complete protection for desert travellers, at least as long as their life support power holds out.

Deep Diving Suit-7
This is a completely rigid suit with rotating joints instead of hinges, allowing a pressure tight seal in high pressure environments, such as deep underwater (up to 20 atmospheres pressure). The suit is extremely roomy, and the wearer can withdraw their arms to scratch, flip switches, etc., and breathe a normal atmosphere at normal pressure, eliminating the threats of the bends and nitrogen narcosis. However, the dexterity of the suit is extremely limited, and manipulation of objects is by means of a mechanically activated claw at the end of each arm of the suit. Normally used for underwater construction and repair, custom-made tools that are easy to use with the claws enable work at some penalty (only a -3DM). All other fine work or application of generic tools is extremely difficult (-6DM), which can be countered somewhat by spending a lot of time at the task. The suit is completely self-contained, and has life support and power for approximately 6 hours of operation. The suit is extremely heavy, but is designed for neutral buoyancy and no encumbrance applies while it is in the water. Despite its ability to resist pressure, it is not exceptionally strong (effectively a rigid armor of 2), using sophisticated design rather than massive quantities of material for its strength. Any breach of the armor at significant

Hot Weather Situations

In conditions of extreme exertion and/or high temperatures, Endurance tasks are necessary to avoid overheating. Each hour spent in such conditions is an Average Endurance task with the following DM's. Note that characters in climate-controlled space suits or armor do not have to worry about the outside temperature (within limits). If the total DM is +0 or more, you do not normally need to roll.

Condition	DM
>30°C	-2
>40°C	-4
>50°C	-6
>60°C	-8
Armor worn	as per armor notes
medium exertion	-1
heavy exertion	-3
adequate rest breaks	+1
adequate fluid intake	+1
condition modifiers	-2 to +2 (shade, cooling breeze, sunburn, etc.)

Failing the task means the character takes 1D of stun damage, which is usually split evenly among physical characteristics and Intelligence, but odd amounts are placed as desired. If adequate fluid is not available, one point for every die of stun damage taken will not be recoverable until the character gets enough to drink. If a characteristic goes to zero, the character passes out. If two go to zero, the character goes into shock. And if all three physical characteristics go to zero, the character dies of heat stroke.

Cold Weather Situations

In conditions of extreme cold, Endurance tasks are necessary to avoid freezing. Each hour spent in such conditions is an Average Endurance task with the following DM's. Note that characters in climate controlled space suits or armor do not have to worry about the outside temperature (within limits). If the total DM is +0 or more, you do not normally need to roll.

Condition	DM
<10°C	-1
<0°C	-2
<-20°C	-3
<-40°C	-4
Armor worn	as per armor notes, but it helps rather than hurts
medium exertion	+1 (Average Endurance task to avoid -1DM on all Endurance tasks)
heavy exertion	+3(Formidable Endurance task to avoid -2DM on End tasks)
Cold weather clothing	+2
Extreme weather clothing	+4
Character wet	-2
Character in water	-4
High winds	-2

Failing the task means the character takes 1D of stun damage, of which 1 point is normal damage (chills or frostbite). Damage is usually split evenly among physical characteristics and Intelligence, but odd amounts are placed as desired. If a characteristic goes to zero, the character passes out, and all further damage is normal instead of stun damage. If two go to zero, the character goes into shock and will require a Formidable First Aid or Difficult Medical task (modified by DM's for TL of care) to avoid losing a few fingers or toes. And if all three physical characteristics go to zero, the character dies.

depth will be instantly (or nearly instantly) fatal to the wearer as high-pressure liquids or gasses jet into the suit, filling it in seconds. It is also not proof against vacuum or very low pressures.

Dry Suit-7

A dry suit allows extreme endurance in cold or very cold water. It is a water-tight insulating suit with an opening only for the face, which is usually covered by a full-face respirator. Installations in icy seas will usually have a version of this suit issued to each crew member in case they fall over the side or an accident causes the installation to be uninhabitable. These function the same but do not have as much mobility as diving suits. Either suit gives a +4DM to cold weather survival rolls on land or in water.

Filter Mask-5

A full face mask and filter set which allows an individual to breathe normal-density tainted atmospheres (type 7). It uses chemical cartridges specific to a type of tainted atmosphere, and which usually need to be replaced after about 10 hours of use at a cost of 20Cr and mass of .3kg. These masks are also used to filter out airborne military toxins of the same TL as the filter cartridge. The lower TL models are not well designed (-2DM to perception tasks), but higher TL models do not suffer the same problems.

Filter Suit-8

The filter suit is a lightweight, permeable overall worn over other clothing and cinched down with disposable adhesive straps. Its sole purpose is to protect the wearer from toxic airborne chemicals (usually military incapacitation agents that could be absorbed through the skin) for a limited time. Normally worn in combination with a compatible respirator, the suit is porous enough to prevent excessive body heat buildup, eliminating the need for a cumbersome life support system. The limitations of the suit are a less-than-100% effectiveness and short useful life (roll 11– on 2D to protect against exposure, -1DM per 2 hours after removing the suit from its sealed package).

G-Suit-7

This is a form-fitting suit with inflatable air bladders, under the control of a worn or vehicle-mounted acceleration sensor. When needed, it compresses parts of the body to regulate blood flow and blood pressure under conditions of extreme acceleration. It does not make it any easier to work in a rapidly accelerating or decelerating environment (like a fighter cockpit), but it does mitigate the biological effects somewhat. By its nature, it is difficult to wear armor over or under it.

Goggles-5

Plastic eye goggles that provide protection against both windblown sand or dust and sun glare. Goggles at TL8+ incorporate protection from high levels of ultraviolet radiation. Military goggles at TL9+ incorporate filters to absorb common laser wavelengths.

Hazard Suit-8

A flimsy disposable suit that can be worn over other protective gear. It provides up to 6 hours of protection from corrosive or toxic environments, and full protection from airborne or contact contaminants, but does not provide any life support on its own. It is discarded after use. While waterproof and airtight, it will not withstand significant pressure differences without rupturing. Perception tasks through the flexible plastic visor are difficult (at -2DM), and it precludes the use of many vision aids like telescopic sights.

Hazard Suit-10
See ISS entry (page 5).

Liquid Atmosphere Suit-8
A liquid atmosphere suit provides the wearer a highly oxygenated liquid instead of air. This is exceedingly uncomfortable to initiate or stop (Difficult Intelligence task to voluntarily do so). The advantage of such a suit is that the wearer is virtually immune to high pressures as liquids are incompressible and the only part of their body containing air (the lungs) is now full of fluid. Breathing the liquid is very tiring (all Endurance tasks have a -3DM), and seeing through the faceplate full of fluid is difficult even with special contact lenses (all perception tasks at -2DM). While the suit technically gives the wearer unlimited high-pressure capability, there is no way to eat or drink while inside the suit, and most have a power and oxygen supply good for around 10 hours.

Oxygen Tanks-5
A complete set of compressed oxygen tanks and face mask for independent breathing in smoke, dust, gas, or exotic atmospheres (types 2 through A and special situations). One set will last a person for approximately 6 hours. With some adaptation to pressure hoses they can be used underwater, but are not meant for this purpose. A special compressor is needed to generate pure oxygen for recharging the tanks, but they can be used as regular compressed air tanks if this is not available, with approximately 1 hour duration. Unlike the oxygen-based respirator, oxygen tanks supply all the needed air, not just supplanting existing atmosphere, and so they are correspondingly heavier.

Pocket SCABU-8
This is an emergency system designed to provide temporary underwater life support in the event that normal SCABU system (see SCABU) suffers a failure. It is a combination air tank/regulator/mouthpiece in a slim package that is normally strapped to an arm or thigh. It provides 5 minutes of resting support, presumably enough time for friends to help, or make repairs to damaged equipment.

Respirator-6
A small compressor and facemask for an individual to breathe in very thin atmospheres (type 3 or 5). It is powered by a belt-mounted battery pack good for 10 hours, and a small hand-cranked generator to recharge the battery. Variants include a simple canister of pure oxygen which is trickled into a mask to supplant local oxygen content. These are slightly lighter (.7kg) and much quieter, but cannot be recharged as the compressor type can. They require replacement cylinders per 10 hours of use at a mass of .4kg and cost of 50Cr. This latter type is used where mass is an important consideration, and long-term use of the system is not needed.

SCABU-6
Self-Contained Apparatus for Breathing Underwater. This is a simple support system for underwater exploration, consisting of one or more tanks of compressed surface air, passed through a regulator that reduces this to a convenient breathing pressure. Few precautions are needed at depths of less than 10 meters, but at greater depths, nitrogen in the bloodstream may cause injury or death on a quick ascent (known as the "bends"). This is proportional to the depth of the dive and the duration at that depth, and greatly decreases the useful time that may be spent at a particular depth (halve "bottom time" for each doubling of depth past 10 meters). The normal duration of a set of tanks is one hour's worth of dive time.

Health Note: Spacefarers may be more accustomed to low-pressure maladies like "earpop" and "methane leak", but the "bends" are a serious concern as is "nitrogen narcosis." Failing to surface from a deep dive at a slow enough rate will cause dissolved nitrogen in the bloodstream to bubble out, and these bubbles can lodge in veins, blocking blood flow and causing serious injury or permanent brain damage. Nitrogen narcosis is caused by having too much nitrogen in the bloodstream, a hazard of using surface-level air mixtures at too great a depth. Signs include clumsiness, poor judgment, and hallucinations — signs that the person experiencing them will not perceive as unusual. The cure is getting back to the surface, but at a slow enough rate to avoid the bends.

If a character overstays their "bottom time", they will have to surface too fast, and may suffer the bends. This is an Average Endurance task, with a -2DM for each doubling of maximum depth past 10 meters, rolled at each depth increment nearer the surface as it is reached (i.e. 80m, 40m, 20m, 10m). Failure results in 1D normal damage to a random physical characteristic or Intelligence. If a character is rendered unconscious by the damage and survives, they lose a point of that characteristic until it can be recovered at any TL11+ medical facility with nerve regeneration therapy and time. Nitrogen narcosis is also an Average Endurance task to avoid, with similar depth DM's, but it is rolled on the way down rather than up. Failing the task results in 1D of stun damage to a random physical characteristic or Intelligence, and requires a Formidable Intelligence task to self-diagnose (Average task for someone else to notice it). If the character is rendered unconscious by the damage and survives, simply getting them safely back to the surface will effect a complete recovery.

Space Parka-9
The thermal-meteoroid garment or "space parka" is a hooded, coverall-like garment added over the top of a regular vac suit. It lessens the risk from micrometeoroids, and can be used to temporarily "harden" a soft suit. It provides insulation to protect against deep space cold, and reflects enough light and heat to permit limited work in the inner zone of a star system. It increases the protective value of what it is worn over against high velocity particle impacts and most other attacks (increase flexible armor up to a maximum of 3), but it is rather cumbersome if not used in a zero-g environment (–3DM to Dexterity tasks in a gravity well). Slipshod outfits will have these as add-ons to vac suits instead of using high-end industrial quality EVA units.

Survival Bubble-9
A.k.a. "beach ball." A large (2-meter diameter) plastic sphere with alternating clear and opaque panels, and a small oxygen tank (capable of supporting one person for two hours) for inflation. Access to the interior is through a conforming plastic seal which functions similar to an air lock. The bubble can be used for life support in vacuum (it can be moved by walking on the inside in treadmill fashion), and can also be used for protection against weather or as a lifeboat on a sea surface. It has good abrasion resistance, but no appreciable armor value. Normal procedure is to sit in one place and wait. Most survival bubbles have one panel modified so that a hand can be used to grip or crudely manipulate (-3DM) outside objects from inside the bubble.

Thermosuit-9
This is a lightweight undergarment lined with thermoelectric filaments. When attached to any power supply it heats up or cools

down and keeps the wearer comfortable in almost any human-habitable environment. The power required depends on the conditions, but ranges from 100 to 1000 watts. At lower TL's where these are available, they are often used in vehicles that do not rate or cannot provide sufficient temperature control, such as race cars. Heat or cold from the thermosuit is routed to heatsinks, which are either placed on the body somewhere, or attached somewhere where they can receive a cooling or warming air flow.

Thermosuits of a cruder type are used as part of TL7-8 spacesuits, but use a network of tubing to route cooled or heated fluids around the wearer. They use about the same power, but mass 2-3 times as much and will break down if the tubing network is compromised by damage.

Vac Suit-10

The standard vac suit is a mass-produced, fully outfitted soft suit designed for those who have little knowledge of space or don't need a more elaborate system. It is slightly hardier than the "space baggie" model, as experienced crews call the minimal soft vac suit. It is equipped with a simple sub-regional range (30km) public frequency radio rather than a more expensive model. It can be worn over normal clothing, and all control hardware is on a small front-mounted pack, allowing normal if somewhat cramped accommodation in most seating. It uses a standard PLSM-10 unit and a pair of fans for 12 hours worth of life support circulation (one for the body, one to keep the helmet defogged). The only rigid part of the suit is the front visor, so the entire suit can be folded into a relatively small space (such as a large attaché case). The suit may be connected to a central life support system via an umbilical hose (not included). While it has normal abrasion resistance, it is not self-sealing, provides no radiation protection, and only minimal protection against damage (treat as a flexible armor of 1, and a penetrated hit will cause slow leaks that will empty the suit in 10 minutes unless sealed with one of the two included sealant patches).

Wet Suit-5

A wet suit allows increased endurance in cold water. A small amount of water enters the rubberized suit and is warmed by body heat. This layer and the insulating rubber decrease the rate of heat loss, and give a +2DM to cold-weather water survival rolls.

Spacesuit Options

The most basic spacesuit simply provides breathable atmosphere and a means to hold it in. Most spacesuits will have other capabilities, either built-in or as user-installed options. As for augmented armor, spacesuits have a usable volume of approximately .2m^3 after the person inside is taken into account. This is the bulkiest a suit can be and still barely fit into standard seating or control harnesses (about the size of a 300kg person). No more than .1m^3 extra internal volume is available if the person is to squeeze into cramped seating, like the passenger seats of an airliner or shuttle.

Anti-Corrosives: Most spacesuit materials are inert, but corrosive atmospheres can take advantage of even the smallest blemish to degrade and ultimately destroy the suit. Anti-corrosive protection consists of multiple layers of extremely inert plastics, possibly specially formulated for flexibility in joint areas. Under the next to last layer is a warning layer, which is very reactive (but basically harmless) in the presence of corrosive atmospheres. If you see a jet of bright pink smoke issuing from a pinpoint source on your suit, you know that your anti-corrosive layer is on its last gasp, and you should get back to a decontamination airlock as fast as possible. Anti-corrosive treatment generally adds 5KCr, 5kg and .005m^3 to the cost and mass of a suit, and should be stripped and reapplied each 100 hours of exposure to ensure full protection.

Anti-Infiltration: While spacesuits are designed to keep in the larger oxygen and nitrogen atoms, smaller atoms like hydrogen and helium are often able to infiltrate a suit, especially in dense atmospheres. This can have adverse effects on electronics and people in some cases. The only cure for insidious atmospheres is a coating of molecular structure dense enough to inhibit their passage. Normally, suits built for insidious atmospheres are custom-made for just this application, and retrofitting normal suits is impractical. The design modifications and special materials for such a suit will add 5KCr, 5kg and .01m^3 to its mass, and the extra rigidity adds an extra -1DM to all Dexterity tasks, over and above any normal penalties a suit of comparable TL would have. Trying to retrofit an existing suit to resist insidious atmospheres would cost and mass several times as much. The best option is to find the limits of your suit and minimize exposure to safe levels, flushing the suit of impurities before re-use.

Communicator: Any form of radio frequency or light beam communicator. Mass and volume are as per the notes under small vehicle communicators (page 66-67).

External Sensors: A full set of external environmental sensors, capable of providing detail on atmospheric pressure (TL4+), radiation (TL5+), atmospheric gases (TL6+), atmospheric chemicals (TL8+), gravitational gradients (TL10+) and space-time curvature (i.e. thruster plates and contragrav) (TL12+). Each sensor has a cost of 2KCr, masses 2kg and takes up .002m^3 at its TL of introduction. Cost and mass are halved each TL after that, down to a minimum mass and cost of .1kg, .001m^3 and 200Cr. Range of these sensors is effectively the same outdoor square, but they can be indicative of phenomenon occurring elsewhere (like downwind of a toxic gas source).

Unless a spacesuit is custom-made for the user, they will likely have to live with a limited set of options from the manufacturers, or have them installed later. Costs listed are for factory-installed options. Retrofitting a suit will be double the normal equipment cost to integrate it properly.

Heat Absorber: Any armor where the wearer is likely to be targeted by thermal sensors can have heat absorbers built into the armor. This is extra thermal insulation around sources of heat leaks, combined with an ice pack kept cold by the suit's power supply. This increases the normal heat signature slightly, but this is not usually a concern. In hostile conditions, all heat from the suit is routed into the ice pack, which absorbs the heat by melting, and which can be refrozen after combat for later use. For personal armor, this option will mass 5kg, cost 3KCr and take up .005m^3 of volume. The 2kg icepack (included in mass) can completely absorb up to .2Mw/turns of heat, giving a -3DM to spot the target with thermal sensors. After this, it can absorb another .2Mw/turns of heat but only at a -1DM to be spotted. An active person with no other power sources is considered to be radiating .005Mw of heat. An inactive person is radiating .001Mw of heat. For instance, an active person in armor with .005Mw of power consumed by on-board systems has a total power output of .01Mw, so a heat absorber will negate their thermal signature for 20 turns. If they shut down all systems and rest, it would negate their signature for 200 turns.

While limited mainly to military applications, it is also a safety feature in some extreme environment suits, giving the wearer a safety margin to absorb extreme amounts of external heat. For instance, firefighters might have a larger than normal ice pack to cool the outer surface of their fire-resistant rescue gear.

Inertial Navigation: Enables user to have an accurate positional reference, regardless of visibility or external interference, limited by the accuracy of initial calibration. Possible for portable applications at TL8, for a mass of 2kg, volume of .002m3 and 10KCr. TL9 versions are .5kg, .001m^3 and 2KCr, and TL11 versions are .3kg, .001m3 and 200Cr. All include some sort of display unit to show position on an internally generated map.

Level 2 Computer/HUD: TL11+ suits can have a level 2 computer incorporated for 5KCr or less, with a mass of 3kg and volume of .003m^3. This is ruggedized for vacuum use, and will include an oversized arm-mounted keyboard, voice interface and heads-up display that projects a virtual screen to one side of the user (only visible to user). This will run all standard programs, and the cost includes interfacing with suit electronics to provide extra computational power if needed. Typical uses include advanced diagnostics, automated flight in combination with inertial or satellite navigation, encryption of radio signals, computer analysis/enhancement of data and translation programs. An installed computer will also include a data port for connection to compatible systems.

Multispectrum Faceplate: This is an inner faceplate that pivots down inside the helmet to provide a false color visual interpretation of all electromagnetic phenomenon in the user's field of view, exactly like the PRIS binoculars. There is no optical magnification, but if used with a computer, it can digitally zoom and freeze-frame selected views for detailed or later study. This is a TL11+ option, costs approximately 5KCr and adds .5kg to suit mass and uses .001m3 of inside volume.

PLSM: At TL10+, the minimum suit life support unit is the PLSM, or Personal Life Support Module. This is a small solid-state module that is usually mounted on or near the helmet of the suit or in a chest pack. When supplied with electric power it can break down carbon dioxide into carbon and oxygen. It pulls excess humidity from the air inside the suit and stores it in a fluid bag (salty but drinkable), and the thermionic modules that do this can also heat or cool the suit. It can also crack the water into hydrogen and oxygen, and vent the extra carbon and hydrogen as methane gas.

The disadvantage of the unit is that it doesn't circulate air very well. So, while it may keep your head comfortably cool and dry, the rest of you may be sweltering, soaked in sweat or freezing your hindquarters off. However, it is cheap, it does work, and if you aren't a regular industrial space worker, the discomfort is not a regular occurrence.

A PLSM can be retrofitted to just about any vacuum-tight enclosure. A larger variant of the technology is usually used to keep the air breathable in small vehicles. PLSM's usually mass about 2kg, take up .003m3 and cost 1KCr. A PLSM hooked up to a full fluid or heat exchanger system will usually mass about 5kg, take up .01m3 and cost 3KCr. Normally a small gas cylinder is supplied to provide initial inflation or replenishment of suit atmosphere. This is 1kg, .001m3 and 100Cr, and will completely cycle the suit volume twice, or provide emergency air for about an hour. PLSM's usually consume around 500 watts of power in extreme environmental conditions, but only around 100 watts for minimum function.

Psi shielding: Provides the same protection as a psionic shield helmet and is available at TL12+. Mass and volume are .5kg and .001m^3, and it costs 4KCr.

Reflec Coating: As described in the basic rules, this adds 3 to the rating of any armor, vs. laser attacks only. It adds 20% to the mass of the armor and 10% to the cost, with negligible volume. If left uncoated, the suit is much more visible to the naked eye, and the reflectivity reduces the load on life support systems in hot, bright conditions.

Satellite Navigation: Gives the user an accurate positional reference, based on radio signals from a set of orbiting satellites or known radio beacons. Possible for portable applications at TL7, for a mass of 5kg, volume of .005m3 and 5KCr. TL8+ versions are .5kg, .001m^3 and 500Cr to 2KCr, depending on sophistication. Higher end models will plot courses, be able to download data from survey satellites, store past movements in memory, and have greater accuracy or speed of determining position and velocity. All include some sort of display unit to show position on an internally generated map.

Stickyfeet: Possible on TL9+ suits, this is an electrically active elastic compound. When a current passes through it, it becomes very soft and sticky, so the user may walk carefully in zero or microgravity conditions on any surface (Easy Vac Suit task) by alternately activating and deactivating them. This replaces normal soles and has no effective mass, but does add 200Cr to the cost of the suit, and the soles need to be replaced fairly regularly at a cost of 50Cr per pair.

EVA Suits

Often called "vac suits", EVA suits are for Extra-Vehicular Activity. Unlike simple pressure suits, these are designed not just for protection from vacuum, but for demanding work in hostile environments (atmospheres 0 through A, with options available for types B and C). As a result, they afford protection from micrometeor impacts, radiation, extreme light levels, heat and cold. Passengers refer to them as "vac suits"; crew call them "EVA's".

EVA-4

The TL4 EVA suit looks and performs like something out of a Jules Verne novel. Bulky, ponderous and alarmingly prone to pressure leaks, this suit has no integral valves for use with individual air tanks (although such valves could be retrofitted with some effort). Instead, the suit's heat and oxygen supply is piped in through a dedicated umbilical tube. The umbilical tube has a variety of predictable drawbacks — it limits the user's range, is an impediment to movement and is extremely vulnerable. However, as individual air tanks are not available until TL5, it is the best the manufacturers can do. The TL4 suit is also noted for its inability to keep heat in and radiation out, in spite of the very heavy lead mesh (flexible armor of 2, but all physical tasks are at -5DM). These monstrosities have actually been encountered on a planet that retained a small amount of working (and extremely durable!) space hardware, but had lost all ability to replace items that had worn out.

EVA-5

TL5 EVA suits are more flexible than their TL4 predecessors, less prone to leaks, and equipped to accept either individual air tanks or improved umbilical connections. Heat comes from small electric warmers (powered by one-hour batteries). Radiation protection, though better than the TL4 model, is still poor (flexible armor of 1 but all physical tasks are at -3DM). The operation of EVA-5 is approximately 2 hours, limited by the heavy exertion needed to use the suit and the short lifetime of the batteries. The suit cannot be used in hot environments without an umbilical to provide cooling.

EVA-7

These are the first practical space suits. The EVA-7 is suitable for careful, extended forays into vacuum and light radiation environments. They incorporate semi-regenerative life support for extended endurance, heating and cooling systems, and rudimentary diagnostics. It provides adequate protection against

abrasion and minimal damage, but is still somewhat clumsy to use (flexible armor of 1 and all physical tasks are at -2DM). The autonomy and endurance (6 hours) of the suit are paid for by its extra mass and cost. At TL7, suits are usually custom-made for the user at substantial expense. By TL8-9, production and space exploration have progressed to reduce cost to listed levels.

EVA-11

Current-manufacture hostile environment suit, applicable for industrial work in zero-g, vacuum, or non-breathable environments. It contains state of the art systems to increase the safety and efficiency of the unit and costs approximately 100KCr new. Used or reconditioned units may be available from mining or construction companies for a discount of up to 60%, but may be close to or past their warranted operational lifetime of 2000 hours use. The normal suit masses 100kg, which includes a current-manufacture Fusion+ unit and antigrav harness so that when activated it has zero weight. However, its mass is still significant and should be taken into account.

The EVA-11 has full atmosphere support for the minimum 72 hour duration of the power plant fuel, sufficient fluid reserves for 48 hours of normal consumption and sanitary hookups for similar duration, provided they are attached. Normal entry is accomplished from the back, takes only a few minutes and can be done wearing normal clothes. However, a special EVA undersuit ("suit skivvies") is recommended for long-duration use to avoid chafing and blisters (-1DM to Intelligence from distraction after 6 hours without them).

Performance figures vary by manufacturer of EVA suits, but the EVA-11 is capable of 2G acceleration, has continental range communications (nominal range 3,000km), transponder, inertial navigation and autopilot, a full suite of on-board environmental sensors including multispectrum visual and discriminatory audio, built-in biomonitoring, self-sealing of punctures, and a flexible outer shell for micrometeroid protection, with a rigid optically compensated helmet (armor rating of 3). Note that non-penetrating impacts may cause damage to the fabric, thermal distribution and insulation underlayers of the suit. Acquire documentation of authorized repair of any apparent damage to a used suit you wish to purchase. This will be listed in the service record of the suit's log computer.

The wearer of an EVA-11 or equivalent suit takes a -2DM on all Dexterity tasks due to the mass and thickness of the suit, and -3DM to Endurance tasks if forced to use the suit in a gravity well (contragrav may negate the suit weight so that you do not have to walk, but you still have to move the heavy arms and legs of the suit under your own power). If they do not have Vac Suit skill at 0 or better, any action taken in combat requires an Average task on their default to avoid a fumble or mishap.

"If you want to make yourself look impressive and be easier to spot on ship's sensors, I recommend the reflec option. It doesn't affect performance much, and most outfits doing mining or construction with heavy lasers get their EVA's that way from the factory. It adds some cost, but it's cheaper than paying off death or dismemberment benefits."

EVA-14

Advances in materials technology and further miniaturization of computers and power sources makes the EVA-14 an extremely practical piece of hardware. Sadly, while we have the theory, the manufacturing techniques are beyond current Imperium expertise, and require infrastructures yet to be redeveloped and perfected. Specimens and portions of specimens have been recovered from derelict ships, and these confirm historical accounts of their performance.

The entire outer surface of the EVA-14 is composed of smart composites. On most of the surface, these can be adjusted for some comfort and flexibility, but more attention is paid to the joints. Built-in stress sensors adjust for the movements of the wearer while maintaining a seamless pressure seal. The next layer in is an extremely thin superdense layer for impact and radiation protection, with some small loss of protection in the joint areas. This is followed by a layer of superconductor for energy dissipation, and a memory foam layer for insulation and comfort. This last layer is capable of wicking sweat and channeling it to a central reservoir where the salt is extracted and the fresh water stored for later consumption. Sanitary facilities are more invasive and less discussed, but capable of keeping the wearer clean for as long as they care to wear the suit. Life support is handled by an advanced PLSM unit, which is backed up by reservoirs of oxygen and inert gases capable of completely cycling the suit atmosphere several times. The suit is capable of self-sealing, the quality of which appears to vary with manufacturer, but some pieces have been recovered with pinched-off limb stumps.

An EVA-14 of high quality will have a battery-powered design with a total power reserve of 50,000 watt hours, since Fusion+ units were not invented when these suits were made. The outer surface of the suit provides photovoltaic power equal to 200 watts in the habitable zone, capable of powering the suit at low levels indefinitely. The suit has an internal contragrav unit that provides up to 2g of thrust and consumes 3500 watts at full power. Life support consumes 100 watts under normal conditions, and the suit itself has an overhead of 50 watts whenever the user is active. Options on the suit will vary, but will generally be TL14 manufacture. The EVA-14 has an overall rigid armor rating of 5 (3 on the hands), and the user suffers a -2DM on Dexterity tasks when wearing it. If available as new manufacture, it would cost around 100KCr. If available intact during Cleon I's reign it would be worth several times that, its utility value modified by its age and inability to be repaired.

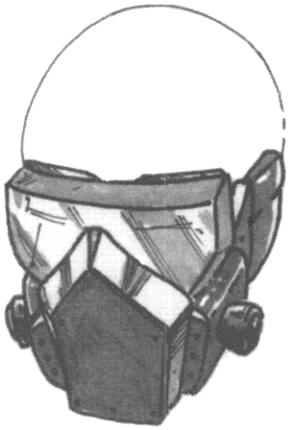
Getting In and Out of Spacesuits

How long this takes and how arduous it is depends on the function and tech level of the suit. At lower TL's (say, below TL8), maintaining atmosphere integrity is more difficult, and so there are numerous cumbersome catches and gaskets to be checked and rechecked. At TL9+, better materials make this a less taxing task, but still one that shouldn't be hurried. The more whistles and bells a suit has, the longer the pre-use checklist will be, though this can be ignored (at your peril) or reduced by the self-diagnostics of higher TL equipment.

Assume that it takes 120 person-turns (10 minutes) to get into a TL8– suit, which can be speeded up by having up to two assistants. TL9+ suits only require 60 person-turns (5 minutes), which can be similarly reduced. Speeding up the process is possible. A Formidable Vac Suit task roll will halve the time required, but you take the Dexterity penalties of the suit if doing it alone. A failure means you spend the normal time, and a spectacular failure means you halve the time, but missed something important. This could range from forgetting the sanitary hookup to having your helmet pop off the first time you bump it against something in vacuum (eeuw!).

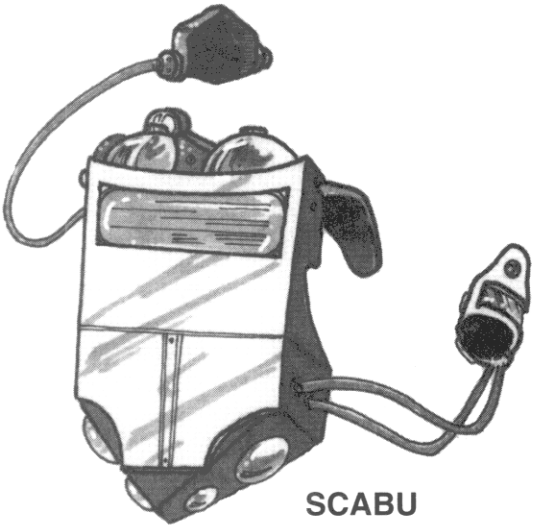
Vacuum Hurts!

Characters will almost certainly have close encounters with vacuum if they spend any significant time in space. Thin atmospheres are more common and simpler to handle. Characters exposed to a thin but breathable atmosphere for any length of time will take 1D of stun damage per hour, of which they will nor-



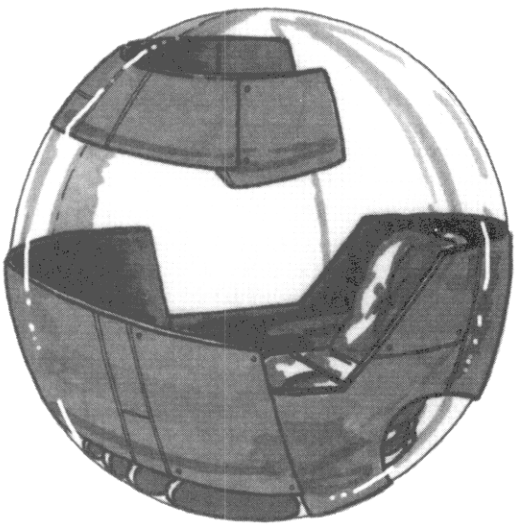
Combination Mask

Filter Suit



SCABU

Survival Bubble



Goggles

mally recover 1D. However, this 1D of recovery also includes any stun damage from fatigue, so exhaustion can take a long time to recover. Normally, you only take the extra stun damage upon any significant exertion, as you maintain a delicate balance when resting. People acclimated to thin atmospheres through long exposure will take slightly less stun damage, or will have higher Endurance if raised there from birth.

Vacuum is another matter entirely. Exposure to vacuum is 1D of damage per turn, applied evenly between all characteristics except Education and Social Standing. If there is not enough to apply at least one point to each characteristic, apply damage evenly as possible among physical characteristics. If the character survives the exposure, recovery is always as for minor wounds. The damage is severe, but evenly distributed over the body's systems so that any individual part is only somewhat affected. Cosmetic effects will last well beyond the actual damage, and may require surgery in some cases. Penetrating hits to spacesuits that aren't self-sealing can also hurt a lot. This is known as "blowout", but is not as catastrophic as it sounds: the closest body part is sucked up against the hole, at which point the skin ruptures and blood, air and body tissues begin spraying out into space. The localized tissue damage is extremely painful, but the fact that suit air is not being hemorrhaged as fast means the victim only takes 1 point of damage per turn.

Personal Armor

While most individuals do not consider combat an environmental hazard, many if not all survey and exploration missions eventually have violent encounters, even if only with previously uncataloged wildlife. Many types of protective garb will provide some damage resistance, but armor is specifically designed to prevent or mitigate injury from deliberate attacks against the wearer.

Armor Notes

A human has a surface area that needs protected of approximately $1m^2$, and a protected volume of $.3m^3$, of which about .1m3 is the human. In the simplest case then, a knight in shining armor (soft steel) wearing .12cm plate will have an armor rating of 2 and be carrying around 9.2kg of extra mass. This assumes perfectly even coverage with no overlap of inefficiencies, which is not the case. The need for protection over a range of motion and adaptation to the human shape will double the area of a person for armor purposes (up to 2m2), so our knight is actually carrying 18.4kg of metal around, plus the padding required to make it wearable with any degree of comfort, plus any safety margin desired because TL2 armorers didn't have tables to tell them to make the plate exactly .12cm thick, and the knight doesn't want his expensive armor dented by blows that exactly match its rating.

This is the simplest way to handle rules for body armor. Torso armor is about $.5m^2$, and everything else is $.5m^2$ (the head is .1m2 of this). The forming and shaping to match the human body is not as simple as welding slabs of armor together, and the cost for body armor is generally x5 that listed per m^3, and x2 for each TL below the introduction date of the material, if it can be worked at all (trying to work TL12 superdense over a TL3 forge would end up with armor having a cost of x2,560 normal, if you could bend the stuff at all!). Armor for a person can be any thickness desired, down to about .1cm, and usually not more than 5cm for anything you want a range of motion with.

Inside a reasonably shaped suit of full body armor there is room for about $.2m^3$ of equipment thinly layered over the body and under the armor, with room for another $.1m^3$ attached to the outside in the form of a small backpack, chest pack, hip packs, etc. While you can make an anthropomorphic (human-shaped) armor any size you want, to fit in a normal vehicle seat it cannot have more than $.1m^3$ of extra equipment (which means that backpacks or hip packs will need to be detachable, if used). That is, armor can have a total of $.1m^3$ of extra equipment if you want to fit in normal seating (total volume $.2m^3$), $.2m^3$ if you want to fit in roomy seating (total volume $.3m^3$), and $.3m^3$ if you want to fit in roomy seating without a seatbelt on (total volume $.4m^3$). This assumes a human with a mass of not more than 100kg in the armor. For markedly different aliens, use a mass appropriate for a large individual of that species, and divide mass in kg by 1000 to get approximate body volume. Twice this body volume is available for internal equipment on armor for that species, with proportionate room on the outside for the equivalent of chest or hip packs.

The figures for all armors listed except the Diplo-11 assume a full body suit. These cover everything, but a skilled person can still find gaps, especially in archaic armors (TL3-), mostly around the arm and leg joints (half damage locations), wherein a blade can be slipped to negate or reduce the armor protection. If you want to cover just the "main cables" (head and torso), the armor will be half the listed mass. To protect just the head will be a tenth of the listed mass. Penalty DM's for armor assume a full suit or the armor as described. If you wear less (say torso only), halve the DM's, but round fractions up for torso and down for head. So, a -1DM for a full suit of armor stays a -1DM even if only the torso or torso + head is armored, but -0DM if only the head is covered. If you mix and match armor, the total penalty DM will never exceed the DM of a full suit of the most encumbering armor. While the archaic armors might seem only as encumbering as modern armors, there is usually a significant hidden penalty in their mass. Most of these armors will place a character in the double or triple load category, which will be an effective DM of -1 or -2 on all their physical stats, in addition to the normal penalties of the armor itself. So, while both Plate Armor-2 and Battle Dress-11 are a -2DM to Endurance and Dexterity tasks, the plate armor will put most characters in the triple load category for an additional -2DM, while battle dress can be fitted well enough to halve its basic penalty to -1DM, and is probably only in the double load category for another -1DM. So, the TL2 knight is at -4DM with an armor of 2, while the TL11 soldier is at -2DM with an armor of 6.

Although there are no "hit locations" in Traveller, you can make the assumption that all normal fire is directed at the center of mass, i.e. the torso, and that is automatically covered by any torso armor. So, a person wearing only torso armor will still have its armor rating vs. any untargeted fire. Assume that a double-damage called shot is aiming for the torso, specifically for the centerline where you will certainly hit something vital. Triple-damage called shots are either to the head, neck or face, or the heart, and half-damage or minimum-damage called shots are to the arms or legs. If a target is only exposing their head and hands to fire, then you either have to do a called shot to the head for triple damage, or the hands for minimum damage.

This only really matters if a target has partial armor. If a person is wearing full coverage protection better than your weapon, your only option is to aim for what you think are weak points. Battle Dress and Augmented Battle Dress in the basic rules were deliberately designed to be impervious to normal small arms, but you can conceivably ruin the hands of a person in basic Battle Dress with called shots. These armors contain individuals who cost a lot of money and time to train and equip, and the Imperium is not going to put them in armor that some goomba with a hundred-year old assault weapon can take out with a lucky shot. These guys only have to worry about crew-served and anti-vehicle weapons, but they are trained to deal with that eventuality when it occurs.

Normally, a person in heavy archaic armor is completely immune to someone with a melee weapon, since the rigid rating of 2 negates any normal melee weapon. As mentioned, any non-sealed armor will have gaps and weak spots. A -3DM called shot can target one of these to halve the effective armor rating, but anything getting through is only half damage. A -6DM called shot can quarter the armor rating of archaic armors, and either halve it on sealed armors, or cause the armor to be treated as flexible armor instead of rigid. The latter means you are aiming for a "sweet spot" where you can possibly bruise or stun someone, even if the armor is untouched by the blow. This requires some GM interpretation, such as bashing someone into a solid object, twisting an arm out of joint, making them bash their nose against the inside of their faceplate, and so on, usually with some input by the attacker on just how they are accomplishing it.

Battle Dress-11

This is the heaviest unaugmented armor a person is likely to wear, and it provides head-to-foot protection from a number of threats. Due to its mass, it is usually relegated to short-term missions or ones with good logistics, like tactical assault teams, high-profile guards, etc. Battle dress is composed of energy-absorbing composite honeycomb, faced with lightweight alloys and backed with high-tensile strength fabrics. It is proof against most small arms (rigid armor of 5 on arms and legs, 3 on hands, 7 on torso and head), and can be equipped with a variety of tactical aids. It is somewhat encumbering (-2DM on Dexterity and Endurance tasks), but a battle dress is usually custom-fitted to an individual to reduce this effect (halve penalties if custom-fitted). Unaugmented battle dress units are not available for purchase or export at this time, though no ban is placed on their possession.

Battle Dress, Augmented-12

These units are prohibited for personal possession. No advance form past this are known to exist. Most of the cost of the units is in the advanced electronics to give the armored trooper the maximum amount of battlefield intelligence, with on-board analysis of sensor data, and access to any sensor data from nearby units, including real-time satellite scans. In addition to using the built-in point defense laser for regular aimed fire, the ABD unit may also have an armored pouch for carrying grenades or other useful tools.

Augmented Battle Dress (powered armor) does not really become viable until TL10, and is not a long-term proposition until the introduction of Fusion+. Higher tech versions would be much the same, but with better armor materials (TL14 bonded superdense would be a rating of 10), smaller and better electronics, more energy storage and more efficient weapons.

ABD units use "leg" propulsion systems for determining top speed and propulsion system mass and volume. The maximum Strength a unit can exert is based on the power the propulsion system can handle:

Internal Equipment: Due to the ultracompact nature of an armor suit, electronics and sensors mounted on or in one are half the volume and mass of vehicle equivalents (see Vehicle Design, page 52), and usually less capable in the number of channels monitored or used. Weapons built into a suit of armor use x1.5 volume of the weapon. Those that are carried or worn use normal volume (x1), but are not protected by armor. They have the advantage of being storable elsewhere if seating would be too cramped otherwise. Fire control systems may be mounted in powered armor, but while they have full cost, they only get half the DM (round up).

Augmented Battle Dress-12

Component	Volume	Mass	Area	Cost
Volume available	.3000m3	-	2.000m2	-
Human	.1000m3	.100t	-	-
Power plant: TL12 Fusion+, .050Mw	.0100m3	.020t	.048m2	.100KCr
Fuel, 200 hours	.0030m3	.003t	-	.021KCr
Power plant: TL12 storage bank,wpn grade,.02Mw/hr	.0133m3	.027t	-	1.875KCr
Propulsion system: TL12 Legs, .034Mw, x.3 speed	.0952m3	.095t	1.428m2	4.284KCr
Secondary propulsion system (arms and hands)	.0190m3	.019t	.148m2	.428KCr
Propulsion system: TL12 cgrav,.75t thrust,.0053Mw	.0150m3	.010t	.015m2	.150KCr
Armor: .385cm TL12 Superdense (rating 8)	.0077m3	.116t	-	5.390KCr
Options: Basic life support	.0003m3	.001t	-	.200KCr
TL12 Fire control system (+3DM)	-	-	-	60.000KCr
RF Point defense laser-12 (mounted) (requires .0002MW/hr per turn used)	.0023m3	.003t	-	2.000KCr
TL12 Fire control system (+3DM)	-	-	-	60.000KCr
RF Gauss MG-11 (carried) (requires .008Mw/hr per turn used)	.0185m3	.037t	-	15.000KCr
TL12 subcont. range mil-spec radio (uses .01Mw power)	.0001m3	.001t	.100m2	5.000KCr
TL12 subregional active radar	.0050m3	.010t	.001m2	30.000KCr
TL12 subregional passive optical	.0050m3	.010t	-	60.000KCr
TFAC-12 system	.0005m3	.001t	-	10.000KCr
Inertial navigation unit	.0005m3	.001t	-	.200KCr
Satnav unit	.0005m3	.001t	-	2.000KCr
Total:	.2959m3	.455t	1.740m2	256.648KCr

Performance: Strength 14, top running speed 68m/turn (41kph), maximum range 8160km
(flight): Acceleration after gravity .6G, maximum flight speed 79m/turn (48kph), max. range 9480km
Agility: +0DM to be hit

Description: The currently classified (Year 0) specs on Augmented Battle Dress. The on-board battery is designed to power any of the carried weapons that may be used, including gauss weapons, lasers and potentially light plasma weapons as they become available. The RF (Rapid Fire) gauss MG is exceptionally useful, but can only do sustained bursts (at the +2DM for Rapid Fire) for three turns, one from its own power supply, and two more from the internal battery. After that, it takes about 30 minutes to fully recharge. This is the main limit of any ABD weapon system at this time, and if it becomes a liability, a version of the VRF medium MG-11 will be used instead. Current tactical doctrine is to use the RF rate only in emergencies. The RF laser is normally set in an automated mode, and acts with an effective skill of 8 (6 for fire control, +2DM for Rapid Fire) against any object matching the signature of a grenade or rocket. Its +3 fire control DM helps offset any movement penalties.

Propulsion System	Strength
.001Mw	2
.002Mw	3
.003Mw	4
.005Mw	5
.006Mw	6
.007Mw	7
.011Mw	8
.014Mw	9
.017Mw	10
.021Mw	11
.025Mw	12
.034Mw	14
.044Mw	16
.056Mw	18
.069Mw	20
.084Mw	22
.100Mw	24

Combat: While armor may be designed as a very small vehicle, characters in such armor are not normally counted as vehicles for combat purposes, either for targeting or damage resolution. However, if a suit of armor with numerous subsystems is penetrated, it might be appropriate to see which subsystem was hit on the way to injuring the character.

Chain Armor-2
Chain armor-2 is links of steel woven together into a flexible mass capable of blunting heavy blows. It may be interspersed with small metal plates, and is usually worn over a padded fabric undergarment. It provides reasonable protection, but has its vulnerabilities (flexible armor rating of 2, but only 1 vs. projectiles). It is very flexible and easy to wear, but its mass may adversely affect performance (no penalties except for its weight).

Diplo-11
This is a lightweight, concealable armor normally worn by important personages like diplomats and politicians for public occasions. It is composed of flexible composites and provides good protection against all weapons (flexible armor of 3). The lack of air circulation makes it uncomfortable in hot climates (-1DM on Endurance tasks), but the slight discomfort is usually worth it. Extremely important (or unpopular) personages will usually have an upgraded version, which has a large number of small reflec-coated plates on top of the composite layer for added protection (double mass and cost, flexible armor of 5 vs. most attacks, 8 vs. lasers, but -1DM on Endurance and Dexterity tasks). This can be concealed under formal wear, but not under lightweight clothing like the normal Diplo armor. Either form (and most concealable armors) requires a certain proficiency in movement to avoid advertising the presence of the discreet protection.

Flex-6
Flex-6 is the first attempt in the gunpowder era to provide reasonable protection to the average soldier. It consists of early synthetic fabrics backed by plates of lightweight alloys or hard steel. It is heavy, but provides reasonable protection against attacks which would otherwise be incapacitating (rigid armor of 2 vs. all weapons). The lack of ventilation and its weight make it unpopular with ground troops (-1DM to Endurance and Dexterity tasks), but it is usually well received by crews of unarmored vehicles. While technically available in full body coverage, it is normally only worn on the torso, with an equivalently armored helmet for partial head protection.

Flex-8
Flex-8 is the standard military "flak vest" in this era, designed to minimize the effects of low-penetration weapons without unduly encumbering the wearer. Its high-strength fabric layers provides moderate protection against shell splinters, ricochets and small weapons, but does little to stop rifles and other heavy weapons (flexible armor of 2 vs. modern weapons and fragmentation, 0 vs. blades, spears, bows and crossbows). It does not unduly affect mobility, but can tire the wearer (-1DM to Endurance tasks).

Flex-9
See ISS entry of same name (p. 5). A limited number of full body Flex-9 suits were manufactured, mainly for use in disposal of explosive or fragmentation weapons.

Leather Armor-1
Leather armor is the earliest armor likely to be encountered, and is simply tailored animal hides, either flexible or rigid (armor rating of 1 vs. melee weapons only). Rigid plates provide marginally better protection, at some loss of mobility (-1DM to Dexterity and Endurance tasks).

Plate Armor-1
Plate armor-1 is usually bronze or a heavy alloy available to primitive cultures. It is always rigid, and provides somewhat better protection (armor rating of 1 vs. all weapons, and 3 vs. lasers if polished highly enough!). It is very cumbersome, and normally only worn if combat is imminent (-2DM to Dexterity and Endurance tasks, plus any penalty for its weight).

Plate Armor-2
Plate armor-2 is the pinnacle of the archaic armorer's art. Made from the best quality steels available and backed with a padded undergarment, it provided a rigid armor proof against most weapons of its time (rigid armor rating of 2 vs. melee weapons and archaic projectiles such as spears, bows and crossbows; rigid armor of 1 vs. modern weapons). It is not normally seen in TL3-4 industrial cultures, but exceptions are possible in the form of torso armor to protect important individuals from low-velocity projectiles and melee attacks. While normally of high quality and manufactured by hand for a specific individual, it is still encumbering and hot to wear or fight in (-2DM to Endurance and Dexterity tasks). Intact suits of Plate armor-2, especially those with artistic design, have fetched prices of several times their local cost. This has led to a market in manufacture of imitations, and suits for sale to collectors now require authenticated "pedigrees" that provide a way to confirm their authenticity.

Plate Armor-8
Plate-8 is that era's equivalent of the knight in armor. It consists of appropriately camouflaged ballistic fabric with hard steel or alloy plates in special overlapping pockets. The helmet is composite plastics with a suspension harness to absorb impacts, and equipped with a heavy transparent plastic visor. It provides good protection against weapons of that period (rigid armor of 4), but has numerous gaps at the joints which are only protected half as well (flexible armor of 2). Units equipped like this seldom have the load capacity for extended missions, and would normally be deployed as special assault units, either military or specialized law enforcement. The bulk and mass of the plates hinders mobility somewhat, but the protection is seen as a worthwhile tradeoff (-1DM on all Dexterity tasks, plus any penalties for the mass of the armor). In most cases, a mass compromise is reached in that only torso + head protection is used, the rationale being that extremity hits may be incapacitating but not fatal.

Psi-Shield Helmet-12
Battery-powered helmet that creates a real electrical field at human brainwave frequencies. Psionic-talented individuals perceive this as static, which prevents undesirable telepathic influences or psionic assaults. The helmet imparts little physical protection, but it gives the wearer a high psionic defense against certain known disciplines (automatic Psionic Strength rating of 15 for purposes of defense against Psionic Assault only). Shielded individuals cannot be detected by characters possessing Life Detection nor can they receive telepathic suggestions, nor can they be probed or have their thoughts read. The electronics of a psionic shield helmet are relatively simple, but may break down or be sabotaged. A small meter on the unit allows testing of the helmet's effectiveness. It should be noted that the "static" of an active psi-shield helmet can be detected by a psi, whether or not there is a person wearing it — the main difference between natural and artificial shielding. These helmets are somewhat bulky and fragile, massing 1kg and costing approximately 4KCr.

Protective Gear	Mass	Cost	Relevant Skill
Artificial Gill-8	4kg	4000Cr	Environment Combat
Artificial Gill, Powered-9	4kg	3000Cr	Environment Combat
Cold Weather Clothing-1	8kg	200Cr	Survival
Cold Weather Clothing-6	4kg	300Cr	Survival
Cold Weather Clothing-10	3kg	500Cr	Survival
Combination Mask-7	1kg	200Cr	-
Combination Mask-9	.8kg	200Cr	-
Deep Diving Suit-7	100kg	50KCr	Environment Combat
Desert Clothing-1	2kg	100Cr	-
Desert Survival Suit-9	3kg	1KCr	Survival
Desert Survival Suit-11	2kg	800Cr	Survival
Dry Suit-7	5kg	1000Cr	Environment Combat
Filter Mask-5	1.0kg	50Cr	-
Filter Mask-8	.8kg	50Cr	-
Filter Suit-8	2kg	100Cr	Survival
G-Suit-7	10kg	1000Cr	-
Goggles-5	.2kg	20Cr	-
Goggles-8	.1kg	50Cr	-
Hazard Suit-8	1kg	100Cr	Vac Suit
Hazard Suit-10	3kg	200Cr	Vac Suit
Liquid Atmosphere Suit-8	30kg	10KCr	Environment Combat
Oxygen Tanks-5	10kg	500Cr	-
Oxygen Tanks-6	8kg	500Cr	-
Oxygen Tanks-8	6kg	500Cr	-
Respirator-6	1kg	100Cr	-
SCABU-6	10kg	300Cr	Environment Combat
SCABU-8	8kg	300Cr	Environment Combat
SCABU-10	6kg	300Cr	Environment Combat
SCABU, Pocket-8	.5kg	100Cr	Environment Combat
Space Parka-9	5kg	500Cr	Vac Suit
Survival Bubble-9	3kg	600Cr	Vac Suit
Thermosuit-9	2.5kg	1KCr	-
Vac Suit-10	10kg	5KCr	Vac Suit
Wet Suit-5	3kg	300Cr	Environment Combat
EVA-4	45kg	20KCr	Vac Suit
EVA-5	25kg	20KCr	Vac Suit
EVA-7	40kg	40KCr	Vac Suit
EVA-11	100kg	100KCr	Vac Suit
EVA-14	30kg	-	Vac Suit
Battle Dress-11	12-15kg	5-20KCr	Battle Dress
Battle Dress, Augmented-12	150kg	100-200KCr	Battle Dress
Chain Armor-2	25kg	2500Cr	-
Diplo-11	1kg	500Cr	Carousing
Flex-6	15kg	1400Cr	-
Flex-8	8kg	500Cr	-
Flex-9	6kg	600Cr	-
Flex-11	6kg	900Cr	-
Leather Armor-1	8kg	500Cr	-
Plate Armor-1	30kg	2500Cr	-
Plate Armor-2	25kg	2500Cr	-
Plate Armor-8	20kg	2000Cr	-
Psi-Shield Helmet-12	1kg	4KCr	-

EXPLORATION TOOLS

Almost anything can be considered an exploration tool, but this section is devoted to equipment that helps increase knowledge of the environment, either directly or indirectly. It also includes a few items that fit in multiple categories, but most appropriately here. Cross-reference to other sections is automatically provided. Some items listed are not commonly available, or commercially available at all. This may be due to very limited manufacture on worlds without formal Imperium ties, or the listed statistics may simply be inferred from historical notes. This is especially true for any items exceeding Sylean manufacturing capability, the known maximum in the Core subsector (officially TL12 in most fields).

"Amaze the Natives" Kit-12

During the long centuries since the last Imperial Survey, some worlds have declined completely into barbarism, reverting to a complete or near-complete lack of technology (by Imperium measure, TL3- is a lack of "technology"). Trade opportunities on these worlds are limited to raw resources such as precious metals or objects d'art, but anthropological, mercantile, or archaeological expeditions can still use the goodwill of the inhabitants of an area.

This simple 10kg shoulder case contains microchip voice recorders, body-heat sensitive fabric dyes, synthetic gems of all colors, high quality steel blades, candy, simple but effective medical preparations, and other inexpensive but impressive goods to pay for hospitality or make as goodwill offerings in exchange for information, guides, etc. Even the canister can be used as a shoulder bag or water sack.

Arc Welder-5

The arc welder operates off of an internal combustion generator that cannot be modified for other use. It can join most metals together with a very strong bond (Difficult Dexterity or appropriate skill task). The arc welder includes the special goggles needed for protection from the sun-bright electrical arc used, and a set of welding rods for a variety of metal joining tasks.

Atmosphere Tester-8

A solid-state device with read-outs indicating the atmospheric percentages of elements present. In addition, a red light glows if the atmosphere is not breathable, and a green light glows if the atmosphere is breathable. The military versions are at approximately double cost, but are more durable and may indicate the presence of a limited set of toxic chemicals, with a loud alert if unsafe levels are reached.

Attaché Case-8

An aluminum and magnesium carrying case similar to that used by technicians to carry precision instruments. It provides reasonable protection against most damage (rigid armor of 1) and may be lined with energy-absorbing foam to protect delicate items. Businessmen and diplomats may carry more ornate versions, lined with leather or exotic materials. These may also have an armor plate in the lid for additional .5kg and 200Cr, which will provide an improvised armor if held in front of the body (rigid armor of 3 for a torso-sized area).

Backpack-8

A good backpack will increase a character's unencumbered load by approximately 20%, and in addition frees both hands to do other things. The normal capacity of an exploration backpack is approximately .2m^3, which, depending on the items carried, will mass up to 100kg.

The rules for double and triple load can be extended to cover quadruple or higher loads, the ultimate limit being that neither Strength, Dexterity or Endurance can be reduced to an effective level of zero. Packing a backpack can be according to the following guidelines:

Light items (clothing, dehydrated food)
.002m^3 per kilogram
Medium items (preserved food, water, electronics)
.001m^3 per kilogram
Heavy items (weapons, ammunition)
.001m^3 per 2 kilograms

So, for instance, 15 meals of dehydrated food (1 kilogram), 10 liters of water (10kg), a change of clothing (4kg), a 4-man tent (2kg) and a sleeping bag (2kg) will have a volume of .15m3, leaving .05m3 for other gear.

Binoculars-5

At TL7 or less, these are often simple optical devices that magnify an image for clearer view. At TL8-9, they may include some electronic enhancement, from rangefinders and compasses to simple detection of non-visible wavelengths. At TL10+, binoculars are usually entirely digital in nature, with some optical focusing and magnification augmented by digital image manipulation and broad spectrum detection capability. For instance, a person could look at a radio tower and see it not only in high detail, but also its temperature, range, position, and the frequencies and power it was broadcasting on.

Binoculars can focus at distances as short as a few meters, which makes them useful industrial diagnostic tools, able to spot local overheating, radio emissions, radiation leaks, and so on. Budget models may have coarser adjustments and less precision, while high-end models will include motion stabilization for use from moving vehicles, and a voice and computer interface as well as fingertip controls. Pocket models (monocs) usually are fairly simple and have a number of fixed on/off type detection settings for easy one-hand use.

Biosniffer-13

The bioscanner "sniffer" scans for evidence of biological, metabolic activity in the area. It is a highly advanced combination sampler/analyzer. As long as the activity is in the same outdoor square, is downwind or took place recently, the scanner will function. The onboard computer will categorize the metabolic byproducts as best it can as far as lifeform and timeframe of deposit. A small hopper will allow introduction of trace samples or samples collected elsewhere. It has a range of Contact and the limitation that the source must be upwind. For unattended use, a small wind sensor and datalog will record the direction and parameters of any data collected for a period of up to several months, provided that a reliable power source is available. It can also sound an alert or send a signal to other computers upon detecting a signal of a certain type or threshold. The TL15 version is more compact and powerful, with a substantially larger on-board database. It is also capable of most chemical analyses such as atmosphere or water testing. The replaceable batteries are good for several hundred hours of operation. TL13 models are of recent manufacture, but are not commercially available on Sylea.

Breaching Charge-11
Breaching charges are configured charges of plastic explosive designed to blow man-sized holes in walls. The charge is the size of a thick notebook, with a self-adhesive panel on one side and an adjustable chemical time fuse on the other.

To operate a charge, the user peels the sheet of protective plastic film from the adhesive panel, breaks the prescored fuse strip at the desired time delay (five to 60 seconds in five-second increments), pulls the primer, and dives for cover (Average Demolitions task to get full effect).

Fire departments and rescue units often have a few breaching charges, used in efforts to free people trapped in burning or collapsed buildings. Charges made for such "civilian" use are striped dazzle yellow and black, and they usually have a fixed 60-second delay. The breaching charge contains sufficient explosive to breach an armor of 12, and has a general blast effect of 8.

Breaching charges purchased on most worlds require proof of competency (formal documentation of Demolitions-1 or better) and no criminal background that would indicate tendency for misuse. In addition, purchaser is often required to document the use of breaching charges or other explosives, and such documentation is subject to occasional verification audits.

Bullhorn-6
Electronically amplifies the voice so that it can be understood out to Long range. The plastic cone that directs the amplified sound makes the device bulky to carry.

Camera-11
Electronic recorder of visual images, either as single frames or sequential motion pictures, stored on standard computer datachips. Each chip can hold more still images than you are likely to need, or several hours of full-motion video. Basic models cost around 200Cr with minimal extra features. Units that cost 1000Cr or more usually have 100x zoom lens, low-light capability, remote control, etc. Most models mass about .5kg and fit in a pocket.

Carpentry Tools-5
Includes basic tools necessary to cut, shape, and build with wood. Woodworking may include construction and repair of shelters, buildings, or furniture. Contains both manual and power saw and drills of different types, measuring tools, hammers, chisels, abrading and finishing tools, ladder (3m), tool belt and locking carrying case for all but the ladder. Add 200Cr to cost at TL8+ for electronic measuring tools and aids. More compact tool kits are available, but have a smaller selection or quantity of tools.

Coldpack-7
Identical to the heatpack, but it drops to approximately freezing temperatures for an hour. Its main use is to reduce the swelling of minor injuries or reduce blistering from minor burns, and is only useful in hot weather to help stabilize a heat stroke victim (+1DM to Survival rolls on characters who have already passed out). It can be recharged by freezing it solid.

Communicator-10
Portable communicators are generally radio-frequency devices with a limited subset of the functions normally found on vehicle systems. While a vehicle communicator will have the ability to handle many simultaneously (TL^2 simultaneous channels), handheld ones are limited to a smaller number (simultaneous channels = TL or less), and are approximately a tenth the size and a hundredth the power requirements. Communicators with a mass of .1kg or less can be worn concealed from casual view. This cost and mass does not include any computer hardware, but does include a battery good for the listed duration of transmission (and approximately 100 times as long for just receiving or passive use). Circuitry for a Comm linkup would add negligible mass and 50-100Cr to the cost of most of these. Prices will vary based on local supply and demand. Full details on reliable communication range are found under the vehicle design guidelines for explorers.

Hand-Held Communicators	Mass	Cost	Battery life
Very Long-10† (1.5km)	.1kg	50Cr	20 hours
Very Long-12 (1.5km)	.1kg	50Cr	40 hours
Subregional-10 (10km)	.4kg	50Cr	80 hours
Subregional-12 (10km)	.3kg	50Cr	80 hours
Regional-10 (30km)	.6kg	150Cr	16 hours
Regional-12 (30km)	.4kg	150Cr	16 hours
Regional-12¶(30km)	.5kg	150Cr	100 hours
Subcontinental§-12 (300km)	2kg	300Cr	14 hours
Continental-12* (3,000km)	2.5kg	550Cr	14 hours
Orbital-12* (30,000km)	5kg	3KCr	3 hours

†This is approximately the range and size of a standard Comm unit.
¶This is a laser communicator, requiring a precise location of the recipient of the transmission, but has the advantage that it cannot be intercepted or eavesdropped on in vacuum or clear atmospheres. It cannot be used at all in obscured atmospheres and is strictly a line-of-sight device.
§A communicator of this range can be used to contact low-flying communication or survey satellites to relay the signals to other points that are out of line-of-sight for the ground unit.
*These use directional antennae that require a good knowledge of the receiver's position, made easier if the receiver is transmitting a signal to be homed in on.

Compressor-6
This is a small internal combustion power plant (.002Mw) that drives an air compressor. The high pressure air output can be used to recharge compressed air tanks, or power paint sprayers, sandblasters and pressure washers. It can recharge a SCABU tank in approximately 15 minutes and can be hooked up to recharge several at once (at a slower rate).

Cryoberth-11
Usually referred to as the "icebox", this is a means of permanently stabilizing an individual who is dying, or even very recently dead. While the preparation of an individual for cryostasis should be done by trained medical personnel, it has been handled successfully in emergency situations by completely untrained individuals. Sometimes. If properly interred, the individual will be placed in cryostasis with negligible tissue damage, and can be thawed out at any later time and revived in a condition no different than when they entered.

Cryoberths are usually powered by a vehicle's power plant, but have a backup unit good for several days. Long-term independent power can be provided in the form of a fusion unit for an additional cost. A cryoberth has a mass of about 200kg plus the mass of the occupant, has a volume of roughly 2.5 cubic meters, and costs 50,000Cr (five can be crammed into one displacement ton of starship space).

While it costs as much as a starship low berth, it is not quite as capable. The increased cost is a tradeoff for decreased size, so it can be used in smaller vehicles. There is an extra -2DM applied to any survival chance when using a miniaturized cryoberth, and most people having to use one would much prefer staying there until the best possible medical facility can be located. Interstellar travellers are advised to have documentation of

their cryonics wishes in case this situation arises. Some individuals of wealth have actually requested that if resuscitation fails, they be re-frozen until such time as technological advances allow a better chance of success. Dame Margrethe Espan (born year -1731), daughter of the last Provincial Governor of Sylea, was "killed" during the Fusileer Riots of -1702 and placed in cold-sleep. Amazingly, her chamber remained intact through a score of owners, not all of whom have been documented, and some of whom were moderately embarrassing (such as a circus sideshow). In -323, her chamber was acquired by a consortium of her family's descendants, and placed on permanent display at the Metropolitan Museum of Science and History, maintained by an endowment set up solely for that purpose. Recent reacquisition of medical technology made treating her injuries possible and, according to her legal request almost two millennia ago, resurrection was attempted. The attempt was successful, though not without complications and a significant convalescence. No longer extremely wealthy but still financially independent, she currently teaches Solomani History at Armitage Polytechnic University.

Cutting Torch-5
A chemically-fueled torch good for small repair jobs and spot welding. Fed by tanks of acetylene gas dissolved in acetone and pressurized oxygen, the torch can be active for 30-90 minutes continuously, depending on the intensity of the heat produced. It can cut through up to a linear meter of 1cm hard steel per 10 seconds, and proportionally less of tougher materials or greater thicknesses. Refills of the gas cylinders cost about 50Cr.

When used as an improvised weapon, it has a damage rating of 2 and can only be used in melee. It can also be used over a few minutes to fill a room with extremely explosive vapors capable of doing 1D damage to everything within the enclosure when it ignites (roll for each affected target).

Densitometer-13
An outgrowth of gravitics technology, the remote densitometer uses an object's natural gravity to measure its density. The densitometer is able to map and display areas of different relative densities, making them useful for detecting and mapping the extents of mineral deposits. They can also detect the presence of objects in empty areas, such as spacecraft or asteroids in open space. A handheld densitometer is not so useful, but can map nearby density contours (within the same outdoor square), bypassing most physical obstructions. Energy fields from nearby contragrav or thruster plates will disrupt its use. Any expecting person can "spoof" the densitometer by planting multiple objects of the appropriate density, or hiding the target object within a larger mass, provided the hidden object is at or near the resolution of the densitometer.

The TL13 densitometer is a backpack unit with a bulky detector array and handheld visual display/control panel. The TL15 model is mounted on a wide, heavy belt and has a smaller display panel connected by a short range radio link (or cable if necessary). Both consume approximately 100 watts of power.

Echo Sounder-6
A device that sends out a pulse of high frequency sound and then reads returning echoes to give a range between the sender and any obstruction. Low-cost models are usually effective to no more than 80 meters, and only little accuracy at ranges of over 40 meters. More sophisticated models (available at tech level 7+) are capable of showing a fairly detailed display of the area at which they are aimed, including animal life and other details.

Echo sounders are usually mounted aboard boats and submersibles, where they serve as depth finders. Portable models, however, can be mounted in waterproof camera housings and used by divers. They not only determine depth but also can be used to find horizontal ranges or to navigate in water obscured by silt. All portable echo sounders have a battery good for 100 hours of use, or are normally hooked into a vehicle power supply.

Electronic Tools-5
Necessary tools for basic assembly and repair of electronic devices such as communicators, detectors, sensors, and control instruments of a TL equal to the kit or up to 2 levels lower. It includes part removal tools (like pliers and screwdriver), sophisticated test and diagnostic instruments (for that particular TL, anyway), circuit repair tools (like a soldering iron), and common spare parts (like fuses).

Emergency Beacon-10
A combination long-range communicator and signal transponder, the emergency beacon is a very sophisticated signaling device. The receiver monitors common emergency search-and-rescue channels (one at a time), and when traffic is picked up on a channel, the device emits a shrill warning tone to alert users to the possibility that help is at hand and transmits a coded distress signal. The more expensive models have provision for a taped, auto repeat distress call in lieu of automatic code signal. In either event, the emergency beacon serves as a means of establishing contact when there is any search being mounted within Continental range (3,000km), and then it serves to continue communications after that initial contact. The transponder operates for 30 days in passive mode, but includes a small hand crank to keep the internal battery charged. These beacons are often found in any high-quality survival kit. Lower TL's (down to TL7) have similar beacons, but with fewer channels and shorter range.

Entry Cutter-10
This is a portable laser cutter designed expressly for making circular entry holes in obstinate barriers. It consists of a water-cooled laser cutter head (attached to a power supply of at least .1Mw), a motor, and gear train. It can cut holes from .5 to 2 meters across in anything that can be melted by the laser beam, with a practical maximum depth of .3 meters. It will generally be calibrated to the toughness of the material in question, but can make a 6-meter linear cut at 1-centimeter deep in soft steel per minute. For tougher materials, adjust the time proportionally. In the event that the laser is unsuitable for cutting, a diamond-edge cutting bar can be fitted, but this requires constant adjustment and head replacement.

The entry cutter will fit entirely within a portable airlock, but care must be taken to make sure the hot edges of the entry hole or removed plug do not contact the walls of the airlock.

Excavating Tools-3
Picks, shovels, etc., suitable for up to 4 people to move sand or tunnel a short distance. Most can be used as melee weapons with damage rating of 1 and -2DM to their combat rolls.

Exoskeleton-11
The handling of non-standard containers from non-Imperial worlds and movement of goods from irregularly shaped cargo holds is usually handled by exoskeleton "forklifts". These are vaguely anthropomorphic machines with large gripper claws and counterweights, enabling the manipulation and movement of very heavy loads. Folded for storage, an exoskeleton unit will

mass around 300kg and take up 3m^3 of volume. Assembled, it is about 2.5m tall and 1.5m wide, an open tubular framework that the user stands in and manipulates via body movements and waldos. They see the greatest usefulness in cargo handling at unimproved landing zones.

An exoskeleton has an amazing Strength in game terms, able to lift and carry objects of two metric tons or less, or slowly crush objects with a rigid armor rating of 5 or less (1D damage per round), but it pays for this with low agility and specialized skill requirements. Battle Dress skill is required to use an exoskeleton (look for ex-army types in the warehouse!). An exoskeleton user suffers a -2 to Dexterity and it cannot be used for fine work at all — this is with an effective Strength of 15. Attempting an aggressive use of higher Strength is an additional -1 Dexterity per point of increased Strength desired, but this penalty does not apply to anything already firmly gripped. Movement is at normal human rates. TL11 units use legs for motion, but new models may be equipped with contragrav for deep space use.

The exoskeleton provides no armor protection to the user, and would be treated as a vehicle with an armor of 2 for purposes of resisting damage itself. The battery power of an exoskeleton is usually good for a little over one shift of constant work, or about 10 hours. Battery packs can be quickly swapped, or recharged in place in about an hour.

Flare-8
These signal flares emit both a bright light and a pillar of colored smoke for 15 minutes after ignition. Once set off, they burn constantly and cannot be extinguished (short of putting them in a fireproof, sealed container). Sighting in either day or night is nearly automatic in line-of-sight. Smoke flares are specifically designed to be hand-held or implanted in the ground. Exercise caution in dry conditions, as accidents may ignite nearby flammable materials.

Flare Gun-8
A flare gun is used for long-range signaling, and it has a number of applications, both civil and military. It consists of a pistol-like launcher which can fire any of several types of flares up to 50 meters. In addition to signaling, it can fire illuminating flares for spotting purposes at night. A signal flare is a standard type which provides an easily noticed trail of light (but no real illumination). An illuminating flare for 30 seconds provides usable light for everything in a radius of 50 meters around the firer. Such flares are always noticed at night but have little effect by day. Flare guns for spotting flares may carry up to five rounds that can be fired in rapid sequence, but parachute illuminating flares are single-shot weapons that must be reloaded after each use.

Flare guns can set fire to flammable materials as secondary effects, but do not have any practical weapon use. If either kind of gun is used as a weapon, treat it as having a range of Contact and a damage rating of 1/2.

Flashlight-5
A small electric light that either provides illumination over a small area (in one outdoor square), or projects a narrow beam out to longer range (Short range) for up to 12 hours, or to greater range (Medium) for up to 4 hours. The main difference at higher TL's is smaller mass. Still the cheapest and easiest means of seeing in dark conditions and most households will have at least one. Battery refills are about 2Cr each, or rechargeable batteries may be used at +50% cost.

Generator-6
Portable generators run on hydrocarbon fuels and are available in various increments of power output. Figures listed are typical for .01Mw units, which consume approximately .1m^3 liters of fuel per 10 hours of operation (one fueling).

Grapnel Gun-8
Originally a civilian climbing aid, the grapnel gun has found its way into the lockers of more than one adventurer. A gas-propelled grappling hook and launcher made from fiber composites, it can loft a lightweight climbing rope up to 100 meters vertically, and the gas cylinder is good for four maximum power shots, or up to ten at shorter distances. Replacement gas cylinders cost 50Cr and mass .5kg. The TL10 version has a small motorized winch capable of lifting up to 250kg, and has attachments to be hooked to a standard climbing harness. The battery pack is integral to the gas cartridge and is good for about 500 meters of lift distance.

If used as a makeshift weapon, it has a range of Contact and a damage rating of 2. In addition, anyone hit by it usually must make an Average Dexterity roll or be knocked down by the grapnel and its trailing rope.

Heatpack-7
This is a reusable, palm-sized chemical pack that produces temperatures of 50°C for about an hour once activated, and has a more or less indefinite shelf life. It won't keep a person warm, but it can negate localized cold effects for a few hours by sticking them in your gloves or boots (+1DM to Survival rolls). After the chemicals in the pack have crystallized, the pack can be recharged by boiling it in water for an hour or so.

Ice Axe-3
An ice axe is frequently useful in making climbs in snow and ice. Has limited use as a weapon, but not to be dismissed lightly (use Brawling or Melee Combat skill, damage rating of 1).

Inertial Locator-9
Indicates direction and distance travelled from any pre-set starting location and will show current position on an internally generated map, including altitude changes. Accurate to within 0.1% of total distance travelled, but must be reset if used in inertially compensated vehicles. It may be belt, arm or headset mounted, depending on manufacturer or intended use.

Intrusion Tools-5
These are tools sometimes necessary for bypassing malfunctioning security equipment. Possession may require permit or registration on some worlds. At low levels of technology, they include lockpicks for defeating mechanical locks, plus small pliers, wire cutters and a simple test meter for checking electronic circuits. Medium-tech versions will include ultrasound, radio and infrared detectors and generators, and simple diagnostic readouts for rudimentary computer circuits. High-tech versions will contain expert system diagnostics to help disengage recalcitrant alarm circuits, magnetic sensors, and basic biometric data generators. Not all tools are required for a given task, but a full set covers most eventualities. Getting a full set usually requires acquiring individual items from a number of sources or access to a central training facility for this specialized task.

Iris Valve Opener-10
This is a small but powerful electric motor attached to an infinitely variable transmission. When hooked up to any power supply of 1,000 watts or more, it can be used to pry open non-func-

tioning iris valves or regular doors, either by force or by attaching it to emergency crank handles. The time required varies with the size and obstinacy of the door in question, but the gearing of the opener can go low enough to eventually bend and tear through almost any barrier (or lock or set of gears) of average resilience. Very few unlocked doors require higher level of persuasion, and few man-sized ones can resist it.

Lamp-3
Burns oil or some other flammable liquid to provide light. Gives about 6 hours worth of light in a small area (one outdoor square), and a small amount of heat, capable of warming small or well-insulated spaces. Refills of oil or gas cost 2Cr and .1kg each.

Laser Cutter-10
An industrial laser cutter is an array of lasers focused through a cooled lens to a minuscule short range beam. It will cut or spot weld up to 1 meter of 1cm soft steel per 6 seconds, with proportionally better or worse performance against more or less durable materials (for instance, superdense is 11/4 as tough as soft steel, so you would cut through 4/11 as much per turn). Normally the laser cutter is used at Contact range, and has a small roller and hood for maintaining optimum distance and catching stray reflections. Industrial laser cutters require about .02Mw of power to run the laser and cooling system. This is now usually provided by a nearby Fusion+ unit, but extension power cables or battery packs may also be used, noting that .02MW/hour of power is needed per hour of operation.

If used at range, treat as a Contact range weapon (maximum range is also Contact) with 4D damage rating, since any hit is likely to be a wavering linear laser cut or multiple spot hits.

Lightsticks-6
These use a non-volatile chemical reaction to produce usable light in a small area (one outdoor square). They last approximately 5 hours, and can be acquired in most colors, including infrared-only versions. Coldlight lanterns use disposable reservoirs of chemicals to produce an adjustable and more constant illumination for 50-80 hours, and can be turned on or off as needed with a several second delay. Refills of the lantern cost 2Cr. Either can be used safely in volatile atmospheres or in the presence of flammable liquids.

Machete-4
Utility blade used in cutting vegetation to clear a path, campsite, etc. As a melee weapon, treat it like a broadsword.

Magnetic Compass-2
Indicates direction of local magnetic north, if the world has magnetic poles. Most habitable worlds have magnetic fields to deflect solar radiation. May be influenced and give false readings in the vicinity of large masses of iron. Sophisticated models (100Cr) may be used for coarse surveying or navigation tasks. Compasses are usually tailored to the needs of a particular world, since alignment of magnetic pole with geographical pole varies with each world.

Mechanical Tools-5
Includes basic tools necessary to repair and alter mechanical devices, vehicles, and guns. It includes adjustable wrenches, pry bar, large and small pliers, micrometer, soft and hard hammers, numerous screwdrivers, small rivet gun and rivets, small quantities of industrial adhesives and lubricants, and a small supply of fasteners like screws, nuts and bolts.

Med Microscan-11
The pocket med scan is an indispensable device in the satchel of a physician. Medical skill is not needed to operate the scan but the skill is necessary to properly interpret readings. A doctor or nurse needs only to press against the patient's chest with the small disk-shaped probe. In 5 to 10 seconds, the scanner accurately determines body temperature, blood pressure, pulse/respiration rate, level of neural activity, and fluid balance. This useful device greatly reduces the time needed to make a Medical task, effectively reducing to zero the time needed to take a patient's vital signs. The scanner probe can actually be used anywhere on the subject's body, but no respiration rate is available apart from the chest site.

Once the reading is made, upon pressing a small button the device records the values in the scanner's memory. These records can be called up later for review. Set points on the scanner can be keyed so if readings reach a certain level (either high or low), the scanner beeps to alert the attending physician. Small adhesive pads or straps are used to attach the scanner temporarily to the chest for this purpose.

Med scanners can be used on any race with most of the same biological parameters (beating heart, breathes air, etc.). This requires a simple scrolling through the menu until the desired race is found. It is, however, a Difficult task to correctly place and use the device on a race other than your own.

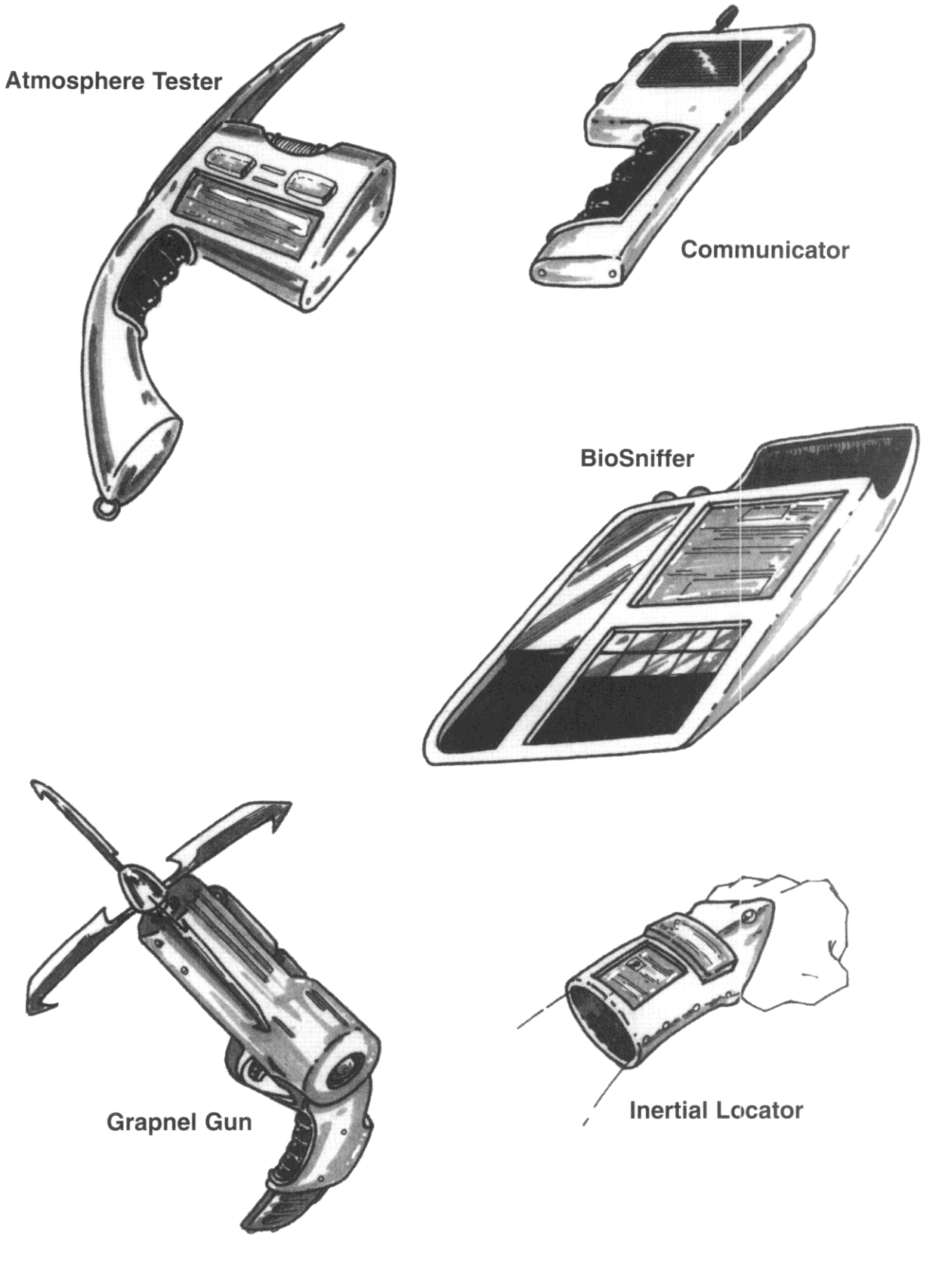
Vac or EVA suits at tech level 11+ are designed with contact points (and a remote sensor) to allow a med scanner to be used without requiring removal of the suit. Some suits may even be equipped with a full unit, which will allow rapid downloading of all vital signs over the past 24 hours, sampled at 1 second intervals. Paramedic kits at TL11+ include a medical microscan unit.

Med Scanner-11
This larger, hand-held version of the pocket med scanner takes rapid readings just like its smaller cousin, and thus greatly reduces the time spent on a Medical task. The larger scanner differs from the pocket version in that this hand-held model includes a complete expert system diagnosis computer, which allows individuals with little or no medical skill to diagnose and treat illness and injury. The larger version also has an ultrasound imaging system and image recognition software that greatly aids in visualizing and treating internal injuries.

Metal Detector-6
Indicates presence of most metals through soil or rock, although the degree of reaction depends on amount of metal present and on proximity. May be used to locate TL5-8 land mines, and will generally detect a liter or more volume of metal to a depth of approximately a meter.

Metalwork Tools-3
Includes basic tools necessary for light metalworking, welding, and shaping. Metalwork may include the construction and repair of shelters, vehicle bodywork, and alteration of metal structural items. Archaic tool kits are essentially a portable blacksmith's forge and tools, while TL5 versions may include a low-power cutting torch, welding rods, heavy hammers, metal cutting shears, files and abrasives. TL8 versions include these and a few basic power tools of various types. Less complete tool sets are available, but usually only include manual tools or a smaller selection of them.

Multiscanner-10
A multiscan (or Multi) is a specialized computer designed for interpretation and analyses of environmental data. In its basic


Atmosphere Tester
Communicator
BioSniffer
Grapnel Gun
Inertial Locator

Tools
In general, for any physical endeavor that can be aided by tools, like running, climbing, swimming, building, repairing, etc., having good quality equipment is a definite plus. If a character has the full set of the best possible equipment, it is usually good for a DM of +TL/5 (round down), applicable only to offset penalty DM's. So, a character with generic TL10 climbing equipment will be able to do climbing tasks at a TL10 level of convenience, but a character with the best TL10 equipment will counter up to -2DM in penalties.

form, it is a rectangular box with a belt attachment and contoured grip. On the face is a 3D screen and touchpad. On one side are up to four chip ports, and on the front side there are four smaller data ports. Typically, you would buy a set of programs and sensors appropriate to the tasks you wished to perform. A geologist might buy a mass spectrometer and mineralogy database, while a botanist might have sensors for analyzing organic material, an anthropologist might have a language translator and a meteorologist could have his linked to a portable weather station and sursats. They can be programmed to run automatically to detect and alert the user if certain conditions are met, and are often used in this way by all members of a survey team if the budget allows. This could include perimeter watch at night, alerts for radiation or atmospheric toxins, signals within a given part of the radio spectrum, and so on.

Many of the individual functions of a Multi can be handled by cheaper and lighter special purpose tools, but most survey teams need a variety of functions and prefer the Multi. A Multi has a mass of about .8kg, and costs 3,000Cr. The price is high because it has all the functions of a personal computer, but is smaller, more rugged and has more ability to handle non-digital data. Individual sensor packages vary in cost, but range from 200Cr to 2KCr, depending on their sophistication and how recently the technology was miniaturized to this level.

Neural Activity Sensor-13
Developed from tech level 12 psionic helmet theory, the neural activity sensor (NAS) was first used medically. It remotely detects the electrical activity of a life form's central nervous system and classifies it according to amount and complexity. The data system compares the activity pattern to known types of life, especially intelligent life. The unit requires some skill to properly calibrate and operate, but once the normal lifeform readings for an area are gathered, an on-board expert system will aid in classification and interpretation of data.

Detecting complex neurological activity in a target area is handled as a ranged combat task with a short range weapon (which may be aimed). This works versus a specific area the size of an outdoor square. Scanning a 30° arc is a -3DM and aiming does not apply. In areas with a high density of life, the NAS may be set to a certain threshold, which corresponds more or less to the size of the creature (within 50%).

The portable unit consists of a backpack and a handset with a retractable parabolic dish focuser. The handset in fact is not attached to the backpack, and it can be operated up to 100 meters distant, which further extends the range. The NAS runs off a pair of .5kg battery packs, which last for up to 20 hours of use. An optional scanning head (2500Cr) will allow unattended use of the NAS (with an effective skill of 6) and scans a 30° arc per turn (the -3DM is taken into account). These units are not available on Sylea, but limited manufacture on other worlds has been reported.

Night Glasses-9
These are simple wrap-around sunglasses with full ultraviolet and low-power laser protection (count as reflec), combined with a thin-film color image intensifier array. These permit normal vision in conditions of nearly complete darkness. Technically, they are not transparent at all, but simply provide a computer image of what the user is looking at. Power consumption is low, and further reduced by an off switch that is engaged when the unit is folded. Military/security versions (available to civilians) have a temple-mounted switch that turns night images into shades of red rather than full color, to reduce loss of natural night vision.

Night glasses have negligible mass and cost about 500Cr. Models that can be used as a computer display and therefore a video Comm unit or targeting adjunct will cost up to 500Cr extra, depending on capabilities desired.

Night glasses are a convenience item, not a high-quality military technology. They do not have the same resolution as binoculars or more expensive devices, and are mainly designed for relatively short-range tasks like driving or walking. Any work that requires fine resolution of detail will be at a -1DM for each point of range band. For instance, identifying a particular person by facial features at Medium range (band 3) would be at a -3DM.

Paramedic Kit-8
This medical kit has rudimentary electronic devices for monitoring a patient's health, and usually has low-speed communication links to transmit this data to the nearest major medical facility. It can be used for diagnosis and stabilization of serious wounds, radiation burns, chemical burns, poisoning, and treatment of minor injuries. A modern TL11 first-aid and medical treatment kit will contain drugs, surgical supplies, and diagnostic materials for doctors and emergency medical technicians. This medical kit is sufficient for both minor and serious wounds, and it can be used for the treatment of animal injuries, radiation burns, chemical burns, poisoning, and drug overdoses. It is not suitable for invasive surgery or major medical procedures.

Pitons-4
Pitons are metal spikes fitted with a ring at one end (to pass a rope through), used in mountain climbing as a hold. Several specific types are available. The simplest pitons (TL4) are soft iron spikes driven into rock. An advanced version, available at Tech Level 7, is of similar design but uses superior alloys. At TL9+, adhesive pitons are available. They are not driven into rock at all, but use a quick-setting superglue to attach themselves to most rock faces. Once set, they cannot be removed without using special solvents. However, using these pitons doubles ascent speeds.

The ultimate in pitons, available at TL10 include a special driving tool (1kg) with high-density battery. Special pitons are attached and the tool pressed against the rock face. When activated, a sudden white-hot burst of heat helps set the piton with a minimum of effort (just steady pressure by the climber). This will also set pitons in soft iron, armor steel and crystaliron as well as stone and cement. The statistics are for a set of 50 pitons, which will be good for up to 50-300 meters of ascent, depending on the difficulty of the face.

Pitons do not provide a bonus to climbing, but simply allow climbing in situations that would otherwise be impossible, and mitigate the effects of mishaps (you only fall as far as the last piton before your rope goes taut).

Personal Datalog-8
These are small electronic recorders commonly used when Comm links to a central computer are unavailable. At lower TL's, they are suitable only for making audio notes or simple sound recordings. At higher TL's, they can link to most electronic equipment and store most forms of digitized information using standard computer storage blocks.

Portable Airlock-10
An inflatable, portable chamber that can be attached to the vacuum side of a bulkhead, entered, and pressurized for a hole to be cut into a pressured area without depressurization. It includes a patch held in place by pressure that seals the hole when the airlock is depressurized. The airlock compacts into a flat parcel approximately 2m x 1m x .2m, which includes rigid doors and external supports, an inflation cylinder and compressor. Due to the basic nature of the airlock, the compressor battery needs recharging after 20 cyclings. Fluid entry and exit valves are included for using the airlock as a decontamination chamber, though it is not proof against insidious or corrosive atmospheres.

Purification Tablets-5
A bottle of 250 tablets to make contaminated water safe. One tablet per one liter will render the water safe in 30 minutes. Kills microorganisms, but does not nullify chemical contaminants.

Radiation Counter-6
Indicates presence and intensity of radioactivity in the immediate vicinity. It can be preset to give a warning signal if levels of radioactivity rise to dangerous levels. Readouts are given in specifics and in terms of danger to humans. Battery life is around 200 hours for TL8- models, and several weeks for higher TL models. TL6 models are the size of a liter bottle, TL8 models are palm-sized and TL10+ models are the size of a wristwatch or less.

Retroreflector-8
A device consisting of several mirrors in such formation that they will reflect exactly 180 degrees any incoming light beam or radio signal within a field of 15 degrees. They are largely used in surveying and tracking, as they extend the range of an active sensor by one range band, solely for the purposes of finding the retroreflector. So, mounting one on something you wish to track makes it easier to spot. They generally are about 25cm on a side, and cost about 100Cr each. Ones designed to work only on limited frequency ranges cost double, but reduce the possibility of interference from broadband natural light sources.

Rock Hammer-8
Used to drive pitons or dig foot or handholds in loose rock. Has limited use as a weapon, but not to be dismissed lightly (damage rating of 2).

Rope-1
Any form of flexible cord designed for carrying, lifting or tying down of small loads. At TL's of 1-5, it is usually of organic fibers. At TL6+, it is of some form of synthetic fiber, and may have special properties at TL8+, such as increased stretch, fire resistance, conductivity or insulation, etc. At TL's of 8+, rope can be made strong enough to climb, but too fine for hands to get a grip. Such rope has half the normal mass, but requires special tools to climb or descend from. Listed cost and mass is for a length of 50 meters capable of safely holding 2000kg (each doubling of mass or sudden stress after this is a 2D roll of 9– to survive intact, and may result in permanent rope damage even if successful: -1DM to future stress rolls).

Slaplock-8
A slaplock is a relatively simple means of temporarily securing a portal of virtually any kind. It consists of a flexible metal plate with high strength adhesives on each end: you simply peel off a protective film, and slap it across the gap between the door and the nearest structural support. It can be removed with industrial solvents, but is normally just pried off. A slaplock adds 6 to the Strength needed to force the portal, whether a conventional door or an iris valve (obviously it works better on locked doors). Each one after the first adds 2 to the Strength required.

Sleeping Bag-5
Allows the user to sleep in cold environments without wearing bulky and uncomfortable cold-weather clothing, or to engage in meaningful cultural exchanges that would otherwise be hindered by such clothing.

Spotlight-6
A portable or vehicle mounted searchlight that projects daytime-level light over a narrow arc out to Medium or Long range, using between 100 and 1000 watts of power. Does not include power supply.

Surgical Tools-5
This includes scalpels, forceps, hemostats, clamps, and other tools for major and minor surgery at low tech. TL3- tools may include bloodletting tools, amputation saws and other items that may appall higher-tech characters. Either set may include extremely basic inhaled anesthetic compounds.

Sursat-11
Cheap, small research satellites that planetary survey teams will often have several of. With a stored volume of .25 cubic meters and a mass of 50kg, a multisystem mission team may have over a dozen in the cargo hold.

When deployed out an airlock, sursats use a built-in fusion plant to maneuver into the desired orbit, and begin cataloging data based on survey needs. Typical information gathered includes meteorological data, geography, radio and radiation emissions and electrical power use, and major urban areas or any apparent artificial structures of significance. In addition, sursats can receive signals from Comm boosters and relay them elsewhere on the planet or in orbit, and also act as a global positioning system, provided at least 6 sursats are in proper orbits.

Sursats cost about 100,000Cr each, and are not designed to be either stealthy or able to take much damage, and so should not be used for clandestine missions or missions in hostile environments of any kind.

In detail, a Sursat includes subcontinental range (300km) optical sensors with a resolution of 2cm at 100km range under optimum conditions, a subcontinental range (300km) radar unit of 5cm resolution, with optional steerable directional antenna to extend its range to track more distant targets, a small-vehicle class continental range (3,000km) video transceiver, a rating 2 computer optimized for communication and data transfer, and a small Fusion+ unit and 1000 hours of fuel. Trying to bypass its internal security for unauthorized reprogramming is a Difficult Computer task, with a time based on getting by a rating 6 program. It has no damage absorption capability in starship terms, and any weapon hit will destroy it utterly.

Survey Shield-12
It is expected that in the 1200 years since the last Imperial survey, some of the worlds contacted will no longer be spacefaring cultures, but will still have a significant orbital presence. In the

final years before a collapse of space travel, low-orbit combat for control of ships and resources would be common, and debris from these battles can remain in transit orbits for millennia, posing a real hazard to lightly armored survey ships. On a related note, extended research near high radiation sources like intense magnetospheres might result in unacceptable levels of radiation exposure. For ships in parking orbits that have to deal with either of these problems, a collapsible shield has been developed. This is a one metric ton self-rigidizing assembly of hexagonal foamed metal plates with high-density ceramic backing and on-board sensing, telemetry and microthrusters. This is placed in front of most ship designs of up to 1,000 tons displacement by manipulator arms, ships boat, or even by ejecting it from an airlock and maneuvering it into place with the microthrusters. Once in place, it will maintain station and report on radiation, micrometeor and macroscopic projectile impacts. Each 30cm hexagonal panel (.1kg) is capable of sacrificially absorbing the energy of a 10km/sec particles up to 1cm in diameter , generating secondary debris particles of negligible force, or providing a safe shadow from exposure of up to 500 rads per hour. In the latter case, production of radioactive byproducts may preclude refolding and stowage of the shield on board the carrying ship. A survey shield costs about 10KCr and is available through Imperial channels or third party contractors. Discounts may be available for sponsored missions.

Survival Kit, Desert-7
A kit containing a variety of items useful in the desert. Includes a one-liter canteen (full), simple first-aid kit, salt tablets, plastic folding shovel, small heat-reflecting tarp, 20m of lightweight cord, plastic watertraps, straws, instructions for building three solar stills, a knife and sheath, a signal mirror for attracting the attention of searchers during daytime, and a water filter kit (see below). The kit comes in a 30x12x12 centimeter pack which can be worn on the back or hip or attached to a larger pack. Provides a +2DM to Survival tasks in desert.

Survival Kit, Individual-8
Imperium safety regulations require that one of these kits be carried for each 4 passenger berths on all Imperium-registered starship lifeboats. However, these regulations are fairly new, and do not apply to ships without lifeboats, military vessels such as scouts, and a number of other exceptions. Inspection of the kits is usually limited to checking the tamper seals on the outside of the lifeboat hatches during yearly spaceworthiness certification. Walton Outfitters makes a standard kit that matches current Imperium regulations, and at a competitive price.

Each kit contains:
4 Filter/Respirator, plus filter selection
4 Resealable 4 liter water bags, full
1 Water purification chemicals (up to 50l)
30 Person-days of concentrated food bars
1 Bullpup and 50 rounds ammunition
30 Chemical lightsticks (24 hours duration)
1 Survival tent
1 First Aid Kit
1 Brush cutting axe
1 Rope, 50m
4 Disposable cold-weather suit (1kg)
1 Survival manual

These items are in a cloth case that it accessible only by sealed hatches on the outside upper surface of a lifeboat, thus making them inaccessible until the lifeboat has landed. The full case costs 4000Cr, has a mass of around 60 kilograms, a volume of .1m3, and floats if intact.

Survival Still-11
Nobody likes survival stills, but every survey team has used them on occasion. This is a small fusion plant and chemical distiller/synthesizer that turns almost any organic material into water and something edible and harmless (but usually tasteless and textureless as well). If material that cannot be safely converted is used, it will not process anything in the hopper until it is removed. The input hopper will hold several liters of material, and can chew it up and spit out what is affectionately known as "glop" in about 2 hours time. Glop is usually stretched out with known edible material or rations into "glop stew", or dried and used as ration bars.

The still is a simple version of a ship's recyclers, which under computer control can turn glop into synthetic food with a bit more texture and flavor. If a crew has a survey ship capable of landing, the still is only used to provide raw glop to the ship's recyclers, because while everyone knows what goes into the ship's recycler, no one really wants to talk about it.

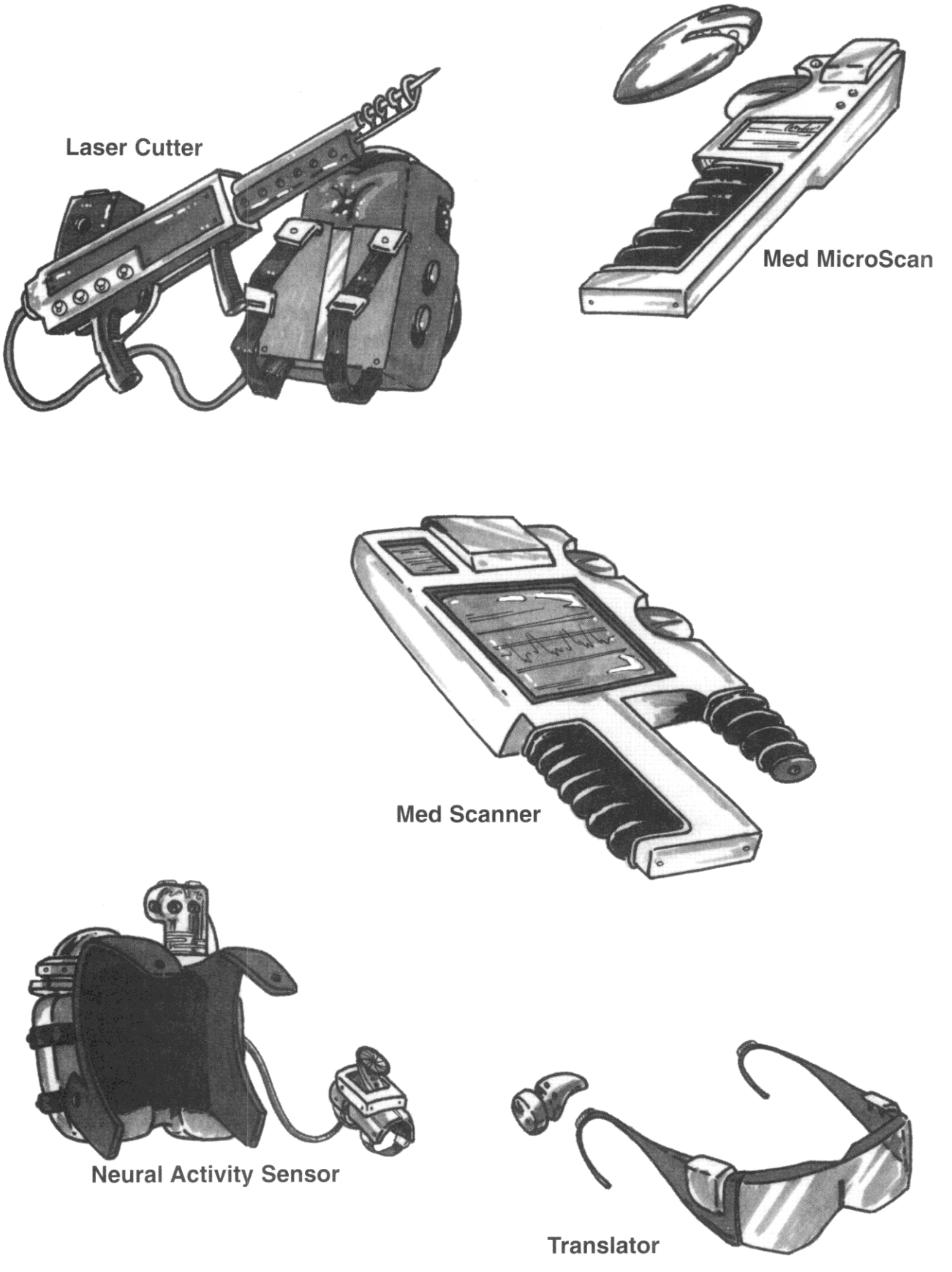
A survival still usually masses about 30kg, and runs off a vehicle power plant or portable generator like a Fusion+ unit. It costs about 5,000Cr, and is internally a fairly complex bit of machinery.

Survival Tent-11
This is a standard item for exploration teams, and ship's boats often have one stowed behind a panel with other emergency supplies. It comes in two cylindrical parts, with the top removed before activation. If directions are followed carefully (and your life may depend on it), the lower half becomes a 2 cubic meter "airlock", plus a 17 cubic meter hemisphere (4m diameter, 2m high), inflated with breathable air from a separate canister. The half-dome and airlock quickly become permanently rigid from a catalytic reaction triggered by activating it. It is anchored to the ground if necessary, and the occupants can enter. The survival tent has a marginal solar power supply built into the fabric, and three windows of reasonable transparency. The "doors" are simply panels of rigid fabric, and atmosphere integrity is maintained by gluing them shut after each use. The airlock has no means of pressure control, and some of the external atmosphere (if any) will get into the tent after each use, and some of the internal atmosphere will be lost to the outside after any use. The remaining piece of equipment is a combination emergency beacon/atmosphere circulator, which can provide a breathable atmosphere for up to 6 people indefinitely, and filter out traces of harmful atmospheres like chlorine, ammonia and methane. The tent cannot keep out insidious atmospheres, but might be able to filter them. Corrosive atmospheres will eat through the tent in 7-10 days, depending on local factors. The beacon uses metal fibers in the tent as an antenna, which also help the tent reflect radar scans. It is presumed that anyone using such a tent on an inhospitable world is expecting rescue within a few weeks, but if not, a small supply of euthanasia patches is provided (patches, so you can change your mind anytime before becoming unconscious).

On hospitable worlds, a survival tent can be used as an equipment locker, shower, radio hut, or any form of semi-permanent dwelling by slapping on a few adhesive strips to act as door hinges and latches, and cutting out the windows for air circulation.

A survival tent is about a meter long, .2 meters in diameter and masses about 20 kilograms. They are available through Imperial channels for about 2,000Cr.

Swimming Equipment-3
Basic recreational swimming equipment, including swim fins, face mask and snorkel. Swim fins double movement rate in the


Laser Cutter
Med MicroScan
Med Scanner
Neural Activity Sensor
Translator

water, and the face mask eliminates the normal problems with underwater visibility (negates the -3DM normally taken for trying to see objects underwater).

Tarpaulin-1
A canvas or waterproof cloth sheet used for temporary shelter, measuring 2x4 meters. At TL8, it is an aluminized fabric sheet measuring 5x10 meters that reduces incoming radiation by reflection. It can be used for any purpose a regular tarpaulin can, and is also large enough to be stretched over a small boat or frame for a multi-person shelter.

Tent-3
Basic shelter for two persons, made of waterproofed canvas or leather. Larger, more elaborate tents weigh and cost more.

Tent-11
A good quality camping tent: self-erecting and compacting thanks to electrically stiffened fabric ribs, waterproof, and a replaceable power cell good for several weeks of operation. It will automatically adjust fabric color and opacity in an attempt to keep the inside close to the human comfort range. It may also have a variety of height settings, so that in windy areas it can be made into a flattened, more streamlined shape. This type of tent will cost about 200Cr for a 2 person version, and 500Cr for one capable of holding 4 people and some gear (4 meter diameter). The 2 person version masses about .5kg, and the 4 person tent is 2 kilograms.

Torches-1
Provides usable light in a small radius (in the same outdoor square). Each lasts about 20 minutes, but can be "recharged" after extinguishing by reapplying combustibles to the top.

Translator-8
Simple computer translator unit with messages entered via keyboard, and translated in characters or symbols on a display screen. Language programs are available on small plug-in modules. The translator normally comes with the prominent language of the world of manufacture, and additional languages are on read-only memory chips at a cost of 20Cr each. One language chip comes with the unit, and is limited to known common languages available to the manufacturer. The small database usually contains about 25,000 words, sufficient for most simple business or tourist needs, provided you can stand the approximate one-minute-per-sentence delay (assume getting a perfect translation is an Average task against a target number of 15, modified by the level of complexity in the conversation. So, two researchers discussing a profound subject requiring skill level of 10 have a 5- chance of communicating correctly, while a tourist asking a Intelligence 4 question has a 11- chance of success). The built-in batteries are good for several thousand hours of use. Models of double cost and weight will have a small speaker that will speak each sentence as it is typed.

Translators at TL11 are substantially more versatile. The user has a bone conduction microphone/speaker in one ear, wears a set of special glasses and speaks normally. If the speaker pauses for one second, the translator will repeat what was just said in the language currently programmed, as best it can, alerting the user if there are un- or poorly translated sections. An external directional microphone picks up the words spoken by the person being observed, and each pause in the conversation (or after 10 seconds) will repeat what was just said after translation, again with alerts in poorly translated parts. In this way, a half-speed conversation of some fluency can be achieved. Translators of TL12+ are better at handling dialects, cultural nuances and filtering out extraneous noise, but function in more or less the same way. Language chips for TL11 translators cost around 100Cr, but are substantially more complex than those of lower TL's (target number of 18, with DM for complexity). Specialized chips for certain trade or scientific fields cost the same, but provide a much greater language facility within a field (+3DM within the field, -2DM outside it).

Wall Patch-10
A semi-flexible patch of composite and metal fabrics with air-tight plastic layers between them. Removing one from its standard wall mount by the carrying handle exposes a anaerobic adhesive layer, which when pressed to a hull breach will form around it and cure in seconds. If the resulting bond is airtight, the repair will usually last indefinitely, but should be fixed at next opportunity. The patch will cover most breaches up to 15cm in diameter, and can usually only be used from the high-pressure side of a leak. Wall patches can be used as suit patches in an emergency, and have been used as impromptu slaplocks to keep portals open or closed (but only half as effective).

Using a wall patch successfully is an Average Dexterity task, modified by Environment Combat skill. Failure indicates that the pressure leak has been slowed but not stopped. Another patch will be required to seal the leakage.

Water Dye-7
A tube of liquid dye which can be used to highlight a patch of water (around a raft at sea or in a lake near a crash site) with a bright, easily-spotted color visible from the air. The primary drawbacks of this form of signaling are the short duration of the colored patch (it lasts no more than 15 minutes in still water and much less if the water is rough or there is any form of precipitation to break it up), and the fact that it cannot be used at night.

The latter problem is offset by dyes available at TL9+. These contain a phosphorescent dye equally visible in day or night. Generally, water dyes are useful only when searchers are aware of the presence of the distressed travellers and are more in need of an exact location than some signal to draw their attention in the first place. A tube provides a single dye patch of around one 10 meters in diameter (one outdoor square). Water dyes can also be used to trace underwater flows by putting them in at an above ground source and then searching for dye streamers at possible exit points, or calibrating sensors for the molecular signature or color of the dye.

Since they are non-toxic, they can also be used to scare unwitting victims by slipping it into their food and encouraging panic when their bodily secretions turn bright orange or glow-in-the-dark green. "Oh man, Rigellian Blood Rot! I don't think there's any cure for that (snicker)...".

Water Filter-7
A combination high-efficiency filter and small water pump, used to purify small amounts of water for drinking purposes. It filters salt, most chemicals, and all biological contaminants at the rate of 1 liter per 15 minutes. The filter cartridge is good for about 100 liters worth of water before its effectiveness wanes, and can be replaced for 30Cr and .2kg.

Weight Belt-5
A diver using any sort of wet or dry suit may have increased buoyancy, and have to expend extra effort to stay submerged. A weight belt is a quickly detached set of lead weights that is tailored to exactly compensate for the diver's buoyancy. The weight of the belt itself is variable from 1 to 20kg. Weight belts can also be used in low gravity environments to maintain muscle tone.

Exploration Tools	Mass	Cost	Relevant Skill
Amaze Natives Kit-12	10kg	200Cr	Diplomacy
Arc Welder-5	50kg	1500Cr	Mechanical
Atmosphere Tester-8	1.5kg	1KCr	-
Attaché Case-8	1kg	100Cr	-
Backpack-8	3kg	200Cr	-
Backpack-11	2kg	200Cr	-
Binoculars-5	.3kg	100Cr	Perception
Binoculars-9	1kg	500Cr	Perception
Binoculars-11	.6kg	500Cr	Perception
Bioscanner-13	3kg	5KCr	Survey
Bioscanner-15	1kg	3KCr	Survey
Breaching Charge-11	2kg	200Cr	Demolitions
Bullhorn-6	.5kg	120Cr	-
Carpentry Tools-5	50kg	1000Cr	Mechanics
Carpentry Tools-8	30kg	1200Cr	Mechanics
Coldpack/Heatpack-7	.1kg	10Cr	First aid
Compressor-6	30kg	500Cr	-
Compressor-8	20kg	500Cr	-
Compressor-10	15kg	500Cr	-
Cutting Torch-5	30kg	500Cr	Mechanics
Cutting Torch-8	20kg	500Cr	Mechanics
Densitometer-13	15kg	10KCr	Engineering
Densitometer-15	5kg	10KCr	Engineering
Echo Sounder-6	10kg	300Cr	-
Echo Sounder-8	6kg	300Cr	-
Echo Sounder-10	3kg	300Cr	-
Electronic Tools-5	5kg	2KCr	Electronics
Electronic Tools-8	4kg	2KCr	Electronics
Electronic tools-11	4kg	2KCr	Electronics
Emergency Beacon-10	1kg	1000Cr	-
Entry Cutter-10	20kg	10KCr	Mechanics
Excavating Tools-3	20kg	200Cr	-
Excavating Tools-8	15kg	200Cr	-
Exoskeketon-11	300kg	15KCr	Battle dress
Flare-8	.3kg	10Cr	-
Flare Gun-8	.6kg	50Cr	-
Flashlight-5	.5kg	30Cr	-
Flashlight-8	.3kg	20Cr	-
Flashlight-11	.1kg	10Cr	-
Generator-6			-
Generator-8			-
Generator-10			-
Grapnel Gun-8	3.5kg	500Cr	Bow Combat
Grapnel Gun-10	4kg	800Cr	Bow Combat
Ice Axe-3	2kg	50Cr	Athletics, Brawling, Melee
Ice Axe-8	.8kg	100Cr	Athletics, Brawling, Melee
Inertial Locator-9	.5kg	2KCr	Navigation
Inertial Locator-11	.3kg	200Cr	Navigation
Intrusion Tools-5	1kg	300Cr	Intrusion
Intrusion Tools-8	1kg	500Cr	Intrusion
Intrusion Tools-11	1kg	2000Cr	Intrusion
Iris Valve Opener-10	10kg	2000Cr	Mechanics
Lamp-3	.7kg	30Cr	-
Laser Cutter-10	8.5kg	1200Cr	Mechanics
Lightstick-6	.1kg	1Cr	-
Cold Lantern-6	.3kg	20Cr	-
Machete-4	.5kg	20Cr	Long Blade
Magnetic Compass-2	.1kg	10Cr	Navigation
Mechanical Tools-5	20kg	1KCr	Mechanics
Mechanical Tools-8	15kg	1KCr	Mechanics
Med Microscan-11	.2kg	500Cr	Medical
Med Scanner-11	1.5kg	2KCr	Medical
Metal Detector-6	5kg	300Cr	-
Metal Detector-8	2kg	200Cr	-

Exploration Tools	Mass	Cost	Relevant Skill
Metalwork Tools-3	300kg	3KCr	Mechanics
Metalwork Tools-5	100kg	3KCr	Mechanics
Metalwork Tools-8	70kg	3KCr	Mechanics
Multiscanner-10	.8kg	3KCr	Survey
Neural Activity Sensor-13	20kg	35KCr	Survey
Night Glasses-9	.1kg	500Cr	Perception
Paramedic Kit-8	8kg	1KCr	First aid, Medical
Paramedic Kit-11	10kg	5KCr	First aid, Medical
Piton-4	5kg	25Cr	Athletics
Piton-7	2kg	50Cr	Athletics
Piton-9	2kg	50Cr	Athletics
Piton-10	2-3kg	50Cr	Athletics
Personal Datalog-8	.1kg	50Cr	Computer
Personal Datalog-11	.1kg	50Cr	Computer
Portable Airlock-10	30kg	2KCr	Environment combat
Purification Tablets-5	-	20Cr	Survival
Radiation Counter-6	1.0kg	200Cr	-
Radiation Counter-8	.2kg	100Cr	-
Radiation Counter-10	.1kg	100Cr	-
Retroreflector-8	2kg	100Cr	Survey
Rock Hammer-8	1kg	50Cr	Athletics, Brawling, Melee
Rope-1	16kg	50Cr	Athletics
Rope-6	6kg	80Cr	Athletics
Rope-10	2kg	100Cr	Athletics
Slaplock-8	.2kg	40Cr	-
Sleeping Bag-5	3kg	200Cr	Survival
Sleeping Bag-8	2kg	200Cr	Survival
Sleeping Bag-11	1kg	200Cr	Survival
Spotlight-6	2.5kg	50Cr	-
Spotlight-6	10.0kg	200Cr	-
Surgical Tools-5	5kg	1000Cr	Medical
Sursat-11	50kg	100KCr	Survey
Survey Shield-11	1000kg	10KCr	Survey
Survival Kit, Desert-7	2.5kg	100Cr	Survival
Survival Kit, Individual-8	60kg	4000Cr	Survival
Survival Still-11	30kg	5KCr	Survival
Survival Tent-11	20kg	2KCr	Survival
Swimming Equipment-3	1kg	100Cr	-
Tarp-1	2.0kg	10Cr	-
Tarp-8	1.5kg	30Cr	-
Tent-3	10kg	50Cr	Survival
Tent-11	.5-2kg	2-500CrSurvival	
Torch-1	1kg	5Cr	-
Translator-8	.1kg	100Cr	Linguistics
Translator-11	.1kg	500Cr	Linguistics
Wall Patch-10	2kg	150Cr	Environment Combat
Water Dye-7	.1kg	10Cr	-
Water Dye-9	.1kg	10Cr	-
Water Filter-7	.5kg	70Cr	Survival
Weight Belt-5	20kg	50Cr	-

PERSONAL MOBILITY

Items for explorers to move or to enhance movement in adverse conditions or unusual environments. Many of these are primitive, but still reliable and more frequently encountered than modern counterparts.

Climbing Shoes-9
Rock or rugged terrain climbing is sometimes the only viable means of getting to an area. Winds, hostile life forms or geographic anomalies may prevent the usual expedient of landing a contragrav vehicle on-site or using grav-belts (if available). Climbing shoes are especially designed to provide maximum traction on all kinds of rock surfaces, and provide the flexibility needed to take advantage of narrow ledges and footholds. The soles are not exceptionally durable, but are easily replaced and can be tailored for specific types of terrain. If the user is travelling light, a hardened sole is used to save from having to carry a separate pair of shoes just for the climb.

Free or assisted rock climbing is an Athletics task, and a person without a full set of proper gear will naturally take -DM's on their chances.

Crampons-3
Crampons are special spiked attachments strapped to boots to assist in climbing or walking in icy conditions.

Wearing crampons decreases the difficulty of crossing ice. Penalties for slick conditions are reduced by +2DM. Crampons are noisy on hard surfaces, and will mar most floor covering.

Grav Belt-12
Contragrav technology has finally reached a point where personal "jump belts" are possible. These consist of a body harness and several contragrav modules arrayed around the body, with a small left or right hand mounted control stick near the waist, and a power pack usually mounted near the lower back. To get the low thrust and fine precision required, a dedicated computer interface is used in conjunction with sensitive inertial sensors, otherwise the belt would only be capable of full thrust (3G) or none at all. The grav belt is controlled partially by using the stick, and partially by the wearer shifting their weight. While a grav belt can be used in zero-g conditions (within 1 planetary diameter), the lower of Environment Combat or Grav Craft skill is used to reflect the increased difficulty. Top speed of a normal grav belt is around 280m/turn or 168kph, with a normal endurance of 1000 hours between refuelings and maintenance.

Advanced technology will increase the performance and decrease the mass of the belt, but operation remains largely the same. Typical options available at all TL's include:

Voice Interface: Allows hands-free control of the grav belt, but lacks the fine precision of manual control. Adds 500Cr to cost.

Roadgrid Interface: Required for use in Sylean metropolitan areas. Includes voice interface and remote control to automatically take you to your destination. Adds 1000Cr to cost.

Emergency Parachute: In the event of catastrophic failure, the single-use parachute will deploy fully at any altitude of 100 meters or more, and the user will usually suffer only minor injury (1D damage, armor does not protect). Adds 500Cr to cost and 3kg to mass.

Backup Power Supply: A high-discharge battery capable of powering the grav belt for 30 seconds (6 turns) in the event the main power plant fails. Standard feature, no extra cost.

Hiking Boots-9
As for climbing, sometimes explorers will be forced to walk long distances on rugged surfaces, for which sturdy lightweight footwear is essential. Most military boots are suitable for this purpose, but dedicated hiking boots are usually lighter and more comfortable. Both provide proper support and protection from ankle-biting fauna, and may be custom-molded to an individual for maximum comfort.

Don't start an extended hike with a heavy load unless you have good footgear. An Average Endurance task is appropriate in these cases, and failure means sore muscles and blisters to the tune of 1 point of damage to a random physical characteristic. If it is not properly cared for and you continue to walk with the injury, it will not heal, and may get worse.

Parachute-5
The simplest of aerial descent systems, the parachute is a large canopy of cloth or other material held to the jumper's body by lines attached to a harness. The simple parachute affords only a small degree of control of the direction and rate of descent. It is largely at the mercy of wind and drift effects. The direction and distance will depend upon the wind speed and direction, the height of release, the time of drift, the tech level of the parachute, and numerous other factors. This fact should be noted in the determination of difficulty level (Dexterity task, modified by Athletics skill) and mishaps.

Parachutes can use either static cord release, where the chute is tripped automatically as the individual jumps, or a ripcord release activated by the individual or by a automatic device preset for a given altitude. A static cord jump must be made from a minimum of 100 meters altitude, and results in immediate deployment of the chute. The ripcord deployment requires 200 meters minimum altitude, but also permits jumps from much greater altitudes with the chute opening delayed until the 200 meter level is reached (freefall in standard atmosphere and gravity is at the rate of around 20 outdoor squares per turn).

A basic parachute weighs 10-15 kilograms. When packed, it fits into a pack worn either on the back or the front of the jumper's body. Many parachute packs incorporate a reserve chute in case of faulty deployment of the main chute. This is slightly smaller and has an increased descent speed (Average Endurance task to avoid a 1D injury, less any foot armor).

Parawing-7
More sophisticated than the parachute, the parawing is an airfoil-shaped chute which permits much more control of the descent (usually a Difficult Dexterity task, modified by Athletics skill, is sufficient to hit a given target area, with appropriate modifiers). Other performance characteristics are as for the parachute. Parawings are lighter, but somewhat more expensive than standard parachutes. A ripcord release is standard for parawing chutes.

Re-Entry Kit-8
The individual atmospheric re-entry kit (AKA Hell on Half-Shell) is a foamed ablative shield that protects an individual while reentering an atmosphere, provided that the velocity of the reentry does not exceed 14 km/sec. This kit may only be used to land on planets with thin atmospheres or denser because the device relies on parachutes for the final stage of the descent. However, the de-orbit thruster is capable of landing on negligible

gravity planets regardless of the planet's atmosphere type. This is because the surface gravity is so small that the thruster has no problem achieving a soft landing.

The vac-suited character bail out of the spacecraft, straps on the shield's plastic inflation mold, connects the foam dispenser to the mold's inlet valve if it is not already connected, and inflates the foam shield. It takes about 15 minutes for inflation and for the foam to harden to optimum consistency.

A chemically-fueled rocket thruster is used to control altitude and to provide the thrust necessary to successfully de-orbit. An optical sighting device/computer is used to ensure that the shield's position and the transfer orbit produced by the retro-burn are both correct for re-entry. When the retro-burn has been accomplished, the rocket thruster may be jettisoned if it is empty. The elliptical transfer orbit produced by the retro-burn will take the shield and its occupant 180° around the planet from where the ship was abandoned, so if possible, the user should know what kind of terrain they will be landing on before initiating retro-burn. The perigee of the transfer orbit will be at the top of the planet's atmosphere at an altitude of approximately 350 km. Atmospheric braking will occur at this point if the shield was de-orbited correctly. If the de-orbit maneuver was not performed correctly, the shield will either burn up as it plows at too steep an angle into the planet's atmosphere, or will miss the upper reaches of the planet's atmosphere and swing back towards apogee. The shield's occupant may be able to achieve re-entry on a second orbit if he has sufficient fuel remaining in the de-orbit thruster.

Time spent in the transfer orbit prior to ablative re-entry may be calculated according to the following formula: Time in orbit (minutes) = 60 minutes/Planet size code x 2D.

The ablative foam of the shield is designed to slough off when exposed to the hot gases of re-entry. This ensures that the occupant is never directly exposed to the high temperatures of re-entry. About 10-15 minutes is spent in the ablative portion of re-entry, which is extremely turbulent. After the ablative portion of re-entry is finished, the remains of the shield will be falling freely at a high rate of speed. At an altitude of approximately 35 km, the drogue chute will be deployed. This parachute will reduce the rate of descent so that the main parachute may be deployed without damaging it. The main chute will deploy at an altitude of about 5 km. This allows the shield's occupant plenty of time to pick a landing spot.

Total time spent in atmospheric descent (from the time that ablative re-entry is finished to the time the shield touches down on the planet's surface) may be computed by the following formula: Time in descent (minutes)= 30 minutes x Atmosphere modifier. The atmosphere modifiers are as follows: .5 if type 4 or 5 atmosphere (very thin), 1.0 if type 6 or 7 atmosphere (standard), 2.0 if type 8 or 9 atmosphere (dense).

The speed of descent after the main chute has deployed may be computed using the following: Descent rate = 5m/sec x surface gravity of planet (Gs) x atmosphere modifier. Atmosphere modifiers are as listed above.

The descent rate computed will be the speed at which the shield and its occupant strike the ground at the end of the parachute descent.

Survival Roll: Even if the character has sufficient life-support capability in their vac suit and performs the de-orbit maneuver correctly, there is still a possibility of a fatal accident. Some of the more common accidents are: the orbit is too high to achieve re-entry from; the foam in the kit may be faulty and burn through on re-entry; the shield might tumble during re-entry; the character might vomit in their helmet and suffocate before reaching the ground; the main parachute might not deploy, etc. Roll an Average task vs. a target number of 9- to survive re-entry and the descent to the planet's surface. Before applying DM's, check the number showing on the dice: a roll of 12 is always fatal, regardless of any positive DM's.

DM's

-3	second attempt
+1/2	per level of Vac Suit or Battle Dress skill
+1	per level of Computer expertise
+1	per Navigation or Pilot skill
+1/2	per level of Environment Combat
+1	if planet is size 1 or 2
-1	if planet has corrosive atmosphere
-2	if planet has insidious atmosphere
-1	for TL8 re-entry kit
+1	for TL11 re-entry kit
+2	for TL12-13 re-entry kit
+3	for TL14-15 re-entry kit

After adding all DM's together, round up to the nearest whole number. All DM's are cumulative.

Note: There is no easier way to kill off a character than to force them to abandon ship and attempt re-entry over an environmentally hostile planet.

A character failing the survival roll by 1 point has undershot their trajectory, and bounced back into a decaying orbit. They will travel an additional 2D x 10 degrees around the planet before encountering the upper atmosphere again, at which point they may make another survival roll with the additional penalty DM to reflect bad trajectory, low fuel, and partially burned ablative shield.

An orbital re-entry kit costs approximately 1,000Cr at the most up-to-date TL, and does not come with any warranty except the reputation of the manufacturer ("survival guaranteed or your money cheerfully refunded!"). It is not a standard item in the lockers of most ships, as it requires a) your ship is unusable, b) you survived the process of it being made unusable, c) you happen to be over a planet, and d) you are likely to be rescued within the time allowed by planetary atmosphere, flora and fauna.

The standard re-entry kit is a cylinder measuring 50cm in diameter by 125cm long. The cylinder is equipped with several handles, masses 100kg and includes everything necessary to survive re-entry, including a small life-raft and low-orbital range transponder. The military version, occasionally issued to special units in place of the more expensive jump capsule, measures 50cm in diameter by 80cm long and masses 60kg. The main difference between the standard civilian model and the military model is the lack of the big de-orbit thruster, the survival kit, and the packet of recovery aids. It is assumed that a soldier using the military kit will carry his own survival and recovery gear.

Usually, the soldier will be dropped from a ship maintaining an orbit that will intersect the top of the planet's atmosphere. The drop point will be as close to the planet as the ship may safely come. Because of this, only a small thruster is needed for altitude correction prior to re-entry. It is not used to provide enough thrust to de-orbit with; that is the job of the troop ship which inserts the soldier into the proper re-entry trajectory. The drogue parachute is usually deployed at an altitude of about 10 to 15 km and the main chute is deployed at an altitude of about .2 to 1 km. The foam shield makes fair armor against small arms fire (rating of 3), but is easily destroyed by larger weapons. The main chute is 14m in diameter.

There are recreational re-entry clubs in the Imperium, organized similarly to the parachute clubs that existed on old Terra. Most clubs are part of the recently formed Imperium-wide Inter-

Sector Re-entry Association. Judges are assigned by the ISRA to preside over the various meets held by the clubs. The type and quality of re-entry kits used by these meets are also regulated by the ISRA. Devotees of the sport find it a near-spiritual experience, and wax poetic about the feel of the planet at their back, patterns that form in the wake of ablating foam and the complete, utter solitude felt when you first touch atmosphere and know that no force in the universe can alter the destiny that you have set for yourself. Professional re-entry events are widely broadcast, and simulated covert military re-entries are standard fare in virtual entertainment dramas.

Rocket Pack-7
Unless you count rumors of backpack helicopters, the rocket pack is the earliest attempt at a compact man-portable flight system. It uses highly concentrated hydrogen peroxide over a catalyst bed to generate a high-pressure steam jet for thrust. It is capable of up to 2G of thrust, but only for an extremely limited time period. Given the mass of the fuel and complete lack of safety measures, it seldom found any practical use.

A rocket pack will provide the wearer with enough acceleration to counter normal gravity (1G) and accelerate at 1G in any direction, for a total of 6 turns, after which the fuel is exhausted. A 1G acceleration will be a cumulative movement of 8 outdoor squares per turn. It requires both hands to operate, and each turn of flight is an Average Dexterity task to move exactly as planned. The size and geometry of the rocket pack precludes carrying much except a sidearm, and the pack itself is extremely vulnerable to damage. It has an armor of 0, and can absorb 4 points of damage before malfunctioning. Any malfunction will result in an 6 point explosion on a 2D roll of 8-, and other results indicate the user and anyone near them is sprayed with high pressure hydrogen peroxide for 2D damage unless wearing a sealed suit.

Skis-3
Cross-country skis are an exceptionally old invention that enables rapid travel over long distances of unbroken snow. Modern materials have made them more efficient, but the mode of operation is effectively the same.

Skis allow rapid movement over unbroken areas of snow. Normal pace is double walking pace. This is increased by double or more going downhill, and halved or worse uphill. Both hands are normally required to hold ski poles in level travel. Any high speed or extreme maneuvering is an Average Dexterity task (modified by Athletics), with failure indicating an inadequate maneuver or a fall. TL3 skis take several turns to lace one's boots into, while TL7+ version have quick-release mounts that can be put on or removed in a single turn.

Snowshoes-8
Large, somewhat awkward, but highly effective, snowshoes that allow normal walking speed over deep snow.

Loose snow up to thigh-deep will halve normal foot movement, and deeper snow will reduce speed to a crawl (from 1-4 outdoor squares per minute). Snowshoes can also be used in boggy or marshy area to distribute weight evenly over mats of vegetation, enabling walking movement in areas normally impassable for foot traffic. Using snowshoes to move faster than a walk is an Average Athletics or Dexterity task, failure indicating a stumble or fall.

Thruster Pack-9
Prior to contragrav availability, the only means of maneuvering a space suit is by chemical thruster packs. These are extremely inefficient compared to contragrav units, but are the best available at lower TL's. A long-range thruster pack provides up to 100 thrusts of .1G for a turn (enough to accelerate to a speed of 2 outdoor squares per turn per thrust).

Personal Mobility	**Mass**	**Cost**	**Relevant Skill**
Climbing Shoes-9			Athletics
Crampons-3	1kg	30Cr	-
Grav Belt-12	25kg	5000Cr	Grav Craft
Grav Belt-13	23kg	5000Cr	Grav Craft
Grav Belt-14	20kg	5000Cr	Grav Craft
Grav Belt-15	18kg	5000Cr	Grav Craft
Hiking Boots-9			Survival
Parachute-5	15kg	250Cr	Athletics
Parachute-10			Athletics
Parawing-7	10kg	500Cr	Athletics
Parawing-10			Athletics
Re-entry Kit-10	100kg	1KCr	See text
Re-entry Kit-10	60kg	500Cr	See text
Rocket Pack-7			-
Skis-3			Athletics
Skis-9			Athletics
Snowshoes-3	2kg	100Cr	Survival
Snowshoes-8	1kg	200Cr	Survival
Thruster Pack-9	50kg	2000Cr	Environment Combat

COMMERCIAL GOODS

There is a bewildering array of goods for sale and trade throughout the Imperium, expanding with each new world surveyed and explored. There is money to be made, and money to be lost. Opportunities may only be available once, and doors may close for reasons unforeseen when the purchase was initially made: the potentially lucrative market in garwac fruit evaporated overnight when Imperium sanitary engineers found chemicals in the fruit that poisoned waste-recycler bacteria. The Korashashi incident, where a major starliner had no working toilets for a week in jumpspace, pretty much nailed the coffin on exports of one of Fotherin's local delicacies.

On the other hand, the inhabitants of Cupri can't seem to get enough of the Kapsicona extract, from a water-intensive crop unsuitable for their climate. Originally a novelty item, it is now shipped in bulk and composes 5% of food imports, largely as an additive in snacks and other non-meal foods. Experts have predicted for years that demand would eventually decline, but it has not done so, and the trading ship that negotiated the original exclusive contract (since expired) made enough of a profit to start their own small interstellar shipping line.

These items are a representative sample of goods that have been seen or reported on. Their economic viability is not known, but they may serve as a benchmark for the unusual nature and variety of goods offered for import or export.

Aircraft, High-Performance (military), TL7
Sylea maintains a number of historical societies and aficionados of different milieus, of which the Rule of Man is undoubtedly the most popular. One of the more wealthy groups recently acquired a number of surplus archaic vehicles from a new Imperium world that was trying to gain capital for more modern equipment. While most of these were destined for Sylea, some were in turn re-exported to worlds of even lower technology that did not have the funds to purchase more modern equipment. Export restrictions are per local regulations, but all weaponry must be removed before import into Sylean airspace.

Calculator-8
Provides basic mathematical calculations. Available at TL6+ and exceptionally cheap to produce on TL8+ industrial worlds, with a limited but very profitable market on TL5- worlds.

Carnak Concise Imperial Encyclopedia
The Carnak Reference Service, one of Sylea's pre-eminent data indexing facilities, has licensed a subset of its indexing and reference software to the Onlet Group, resulting in the Carnak Concise Imperial Encyclopedia. This is a durable paper-based product the size of a notebook, with heavy-weight covers that conceal the power supply and circuitry. Designed for export use, it contains approximately 100,000 pages of cross-linked information on all subjects, and includes sound and video, the former programmable on request to non-standard languages for an additional fee. The Encyclopedia has a retail cost of 250Cr and masses 1kg.

The Carnak Encyclopedia is a hot export item, as it is glitzy and contains gobs of information from outside the destination solar system. To most explorers, it is not that useful, as they can reference all the same information for trivial cost from their home computers, or a similar database may already be part of the entertainment software on a starship. The Encyclopedia also deliberately does not provide details on manufacturing processes or other details that would allow a culture to short-cut their way to a higher tech level, but rather provides a hunger for outside goods. In 20th century terms, it is an encyclopedia set packed with subtle advertising messages (and a number of com-

Air Superiority Fighter-7 (stripped)

		Volume	Mass	Area	Cost
Displacement:	3.0 (USP7)	42.000m3	-	-	-
Volume:		-	-	98.69m2	-
Configuration:	Needle airframe (22.77m2 wing)				
Dimensions: 12.90m long x 1.81m high x 11.35m wide (approximate)					
Structural material:	Light alloy				
Chassis: 6g rated		1.518m3	4.554t	-	.073MCr
Armor: .3cm Light alloy					
Armor rating:	Overall rating of 2	.297m3	.888t	-	.012MCr
Power plant:	TL7 Gas turbine, 7Mw	14.000m3	7.000t	5.600m2	.280MCr
Fuel consumption:	105m3 per 100 hours				
Fuel volume:	x1 (high grade hydrocarbons)				
Fuel carried:	2 hours	2.100m3	2.100t	-	.001MCr
Propulsion:	TL7 High perf. craft (spd.x1.6), 2Mw	17.500m3	8.750t	-	19.250MCr
	Adverse condition propulsion (high alt.)	3.500m3	1.875t	-	3.850MCr
Crew: Pilot		1.000m3	.100t	-	-
Options: TL7 Ejection seat		.200m3	.100t	-	100MCr
	Internal weapon bay (holds up to .4m3)	.600m3	-	-	-
	Four hardpoints (holds total of .4m3)	.600m3	-	-	-
	TL7 active radar (subcontinental range)	.450m3	.900t	.100m2	.250MCr
	TL7 mil-spec sm. vehicle continental radio	.010m3	.020t	.010m2	.025MCr
Total		41.775m3	26.287t	5.710m2	23.841MCr
Performance:	acceleration .8G, top speed 1917m/turn (1150kph), maximum range 2300km				
Takeoff speed:	462m/turn (277kph)				
Agility:	-1DM to be hit				
Description:	Archaic combat aircraft, used near the cusp of fusion and jump drive development.				
Note:	As antique vehicles, there are no import restrictions on unarmed versions. However, these vehicles have extremely primitive electronics, no inertial compensators and no inherent collision-avoidance capability. To date, seven pilots have died in accidents involving these vehicles, and all were attributable to pilot error. In game terms, you take a -3DM on any piloting or related skill unless your character is from a TL7-9 world, until you work off your unfamiliarity with purely aerodynamic flight (2D flights worth of experience).				

panies paid Carnak Reference a handsome sum to have their products integrated into the "reference information" section of the encyclopedia).

Cloth

"Cloth" is a term for the generic fabric used in durable clothes. It has good cut and abrasion resistance, is mostly waterproof yet still breathes, and closes weave in cold weather to provide better insulating properties. It is as common at TL11 as cotton is at TL7, and costs perhaps 5Cr per 1m2, or 250Cr for a $1m^3$/1 ton "bale" packaged for shipping. Advanced fabrics are available for higher cost. These include:

Stretch Cloth: Woven from electrically sensitive fibers, a discreet battery pack and control switch allows it to custom-fit the wearer. Not strong enough to be dangerous, but more than enough to pull in that overhanging belly, or give a chic skin-tight look to any outfit. Due to the nature of the fabric, such outfits are hard for the home tailor to create without special equipment. Stretch cloth costs about 50Cr per $1m^2$.

Chameleon Cloth: The fibers in chameleon cloth can change color in response to specific electrical charges. Like Stretch cloth, a discreet power pack and controls are used to activate the change. Simple chameleon cloth changes in large patches and has a limited number of colors (2 or 3). Advanced versions are sufficient to generate medium resolution images in several colors, which can appear to move across the fabric with time. In conjunction with a small computer and sensor, chameleon cloth can provide a good match to most backgrounds, making the wearer somewhat more difficult to spot with the naked eye (-2DM if stationary, -1DM if moving). Chameleon cloth costs about 100Cr per 1m2.

Video Cloth: This is woven into any other fabric and is simply a fiber-optic network and tiny light-emitting elements. In the dark, the wearer can light up like a fireworks display, or use the clothing as a low-resolution flat screen video terminal or television. Video cloth costs about 100Cr per $1m^2$, in addition to any other cloth cost. Note that you usually get distorted images if used in stretch cloth, unless programmed.

Tailoring an outfit out of any cloth generally requires a specific skill, or an expensive piece of computer controlled hardware.

Comm Network

Stellarcom (a division of Nactel, Inc.) is producing a basic Comm network package for export to developing worlds. This is a TL10 unit that is fully compatible with Sylean communication protocols, is capable of handling and routing up to 1000 simultaneous Comm calls, and can be linked to other such units in close proximity to form a close approximation of a modern Comm net. Each cell is a separate unit that comprises a central computer, antenna, power conditioning circuitry and all necessary wiring. It is designed for field installation by marginally trained personnel, and is largely maintenance-free. The full package has a retail cost of 15KCr and masses about 100kg (including packing crate). Even a medium cargo ship can carry enough of these to provide full wireless communications to a major TL9- city.

Stellarcom provides a discount on the sale of their Comm package to any buyer who also acquires over 1000 Nactel Comm units of any type at the same time, and other manufacturers entering this potentially lucrative field are planning similar offers.

Imperium Intelligence, through operatives in Stellarcom R&D, has provided a "back door" into the programming of these units, allowing automatic eavesdropping, tracing and decryption of any traffic going through one of these units. Stellarcom is unaware of this modification to their programming, and I.I. obviously isn't going to tell anyone either.

DM	Condition
-2	Superficial disguise (makeup on face, hands, hair)
-4	Moderate disguise (appropriate body padding, facial prosthetics)
-6	Detailed disguise (skin overlays, chemical treatments)
-8	Extremely detailed disguise (full body makeover)
-10	Maximum disguise

Each additional -2DM increases task difficulty by one level, to a maximum -10DM on an Impossible Disguise task, noting that some disguise techniques are impossible at lower TL's. Applying a disguise takes 5 minutes (60 turns), tripled for each extra -2DM required, so the best possible disguise would take nearly 7 hours to apply, and almost certainly require someone else do the work on the person to be disguised. A disguise at maximum levels of effect is a full-body makeover, and is sufficient to pass inspection by all devices of less than the TL of the disguise kit, provided the person doing the disguising had accurate information. For instance, with accurate data, a TL9 disguise kit could configure a person to bypass TL8 fingerprint, retinal and voice scanners, but would still fool the unaided eye equally well at all TL's. In the end, a disguise kit only fools the senses. Interaction with other people is based solely on the skills of the person, not their makeup.

Disguise Kit-9

Enables change of personal appearance on a temporary basis. The sophistication of a kit depends upon its TL, but even rudimentary technology used by a skilled individual can effect dramatic changes in appearance. Disguise kits of various complexity are often used by entertainers, whether to mimic a particular individual, or to convey expressions better to a large and sometimes distant audience.

A superficial disguise is an Average Disguise task, with a DM of half the TL (round down) of the disguise kit. This could prevent a known person from being recognized, or make the person appear to be someone known to the observer. A basic disguise will fool only the most cursory of inspections, but may be sufficient for dramatic purposes or in conditions of poor visibility.

Flashtray-10

The flashtray is a small, desk-top convenience used to incinerate small items, particularly cigarettes, but it will also destroy plastics, destroy magnetic media, erase optical media and ruin other easily melted items. A fan and efficient air filter prevent noxious fumes from escaping. Any flammable item placed in the flashtray is reduced to a pile of ashes in a matter of seconds. It requires hookup to vehicle or household power to work. Secure trash cans usually have a larger variant of the flashtray, cleanly incinerating contents before dumping them into an ash bin for disposal.

Flobee-10

Flobees are a novelty sport item recently invented on Sylea. They are flying disks, made with a variant of structurecomp (see "Struturecomp" listing), with the interstices in the foamed core filled with helium instead of air. In addition, there is a small battery-powered ducted fan in the center of the unit, driving counter-rotating blades. The net effect is that when turned on, it has negligible weight. It can be thrown extremely long distances and has aerodynamic properties that set it apart from conventional flying disk toys. Flobees cost about 25Cr, and mass around .1kg. They last around 3 months before the helium leaks out, but this simply makes the fan work harder and need recharges more often.

Fractal Heat Sinks
The capability of any high-power electronic device is limited by its efficiency and the speed with which it can dissipate waste heat. This is especially true of energy weapons. One of the TL10+ solutions to this are fractal heat sinks. The thin metal or other vanes are custom cut with a microscopically precise laser into convoluted shapes with the maximum possible surface area for dissipating heat. This substantially increases their heat dissipation ability, but at the cost of making them almost impossible to clean manually. Highly filtered air is usually used to prevent clogging the delicate vanes, or they are designed to be cleaned by ultrasonic bath or other non-contact technologies. The off-world market for these depends on the products they produce, but the beauty of the sinks is that a larger sheet can be cut into pieces of any size, which retain all the properties of the larger sheet. The sinks usually come in rolls, with metal thickness dependent on the anticipated size of the application (microchip sinks would be thinner than automobile radiators, etc.). It costs 100Cr and masses 30kg for 10 liters.

Note: Since spaceships in vacuum can only radiate heat away directly, rather than by transferring it to air or water, fractal heat sinks are of no benefit to spacecraft.

Instant Camera-7
The so-called "instant" camera is a TL7-8 invention that uses self-contained chemical cartridges to fix a visual image on a permanent, non-electronic medium. Resolution is poor, the pictures take around a minute to fully develop and cost 1Cr each in supplies. But they have been successfully traded on lower-tech worlds as luxury items, and on Sylea as novelty items — one of many "new antiques" that find temporary favor before being discarded. These cameras cost about 50Cr each at TL8 and mass .5kg. Disposable 10 picture cartridges cost about 10Cr.

One-Way
One-way is the trade name for a transparent surface treatment with good protective properties. A thin transparent composite, its structure is designed to spread incoming energy over as large an area as possible, through custom-grown microarches and trusses in the material. However, it is designed to allow outgoing energy to pass through it with as little disruption to its structure as possible. The net effect is that when applied to the outside of a rigid surface it effectively adds 1cm to its thickness for outgoing kinetic energy only. It main use is in discreetly retrofitting armor to a vehicle. Normal opaque body panels can be armored with other materials, but armor-thickness diamondpane can still be easily cracked, and other transparent armors are noticeably thick. One-Way allows reasonable upgrading of normal diamondpane (and holds together cracked pieces), and permits the entire window to be used as a "firing port" by sacrificing a point off the damage rating of the weapon (assuming the window has an armor rating of 1).

One-way comes in meter-wide rolls and costs 200Cr per square meter (minimum roll is 2KCr), with a mass of 10kg per square meter. Each roll comes with an electrical curing kit to give reasonable hardness to the finished application.

Personal HUD
This headpiece represents a significant breakthrough in holographic display technology at TL12. A small rectangle of polylucent cuprothallium provides a constant heads-up three-dimensional display for the wearer. Although useless by itself, the headpiece can be interfaced with virtually any number of compatible devices of similar TL, such as reference comps, multi-scanners, security cameras, etc.

Their use is common among bridge and engineering personnel on starships as well as smaller craft. For example, someone flying in a grav belt while using a neural activity sensor handset would find it inconvenient (to say the least) to refer to the readout on his backpack. Instead, the sensor's output is immediately displayed on his headpiece. At the same time, he can monitor his altitude, airspeed, position, and the operational status of his grav belt batteries and grav units. If he is also wearing a vac suit, he can read off his oxygen supply and internal temperature, too.

When desired, the headpiece can be swung out of the way above the head. When the display is turned off, the cuprothallium is transparent.

Plascrete
Plascrete is a TL10 invention, and is the *de facto* standard Imperium building material. Mixed in about a 1:10 ratio with filler material such as sand or plastic pellets, it makes a slurry that hardens only when a high-frequency electrical discharge is passed through it, a process that normally takes about half an hour for quantities of this size. Normally, an electrode grid is painted at the bottom of the form, and another on the top, though other means of achieving the discharge are possible. The resulting plascrete is waterproof, airtight and resistant to all known molds or micro-organisms. It has a much better compressive than tensile strength, and is only used as pressure walls if the pressure inside is less than that outside.

A variant of the plascrete is foamed plascrete, and is actually the more widely used form. Nozzles and aerators blow an air-filled slurry of plascrete into a mold or onto a surface, and electrode connections harden the result almost instantaneously, but only a thin layer at a time. The benefits are that 75% less plascrete is used, it is self-insulating because of the air spaces, and it is much lighter than solid plascrete (it floats). In addition, vertical surfaces or inverted surfaces can be "plascrete-plated", making it useful to stabilize weakened structures. Additives are available to enhance or retain normal properties.

Plascrete is normally sold dry, in 250 liter drums for 50Cr at 500kg, though other container sizes are available. 250-liter plascrete sprayers are available for 5KCr each, and mass 500kg.

Some enterprising individuals have used plascrete to make semi-legal weapons, composed of a custom-designed plastic bag, a slurry of plascrete and a battery. When you squeeze it, the slurry fills the mold and sets almost instantly, forming a cudgel, a set of plascrete knuckles or other simple blunt shapes. It does not trigger weapons scanners yet, as it has not been a major problem, but eventually scanners will be programmed to detect plascrete slurries. The street name for the product is Stonehands, and they cost about 20Cr each, with a mass of .2kg.

Reference Comp-11
This is a small, powerful multi-function computer for storing and recalling basic factual data, performing complex calculations, and controlling other electronic devices. They provide many of the functions of home comps or linked Comm units, but are especially useful in areas not served by a Comm net. The user simply downloads the information they expect to need into the large memory capacity of the unit, and it serves as a source for all queries on that topic or topics. It can be accessed by voice, keypad or linked to a Comm by a built-in short range radio link. It will usually be able to hold an exhaustive database of up to five specific topics, or a reasonably complete database on one broad topic. Most reference computers are capable of accepting environmental data and correlating it with on-board databases with some degree of accuracy.

A reference comp is to recorded knowledge what a multi-scanner is to environmental data, a good general purpose tool that can be configured to specific applications. It allows the use of most academic skills at a default level for purposes of answering specific questions. You can't ask hypothetical questions, but you can ask for information on how well a given situation correlates with known data, and get answers based on the reliability and completeness of both sets of data.

Solar Verifier
This is a 10KCr unit massing about 2 kilograms, approximately 20cm square and 10cm thick, constructed of transparent plast with anti-scratch finish and embedded Imperial starburst. All electronics are permanently embedded in the plast, and the battery is guaranteed good for at least 20 years of normal operation. It provides tentative verification of any Imperial Solar placed in the data port, showing serial number, date of creation and denomination. It also files this information in internal memory, and may be programmed to send it to any computer within Comm range.

Any trader using Solars will want one of these to verify validity of payment outside the Sylean system. In addition, Verifiers are a useful trade good for any government or financial institution planning on doing business with the Imperium, and the first such institutions will have a significant edge in dealing with future visitors that have or accept Solars for transactions. In this case, a Verifier can be sold for a significant profit. Most such buyers will wish an exclusive arrangement to protect their own interests, limiting the quantity that can be sold.

"If you aren't the first or second ship to show up with Verifiers for sale, don't bother. Once competition starts and corporations start accepting Solars on face value alone, the utility and perceived value of the Verifiers drops to around market value."

Space Watch-12
Designed as a functional item for spacers, the "S-watch" has recently become a fashion accessory and also an off-world commodity. It is a normal timepiece with alarm and timing functions, but has the added functions of showing atmosphere pressure and percent of oxygen, nitrogen and carbon dioxide variance over the past day. In addition, it can be remotely set by ship's computer to any local day length, including day names and local calendar events. A space watch goes for 200Cr, with negligible weight.

(Spacers with experience can often tell slight variations in air quality just by "feel", a slight tang that indicates the recyclers need adjustment, or the way sound carries giving an idea of air pressure. A true veteran can pick up subtle cues that instruments don't, providing warning of potential problems while instruments say things are still in the safe range. This is normally a Formidable Intelligence task and best three space-related skills added together to represent overall "in space" experience. A space watch simply provides some of this information without the years of experience, and is a -2DM to the task.)

Spray Paint-11
Microelectronics and custom-designed pigments have made simple surface coatings an attractive economic proposition in some locales. Normal pigments and coatings are seldom worth the shipping expense, but high-tech coatings to protect against a particular type of atmosphere or environmental hazard such as oxidation, mold or insect infestation are popular, as are specialty paints like color-change, striped, and polkadot sprays. A liter of specialty spray paint costs 10Cr and weighs 1kg.

Structurecomp
A generic term for a medium quality TL11+ structural material with the properties needed for many civilian applications. It is usually a honeycombed or foamed core of metal and/or ceramics, spray-faced with synthetic fibers to provide an extremely high tensile strength on both sides, with corresponding stiffness. The outer face is then sprayed or dipped with a similar fiber matrix in a smooth carrier to provide a mirror-like finish. For applications like vehicle bodies, all layers are dyed the same color if possible, to minimize the visual effect of scratches or other minor damage. The resulting product is stiff, light and has good energy absorbing abilities. Structural members may also be made in the same fashion, but without the attention to coloration.

Synthetic Diamond
Mass-produced slabs of synthetic diamond are a useful industrial good in TL6-9 cultures which cannot produce it themselves in monolithic blocks. Basic 1m2 x 10cm slabs cost about 100Cr in bulk and mass 200kg each. The most common TL6-9 applications are research and industrial, such as windows in high-performance aircraft or deep-diving submersibles, wind tunnel monitoring ports or high-refraction lenses for astronomical use.

A slab this thick has a rigid armor rating of about 8, but will shatter on impact from an attack with damage rating of 6 or more.

Synthetic diamond in large and/or curved areas is only commercially possible with fusion power and contragrav technology, and is not economical until TL11. It is the material of choice for transparency, toughness and scratch resistance. Prior to its development, such applications required synthetic quartz, which is technologically less sophisticated, but also not as capable and prohibitively expensive for most applications. If used as vehicle windows or vision ports, it has a rigid armor rating of 4 for 1cm, is transparent to most laser wavelengths and has a mass of 2t per m3. Its limitation as a structural material is its brittleness: it breaks rather than bends, and any weapon with a damage rating of 4+ will cause severe cracking over a large area, regardless of its thickness.

"I carry a few of these against the back of the hold just as a sweetener in deals. I know of a few places where the buyer turned around and sold them for a hundred times what I paid for them. He made enough profit to start his own import brokerage, and I got a solid repeat customer.

"Some people want them, others don't care. It's like a lottery. Besides, you can use them to repair your cockpit glass if it gets messed up."

Computers

Computers first show up in a practical sense at TL7. There are computational devices available at TL6 or even 5, but those are primitive devices suitable only for raw mathematics like trajectory analysis, basic accounting or figuring out the first few thousand digits of pi.

To keep things on a manageable scale, a problem that requires all the computational horsepower of the best parallel processing computer available at TL7 will be a program rating of 1. Personal computers at TL7 will having a rating of 0 if they are sufficient for basic tasks, or ones that do not require results in a hurry.

Computational Ratings

Computer programs are extremely sophisticated at TL11, even for mundane applications like voice recognition and home appliance control. These programs take up space, which is not that

important, and processing time, which is. If a program has a rating equal to the task at hand, it will take about 10 seconds to process the task. Each rating higher than this divides the time by 10, and a rating 2 higher than the task at hand is effectively real-time processing. Computers that are designed for a specific task are counted as being one rating higher for that task, and one rating lower for general purpose tasks. If a computer has a rating lower than the task, the time is multiplied by 10 for each point lower, and the computer is usually incapable of handling something more than double its rating+1. If 10+ computers are linked together for a specialized purpose, the rating of the combined system is increased by another point. Technically, it is possible to have ten computers linked together, specialized for the task of faster processing, and then have ten banks of these linked together for a specialized task of their own. This would require 100 computers, but would give you +3 rating over any one computer alone, and allow you to attempt tasks that would otherwise be impossible.

A computer trying to run several programs at once will multiply the time required for each program by the total number of programs running. Note that the maximum computational rating that can be transmitted over a wireless Comm channel is 2. Higher wireless transfer rates are possible, but require more expensive circuitry. So, if you are relying on a portable computer to interface with a mainframe computer, you can't get results transmitted at faster rate than a rating 2 computer could generate them. Plugging into a dedicated fiberoptic link would be a way of getting around this, and fiber links are used to connect most stationary systems (like homecomps) to the net.

Sample Task	**Rating Required**
Language translation with 10 second delay	0
Real-time language translation	3
Real-time high-res graphic simulations	3
Real-time global weather forecast	8
Real-time military software (target, evade, etc.)	3
Real-time decryption of regular Comm traffic	5
Locate someone on Comm net in 10 seconds	1
Small craft Roadgrid link	2
Small craft on-board autopilot	3
Maintain TL12 household appliances/communications	1
USP Size 6 on-board diagnostics	0
USP Size 7 on-board diagnostics	1
USP Size 8 on-board diagnostics	2
Maintain communications net*	population code-5
Reprogram communications net in a day*	population code-4
Bypassing a computer's security	target computer's Rating+4

*population refers to those with communications devices.

Modifiers

Specialized computer	+1 Rating for specific task, -1 Rating for all other tasks
10+ units linked	+1 Rating

Computer Rating Minus Program Difficulty	**Time**
3	real-time
2	.1 second
1	1 second
0	10 seconds
-1	100 seconds
-2	1000 seconds (15 minutes)
-3	10000 seconds (2.5 hours)
-4	100000 seconds (1 day)

General-Purpose Computer Costs and Sizes

Type	Mass	Cost	Type	Mass	Cost	Type	Mass	Cost	Type	Mass	Cost
TL10 R0	.3kg	60Cr	TL11 R0	.1kg	20Cr	TL12 R0	.1kg	10Cr	TL13-0	-	-
TL10 R1	1.5kg	600Cr	TL11 R1	.5kg	200Cr	TL12 R1	.2kg	100Cr	TL13-1	.1kg	70Cr
TL10 R2	9kg	6KCr	TL11 R2	3kg	2KCr	TL12 R2	1.5kg	1KCr	TL13-2	1kg	700Cr
TL10 R3	60kg	60KCr	TL11 R3	20kg	20KCr	TL12 R3	10kg	10KCr	TL13-3	7kg	7KCr
			TL11 R4	100kg	200KCr	TL12 R4	50kg	100KCr	TL13-4	35kg	70KCr
						TL12 R5	250kg	1MCr	TL13-5	180kg	700KCr
									TL13-6	900kg	7MCr

Note: Size and quality of peripheral devices will significantly alter the mass and cost of smaller units. While the computational load of the entire communications network on Sylea can be handled by few tons of computers, the terminals, routing hardware, etc., take up a number of structures on planet and in orbit. It is important to remember that in terms of computer technology, each TL of increase represents about the same increase in potential as occurred between 1975AD and 1990AD. For those unaware of this, this is from the advent of personal computers running with a fraction of a megabyte of memory and processor speeds of below 5 megahertz, to computers running with over ten times the memory at over ten times the speed, or from TL7 to TL8. Most computers in Year 0 run at TL11 speeds, which at this rate of increase would be over 10,000 times as fast as the TL7 models of comparable size and price, not counting increased processor efficiency. The new TL12 models are even faster, smaller and cheaper. However, this growth curve starts to level off around TL11, and while computers get smaller, they do not gain speed as fast, nor pack more memory into smaller spaces the way they used to. By TL15 the curve has reached the maximum possible for conventional technologies.

The maximum rating of a single machine at a given TL is its tech level minus 7 (and Imperial Intelligence has an edge no one else knows about). Computers can be physically larger than the mass of their central processor, especially at lower TLs in which bulky mass storage and display devices are used, but the actual processing circuitry seldom takes up a lot of space or power (say 10 watts with a number of zeros after it equal to half its rating, round up). So, a TL8 rating-1 computer is about 12KCr and 30kg (i.e. a workstation-level computer), and consumes about 100 watts of power. Higher ratings at this TL would be through linking units of this capability to create a parallel-processing machine.

Hacking: Hacking into a computer requires that you have access to it. Computers containing the most sensitive data are usually physically isolated from the global computer net, making long-distance intrusion physically impossible. If you do have remote access to a computer, bypassing its security is usually a function of how powerful the target computer is. Normally, bypassing computer security is a Formidable task, and the time it takes is based on your computer's rating compared to the rating of the target computer+4 to represent its security programs. This includes attempts to fool the computer into thinking you are someone else, bypassing security code, finding hidden pathways, guessing passwords and so on. Normally a remote intrusion attempt can't take more than 10 seconds, as computers are smart enough to sense something is fishy if John Doe calls up 270 times with different passwords (even your house computer has the wits to call up the authorities and report the intrusion attempt). This pretty much limits serious intrusion attempts to large, dedicated computers, since it takes a rating 6 machine to be able to hack a rating 2 machine in 10 seconds or less. In addition, failing the computer task almost always leaves evidence of the attempt, but close failures will not apply penalty DM's to an immediate re-try. Actually being at the computer in question allows as much time as needed for the intrusion attempt, and if signals to the outside are cut off, even failed attempts cannot be reported. So, if your portable rating 2 computer is confiscated by authorities with a rating 5 code-breaking machine, it will give up its secrets in about 100 seconds and there isn't much you can do about it. Keep your incriminating data off-line, in someplace secure and hidden.

Aide

An Aide is a simple adjunct to a Comm or other piece of communications hardware. It has a specialized microprocessor that has a rating of 0, sufficient to communicate with other simple electronic devices. Specialized language translation Aides do not have these communication capabilities, but can act as rudimentary translators. They are pre-programmed with a specific language, and let the user converse with a single other translator Aide-equipped individual with some fluency (using the same rule as for Translator, page 31). Unless both parties have compatible Aides, communication will only be in one direction. Aides generally cost around 100Cr.

Business Ring

This is the TL11 version of the business card. If you have one, whenever you shake hands with someone wearing such a ring, all the information about you and your company on your ring gets transferred to their ring, and vice versa. If you have an Aide, it will immediately give you one of several audio cues as to whether or not this person is someone you need to deal with, based on your programmed preferences, such as field of business, size of business, social status, company name, etc. If you don't have an Aide, you can simply upload the info to your home or business system at a later time. Business rings are about 50Cr and up, depending on materials desired, with a nominal reprogramming fee. Like business cards, they are easily available for non-existent firms. However, an Aide/Comm/Ring combination can query business databases and in a fraction of a second verify whether the business is genuine, for a search fee of a few Cr. Count on the fact that wealthy businesspeople are willing to spend a few Cr without even thinking about it just to avoid impostors. Business rings have no effective computational rating aside from simply being able to route data a few meters via extremely low-power radio signals.

Comm

The ubiquitous communications device carried by everyone on Sylea from the time they are old enough to talk. Their prevalence and usefulness is slowly expanding Imperium-wide, and exports of the technology continue to flourish, and ensure compatible communications protocols as they are universally adopted. For those who have never delved into the technical side of Comm traffic, a Comm is a fractional-watt video transmitter and receiver, operating in a narrow band of the microwave frequencies. Each Comm is capable of scanning several hundred frequencies when transmitting, automatically picking and choosing the ones with best reception. Likewise, a Comm signal is simultaneously spread over several frequencies when transmitting, so that temporary interference on one does little more than temporarily degrade signal quality. Due to the low power and frequencies used, Comms will not work if underground, underwater, or in areas blocked by large masses of metal. Most urban areas have Comm repeaters in buildings, tunnels, and so on to prevent loss of signal, but Comms are not reliable communication in many wilderness situations.

Comm signals are picked up by local Comm repeaters — dedicated units whose only purpose is to receive and retransmit Comm traffic. Initial routing of signals is handled by these units. For local calls, the signal is transmitted to the Comm repeater closest to the recipient. For long distance calls, it is routed to a central repeater which beams the signal to its counterpart in another city, which in turn broadcasts to a Comm repeater near the recipient. Orbital or across-planet calls are routed to a central repeater, which then sends the signal to a communications satellite, which routes the call to the nearest central repeater, and so on. Comm boosters are used when a Comm is out of range of local repeaters. These receive a personal Comm signal and alter frequency and boost its output so that it goes directly via satellite. This is convenient, but also incurs a charge of 10Cr per call.

Comm traffic is normally encrypted at a sophistication of rating 2. Military and police Comm units operate much the same way as civilian Comms, but have additional frequencies allocated that are unavailable to civilian Comm users. In addition, their Comms usually have encryption at a rating of 4. Much better encryption is possible, but not within the limits of most Comms.

A Comm has a computational rating of 1, which is specialized to a 2 for communications purposes only. Civilian Comms range in price from 50-200Cr, and police and military version cost 2KCr and up, depending on their features.

Homecomp

This is the standard house computer any permanent dwelling usually has in the utility closet. It costs about 2,000Cr for a standard model. Prices range from as low as a few hundred Cr for ultra-simple models for that vacation cabin in the woods, to as much as you want to spend. At TL11, the standard homecomp is a general purpose rating 2 machine that is proficient as voice recognition, interfacing with the Sylean communication net and

understanding appliance and home security protocols. The standard installation for 2KCr includes wiring in power control to all electric outlets and microphones in each room for voice control. Appliances have a standard control chip, and this will tell the homecomp anything that is plugged in, and what commands are available to that appliance. A medium-quality camera in each room would be another 50Cr per room, and a metabolic/voice scanner at each door would be standard for whatever level of security is desired.

Personal Computer
This is a standard, general purpose home computer that would be used for tasks outside the parameters of a homecomp. However, the two can talk to each other in such a way that all the interfacing is actually through the homecomp and the personal computer just provides extra memory and processor power. Normally the personal computer handles the number-crunching, data analysis and graphic manipulation tasks, and farms out data searches and the like to the homecomp, which pulls the information off the net and feeds it back to the personal computer as needed.

A personal computer has several hundred gigabytes of storage, holographic display, voice and keyboard or other interface, and comes with a standard suite of interface, home management, finance, communication and entertainment software. Offline storage is in the form of "blocks", encapsulated non-volatile memory chips in an irregular trapezoidal shape (so you can only insert them one way). A personal computer costs about 2,000Cr, give or take the size of memory and display hardware, and has a computational rating of 2.

Vehicle Computer
The specialized Roadgrid hardware is separate from the normal on-board computer many vehicles have. The normal vehicle computer is a specialized unit, hard-programmed for a specific vehicle type (the chip can be changed if the computer is moved to a different vehicle). This computer includes the vehicle identity number, and handles all the needs of the power plant, vehicle diagnostics, navigation system, electric door locks and basic voice recognition and response. It is usually tied to a vehicle Comm, which it uses for a variety of purposes, depending on the sophistication of the vehicle. Personal ground vehicles usually have a rating 1 unit specialized to rating 2, while personal air vehicles are usually rating 2 specialized to rating 3. They only mass a few kilograms and cost between 100Cr and 2KCr, depending on their sophistication.

Personal and Business Security

The access to interstellar imports, potential trade secrets and the general desire to own "new" items breeds an equally intense desire to steal them on most planets. Physical security is taken for granted on Sylea, but other worlds are not as secure, and have developed various types of security measures. Some of these are suitable for import and export in quantity.

Bugs-12
With modern technology bugs are minute, difficult to detect monitoring devices, which enable an individual to hear conversations or to record them for later monitoring. Typically, a bug array is packaged as a small rod containing fifty implantable bugs, together with a bug detector. Placed by touching the rod to a wall joint, light switch, or some other feature of a room, implanted bugs are not recoverable, but they can be destroyed. Bugs send a constant signal to a nearby receiver, which stores the data, compresses it and sends it out as short bursts, either on a time delay or upon receiving an activation signal. Once placed, bugs are almost impossible to detect without a bug detector. Even low-tech worlds may have acquired these devices, and no group should consider their conversations secure unless adequate precautions have been taken.

Detection of bugs is relatively reliable with detection equipment of the same or better technology level (Average Electronics or Intrusion task to clear each area of 5 indoor squares on a side, with -2DM for each TL the detector is below the bug, and +1DM for each TL it is above the bug). A bug detector can be on one of three settings: detect, smother, or destroy. "Detect" merely indicates the presence and location of a bug. If worn, the detector can provide a tactile signal that is not detectable by outside observers. "Smother" prevents a bug from sensing conversations, but allows the bug to remain active. This will be noticeable to the listeners as deliberate "static" on the recording. "Destroy" actually destroys the bug which has been detected with a directed electrical pulse, and requires close proximity to the bug and a repeated detection scan to confirm destruction. Bug detectors will also detect magnetic recording devices, but will not detect computer-based recorders as different from any other computer device (so security-conscious people have guests remove all electronic devices), neither are they be effective vs. eavesdropping by mechanical means, such as holes in the wall, hollow tubes leading to transmitters, or recorders elsewhere.

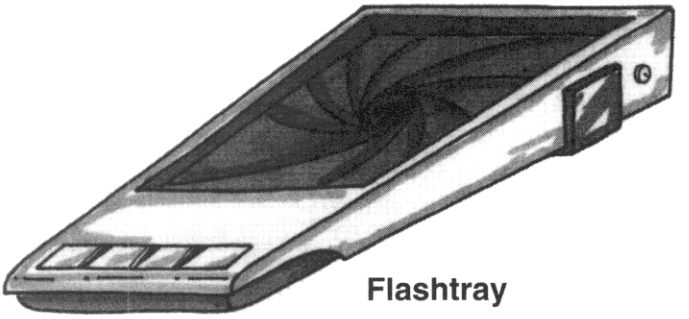
Locks, Combination
A nested series of notched disks are rotated by a numbered outer disk to points where a tumbler falls into each notch. These locks depend upon the large number of possible combinations for security. These are also available as padlocks. In door locks, the lock mechanism is usually inside or behind the protective structure of the door and cannot be easily destroyed to allow opening. Padlocks usually have moderate to good resistance to forced opening (armor rating of 1-2, depending on the security level desired). Combination locks usually run about 25Cr and weigh .5kg each.

Locks, Electronic
Any of several types of locks that depend upon solid state circuitry to arm and disarm them. Most have an automatic locking or unlocking device in the event of power failure; public facilities are designed to let people out but not in, security facilities just stay locked. More expensive versions and most versions at TL8+ have their own power sources (either primary or backup). All electronic locks can be set to give selective access (that is, limit access of certain individuals, to certain times of day, etc.). The circuitry of such a lock is usually protected by the material of the door, while portable versions have reasonable resistance to being forced (armor rating of 1-2). Almost all permanent applications will keep a datalog of when a given portal was opened, and by whom. Higher security applications will allow access to certain areas, but automatically alert security forces if the time or person doing the accessing is unusual.

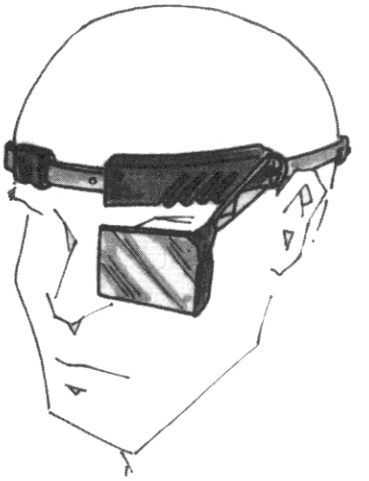
Keypads are similar to combination locks in that a series of numbers or letters must be entered in order to open them. This lock usually takes the form of a terminal-like keyboard next to the door.

Magnetic readers recognize the coding imprinted on a magnetized strip. This coding is usually sealed in a plastic card, sometimes with secondary security measures like a photograph or hologram of the person authorized to use the card.

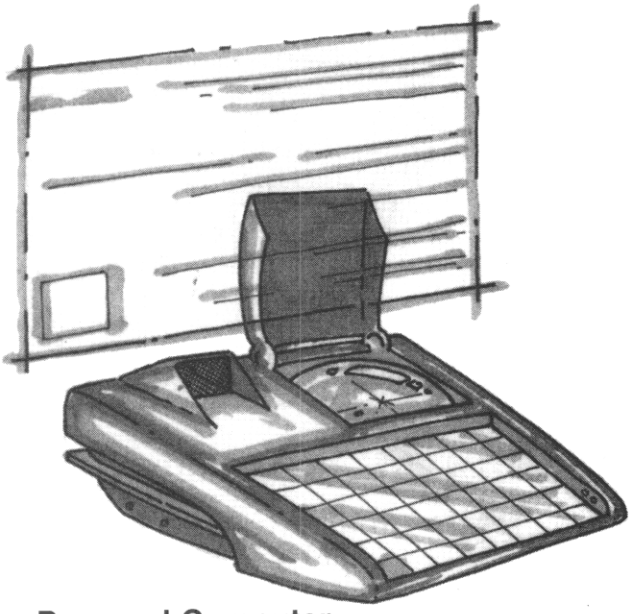
Proximity readers look for a coded response to a pulsed radio signal or magnetic pulse. The response circuitry is usually sealed in a plastic card, sometimes with secondary security mea-



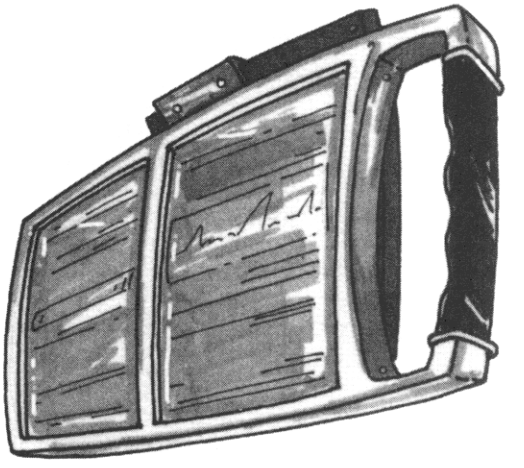
Flashtray



Personal HUD



Personal Computer



Metabolic Scanner

sures like a photograph or hologram of the person authorized to use the card, and can operate at minimum non-contact ranges (within 1.5m).

Fingerprint readers contain a small sensor that recognizes the distinctive markings on the skin of a human thumb pressed against a glass or plastic plate. Higher tech models may have adaptations for similarly unique characteristics of alien species.

Voiceprint readers identify the distinctive tones of individual voices. They are not considered as reliable as other biometric measures and are usually used in combination with one or more other technologies, like a keypad and voice authorization system.

Retinal scanners identify the distinctive pattern of blood vessels in the retina of the eye.

Metabolic scanners are a sophisticated network of scanners and sensors to distinguish individuals by various physical and chemical characteristics (size, mass, retinal patterns, voice patterns, brainwaves, blood analysis, and so on). Some models may require a small sample of tissue (such as a hair or a drop of blood) to be deposited into the lock. More advanced versions only require the user to be near them. The system used to verify purchases in most Sylean institutions is considered to be a type of TL11 metabolic scanner that works in concert with other forms of identification. The DM to fool such a scanner depends on the merchant. Better scanners cost more, but since the store is liable for failure to properly identify a buyer, it makes sense for more expensive establishments to have better scanners. Assume a –1DM for 100Cr of average purchase and each 10 times this, up to a normal maximum of –4DM. So, a vehicle dealership with an average transaction of 10KCr would have scanners with a DM of –3 to bypass.

Note that most prices for electronic locks below only include the basic hardware. Almost all except the keypad require hookup to a computer database of individuals who have valid entry codes, and at higher TL's, their biometric data.

Keypad	TL7	75Cr
Magnetic reader	TL8	100Cr
Proximity reader	TL8	200Cr
Fingerprint reader	TL8	250Cr
Voiceprint reader	TL8	400Cr
Retinal scanner	TL8	500Cr
Metabolic scanner	TL10	250Cr

Locks, Tumbler-4

The first true locks, these devices work by moving a number of small metal or plastic pins into sleeves measured to precise lengths. When the tumblers are moved the proper distances by a properly-shaped piece of metal, the latch is free to move. Two keys generally come with each lock, and duplicates can be made for a few credits. Tumbler locks can be keyed to work for several different keys, allowing some keys to open a series of locks, others only one. Average tumbler locks have reasonable resistance to force (armor of 1), and higher security models are very resistant to manual force (armor of 2), but the bulk of the lock can always have the protective rating of whatever door or structure they are mounted in. Padlocks (portable versions) appear at tech level 5. Non-violently bypassing a tumbler lock requires appropriate skills (usually Intrusion) and tech-level specific tools (the technology uses the same principle from TL4-10). A tumbler lock costs 25Cr and masses .5kg.

Security Fence-12

This is the latest "style" for medium-security access control. It consists of an extremely fine superdense wire with a layer of dyed fiberoptic strand around it. During the day it looks like a grid of fluorescent blue fishing line, and at night it is usually internally lit to appear like a grid of criss-crossing laser beams. Casual contact with the fence has no effect, but any attempt to push through it will cause the superdense wire to push through the fiberoptic cable, leaving the extremely sharp edge of the superdense to cut through whatever is pushing against it. In addition, the severing of the fiberoptic strand will set off an alarm at any security post monitoring the fence (the strands can be cut by any diamond edge or an attack with a damage rating of 3 or more. Pushing or ramming the fence will do up to 3D damage against whatever is doing the pushing). Security Fence costs 10Cr per m^2 at .1kg.

Stress Detector-11

The linear descendant of the polygraph stress detector uses readings of a suspect's physical responses, voice stress, and

Using Locks

Most locks or scanners are a Formidable Intrusion task to bypass, with a +1DM for each TL of appropriate tools used that is higher than the lock's technology, and -2DM for each TL below it. Very simple locks would be Average or Difficult tasks. The negative DM's can also apply to the TL background of the skill itself. A TL6 safecracker will obviously have a tougher time with a TL9 safe than his TL9 counterpart, regardless of the tools used. A suggested method of applying DMs based on a lock's effectiveness is to allow a -1DM for each multiple of the lock's basic price spent on the lock in question.

For instance, a 2KCr TL11 metabolic scanner would be a -3DM to bypass, since this is doubling the basic price three times. However, a TL15 character with a suitable forgery and disguise kit could get a +4DM, and end up with a net +1DM to get by it.

Failing to bypass an electronic or computer controlled lock usually results in a record made of the intrusion attempt, or an alarm alerting whomever is to look into such things. Failing to bypass a mechanical device usually means you just try again. Spending 10 turns is worth a +1DM, and spending 100 turns is good for a +2DM, if extra preparations would make a difference in the chance of success.

Given the paranoia of some institutions, it is not surprising that multiple levels of security are used to protect important places or data. An example would be a secure room in a secure building. An appropriate scanner blocks access to the building itself, and to get in the secure room, the intruder must enter a keypad code while stating their name for a voice scanner and passing a retinal scan. In addition, there will usually be an armed guard behind security glass to watch for suspicious activity like trying to physically compromise the system.

Use of these types of locks by NPCs is up to the referee, but here are a few suggestions and guidelines. In general, the more expensive a lock is, the more valuable the area to which it restricts access. Starships generally use state-of-the-art electronic locks with remote controls on the bridge. Starships usually set a stateroom's lock for the passenger or passengers who are using it, and restrict access by others to the high-level officers of the ship. Residences primarily use tumbler locks up to about TL10, and do not often use other types until two TL's after their introduction. Industry and commercial applications will probably adopt them within one TL of their invention, such as electronic timecards for factory workers, or magnetic stripe keys for hotel rooms. The simplest way to get around minimum to moderate security is to go for the weakest element, a person with the keys or codes. Want to get into a hotel room? Con a maid into using their key. Need to break into a starship stateroom? No need to hack the starship mainframe, just pick the pocket of the person whose room it is.

similar phenomena to establish the individual's degree of truthfulness under questioning. It is not, however, necessarily accurate in its readings, and the interpretation of readings is a complex matter (Difficult Endurance or Intelligence task for the speaker, or Interrogation task for the questioner, whichever is lower. Physically demanding interrogations use Endurance, while psychological probing uses Intelligence. Applicable DM's include any espionage type skill such as Disguise, or psychological factors that would give either party confidence in the situation, like differences in Social Standing). Voice stress detectors are less reliable, but are much smaller and can be used undetected. They can also be used on recorded conversations with no loss of accuracy (Staggering task to get reliably accurate readings. In either case, the gamemaster should be making the rolls, and giving replies like "reliable", "inconclusive" and "unknown" based on the rolls).

Robots, Security

Security robots are in limited use, their export has been restricted to certain specific models and programming regimes. Security robots are considered lethal weapons and all Sylean licensing and export regulations apply, both for on-world ownership and off-world sales.

Security Bot-10

These are TL10 battery-powered tracked units, used for patrol purposes. These are capable of remotely reading laser-coded identity badges and accessing central computers for confirmation or change of instructions. They are protected against chemical, obscurement and electromagnetic disruption, and are armed with a very short range stunner and wide-angle Blur projector with a maximum range of 15m and at least 20 bursts. It is capable of scaled threat response, self-righting behavior, and programmed actions in case of partial malfunction or communication breakdown (roll 5- on 2D to make the best of several choices).

Knowingly selling a Type 1 unit to any person, persons or group which the seller has reason to believe will use it to violate Imperium law is a Class 2 infraction of the Sylean Unified Code. Type 1 security robots are restricted to worlds already part of the Imperium, to agencies or individuals pre-approved by the governmental body of that world. Type 1 security bots sell for 20KCr each and weigh 100kg, taking up volumes equal to 50 liter.

For combat purposes, treat the Type 1 security robot as having physical characteristics of 6, a rigid armor of 4 and a weapon skill of +1 to represent its motion compensators and rate of fire. It can move at normal human movement rates and has low-light vision capability. It is not incapacitated until its Endurance drops to zero. Strength of zero is immobilization, and Dexterity of zero immobilizes its weapons.

Security Bot-12

These are TL12 battery-powered contragrav units, capable of patrol, stair climbing and other enhanced mobility tasks. It is equipped with the equivalent of two cP-03 pistols, one loaded with Blur-coated elastomer rounds (non-lethal damage of 1D), and the other with normal rounds. The outer surface of the Type 2 is also electrified when in an alert mode. On-board programming allows limited flexibility and tactical responses, as well as threat evaluation and scaled force response (7- on 2D to make best of several choices). The use of lethal force by a Type 2 unit is regulated by the laws and policies of the world it is sold on. Knowingly selling a Type 2 unit to any person, persons or group which the seller has reason to believe will use it to violate Imperium law is a Class 3 infraction of the Sylean Unified Code. Type 2 security robots are restricted to worlds already part of the Imperium, and to agencies or individuals pre-approved by the governmental body of that world. A single unit costs 50KCr, with a 50-liter volume, and masses 100kg.

For combat purposes, treat the Type 2 security robot as having physical characteristics of 8, a rigid armor of 5 and a weapon skill of +1 to represent its motion compensators and rate of fire. Any armor that doesn't insulate the wearer will result in 1D stun damage if a grounded person touches the robot while it is airborne, and Type 2 units can be used for crowd control in this capacity. It can move at double human movement rates indoors and triple human movement rates outdoors, including vertically, and its contragrav means it is unaffected by terrain. It also has low-light and thermal vision capability, and sonic amplification linked to its tactical programming (i.e. it can overhear what you say, understand it and act appropriately on a 2D roll of 7-). It is not incapacitated until its Endurance drops to zero. Strength of zero is immobilization, and Dexterity of zero immobilizes its weapons. Weapon skill drops to +0 if refitted with other weapons.

While it is not highly publicized, all security robots are required by law to include an Imperium-supplied chip in their command pathways. This chip includes a short-range radio receiver, capable of being self-powered by a strong outside signal. Upon receipt of the proper coded transmission, it detonates inside the robot, destroying the command electronics. The actual nature of the chip is classified information, although its presence is not, and is explained as a unique Imperial serial number for tracking misuse of the bot. It performs this function as well, and any security bot that does not return a properly coded serial number when queried will set off an alert to local law enforcement. This safety measure ensures that any Imperial units that ever find themselves facing Imperial bots can quickly deactivate them. Bypassing this TL12 chip is a Formidable Electronics task; bypassing it and including a valid serial number response circuit is a Impossible Electronics task.

Robots, Utility

Most Sylean utility robots are designed to interface with homecomps. For lower-tech cultures, simple adjustments in programming will allow more autonomy but less flexibility. The following is a representative sample of units available from a variety of manufacturers.

Note: Consumer robots are designed with safety in mind and even if reprogrammed would be hard-pressed to seriously injure a person.

Companions-12

These are a fairly recent development of the robot-makers art, and fall more under the heading of androids. They are fully anthropomorphic robots designed around an artificial duplicate of the human (or other) skeleton and musculature, giving them a very realistic appearance and movement pattern. Linked by several Comm channels to a central computer, they are capable of mimicking human behavior in a variety of fields with the exception of eating and drinking. Note that this is not in any sense an artificial intelligence, but a very adaptable expert program system. The high cost of development and programming has limited the market for Companions, and it is expected they will remain a luxury item for the foreseeable future. The purchase price of 250KCr includes a 1 year warranty on all parts and software, and yearly maintenance contracts are 25KCr per year. A companion bot usually masses about 80kg.

In game terms, a Companion is noticed as artificial on an Average Intelligence or Engineering task, modified by any visual obscurement like heavy clothing, helmet, etc. At higher TL's, the difficulty of this task will increase. Stationary, they appear very

lifelike, but when moving, the very subtle differences become apparent to humans who have seen "the real thing" all their lives. A Companion's stats are 7695-0: Intelligence represents the flexibility of the programming; Education is irrelevant, as a Companion has access to any information available on its central computer (or on the global net if on Sylea); Social Standing is always 0, as they are not considered anything more than a fancy tool. For accomplishing complex tasks or using skills, Companions can have any Dexterity skill at +1, and any Intelligence skill at +2, so long as the task does not require genuine creativity (note that "Acting" could be the Intelligence skill, making the "hey, it's a robot!" check have a -2DM). Normally a Companion comes with up to 4 skills, and more can be acquired at the cost of 10-20KCr each, as they are exceedingly complex programming tasks to develop, and any skill which does not have a mass-market application will cost at least 100KCr, as it will be developed just for that single customer. Its computer has a rating of 4 for purposes of mimicking human behavior, and a rating of 2 for general purpose tasks. The processor inside the Companion is a specialized rating of 2, just for communications with the central computer. Companions may be controlled by a virtual reality harness, though this is not a standard option. If access to its central computer is lost, the Companion is not capable of independent action, and will usually remain stationary and power down except for communications links.

Legally, Companions have no status, and like any other tool, the owner is responsible for any misuse. So, while a Companion is sophisticated enough to go out and buy your groceries, if it hits someone with your car, you will be the one charged with manslaughter or negligent homicide. Current laws regarding robotics are applied to Companions. No cases that touch on their unique complexity have come to trial, but in this eventuality, changes or modifications to existing law are expected.

For combat purposes, a Companion is treated as a character with the appropriate skills. They have an inherent armor of 1, although any damage may mar their synthetic flesh. They do not take blunt trauma damage, and are only rendered "unconscious" when Endurance (i.e. power source) is reduced to zero. They are immune to vacuum or water depths up to 2 atmospheres, and can tolerate corrosive and insidious atmospheres for several hours, though all of the above will affect their synthetic skin.

Companions, Animal Bot-11
The popularity of the so-called "catbot" has never been fully explained, but the item is easily described. Designed to look like a small feline, it develops an "attraction" to the owner in a somewhat annoying fashion. It will climb onto high surfaces to observe, walk behind the owner to get stepped on, or get into the frontal arc of the owner, usually in or on reading material or work. When the owner is not present, it finds the largest source of light and remains stationary for hours on end to recharge itself through solar panels. It is programmed to understand voice commands, and is also programmed to ignore a large fraction of them in a random fashion. The catbot, like true felines, makes comforting sounds when held, and has a random preference as to which touch sensors elicit this response. Such a "pet" costs 500Cr and weighs 5kg.

Aside from the novelty value and ease of maintenance, catbots have found the most off-world popularity in lower-tech space colonies that do not permit the overhead needed to support real companion animals. The simple behavior patterns of the catbot belie its complex programming and random utility. Infirm individuals can have bioscanners in the bot that automatically report any change in vital signs. Home computers can use them as an adjunct to security systems, and adept spacers have reprogrammed them to spend part of their activity cycle exploring dark places and catching hitchhiking pests. It has no armor, and can absorb 3 points of damage before becoming non-functional.

Groundskeeping Unit-10
When needed, the unit will mow and edge lawns, and electrically zap weeds it is programmed to detect. It is normally solar-powered with battery backup. Basic programming is by initially spraying an invisible paint line on the perimeter of the area to be covered, and providing visual samples of weeds or other undesirable plants. After that, inertial navigation and on-board memory serve. One unit is sufficient for several hectares of flat lawn. Tracked models are available for uneven or extremely hilly lawns, for approximately double the price. It has no armor, and can absorb 6 points of damage before becoming non-functional. These "mowbots" cost 250Cr each, mass 30 kg and 20 liters of volume.

Manipulator Unit-12
Also called the "waldobot". These have been technically available since TL10, but reductions in the size of thruster units have made them eminently more practical in the past century. A waldobot is a small antigrav unit that has power supply and a pair of manipulator arms with multi-digit hands. The user wears a pair of virtual reality goggles, and can see and manipulate items remotely with the robot. This is a common alternative to suiting up for trivial vacuum work, like hull inspection, minor repairs, etc. In this case, waldobots can simply be dumped out the nearest airlock, or deployed from external stores lockers. Waldobots can also be used planetside to do work in hostile environments like radiation or chemical contamination. They cost 2000Cr each, mass 20kg and 12 liters of volume.

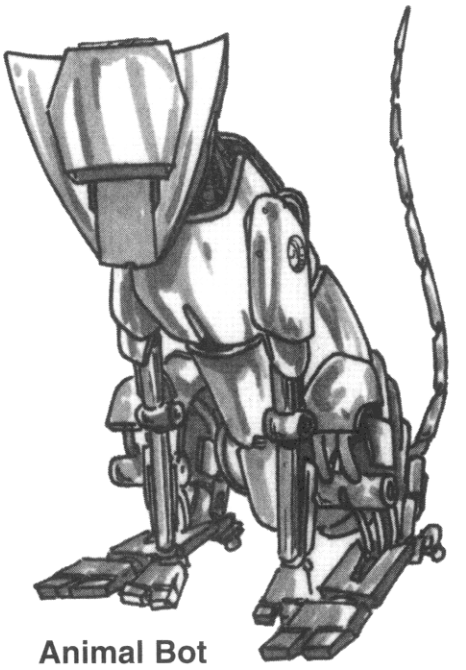
Waldobots have a Strength of 3 and normal human movement rates, albeit in any direction, and it can carry up to 10kg of tools or equipment. The user takes a -1DM to perception and the maximum Dexterity skill they can apply is their Mechanical, Vac suit or Battle Dress skill. Waldobots can be adjusted to match the manipulative members of most species, but trying to use manipulators of a species other than your own is a -2DM. Waldobots have an inherent armor of 1, and can take up to 9 points of damage before ceasing to function (assume all physical characteristics are 3 for impairment purposes).

Vacuum Unit-10
Either when the occupant of the house is away or at pre-scheduled intervals, the low-profile unit will emerge from a storage nook and vacuum the floors. It will detour around all floor obstacles, and will respond to simple voice commands. When done, it will dump debris down a chute, or signal to be emptied when it is full. More sophisticated units can discriminate between dropped debris like food and important things like personal possessions, and will sort and place items accordingly. It costs 100Cr, masses 10kg and 10 liters of volume, has no armor, and can absorb 3 points of damage before becoming non-functional.

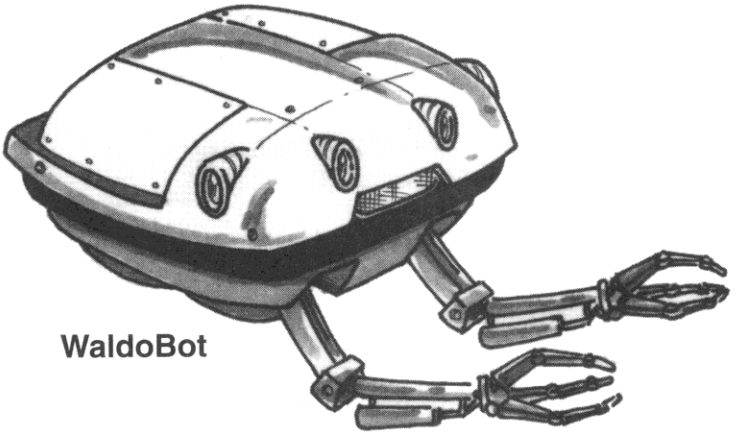
Robot Design

Robots are built as very small vehicles, which covers most of their needs and capabilities. Small robots will normally use the hand-held communicator equivalents rather than full vehicle-capable units, both to reduce mass, volume, and power consumption. Robots are never self-aware or artificially intelligent, but they can have a depth of programming capable of thinking ahead on multiple possibilities and their likelihood of success in a given situation. How well they can do this depends on the level of computing power available to them. A rating 2 computer is standard for most TL11-12 robots. For most purposes, a robot can

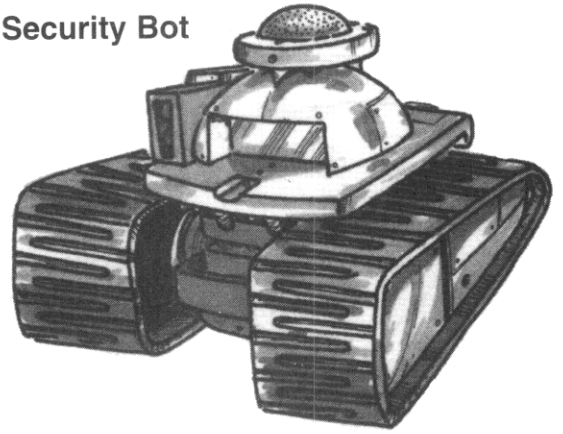
Companion Bot



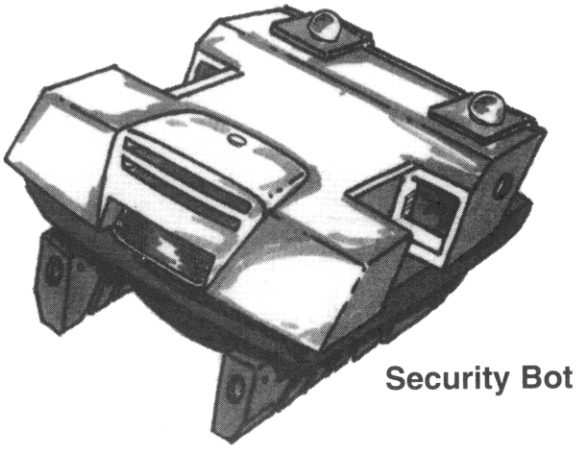
Animal Bot



WaldoBot



Security Bot



Security Bot

have a specific Dexterity total (e.g. Pistol skill) at TL/2 (round down) plus computer rating, or a generalized Dexterity total (e.g. Gun Combat) at TL/2 (round down) plus half the computer rating (round down). Specific Intelligence skills are available at the computer rating, while generalized ones are at half the computer rating (round down). Note that a robot linked by radio to a larger control computer will use the rating of the larger computer as long as the link is active. So, if you broke into an area, and a security bot saw you, reported to the central computer and the central computer recognized you and could find records of your previous activities and tactics, it could design a security response optimized just for you.

For human-equivalent characteristics, do the following:

Strength is based as for the Augmented Armor rules (p. 18-19). A robot that has been partially or completely anthropomorphized can use its manipulative limbs at this effective Strength in combat or to hold/grip an object.

Dexterity equals Tech Level divided by 2, round down. Dexterity can be increased by 1 for each doubling of cost on the propulsion system. Partially anthropomorphizing a robot (i.e. giving it some human appearance or function) will double the cost of the propulsion system. Being able to use human hand-held equipment without penalty is possible with partial anthropomorphizing. Full anthropomorphizing gives the robot a comfortably human-like (or alien) appearance, and doubles the cost again. This allows the robot to use any human equipment of the appropriate size without penalty. For instance, a partially anthropomorphized robot could pick up and use a gun or a radio, while a fully anthropomorphized robot could sit in a cockpit and fly a plane (if it was the right size). A robot can have a high Dexterity and maneuver very well, but be completely unable to manipulate objects except by bumping into them.

Endurance represents the general damage compensation and redundancy, as well as the power distribution network, and is equal to the Strength of the robot. Robots are generally immune to damage from vacuum and +1 atmosphere pressure difference, and have a temperature tolerance range of +/-30°C more than humans. Temperature extremes can reduce battery life, cause programming glitches or propulsion system malfunctions. An onboard "life support" system suitable for its volume will act to negate temperature extremes as it would for a human in a space suit. To figure out the time a robot can run on a limited power supply, you will have to find the total power available, and then find the power used by each subsystem of the robot. This can be cumbersome. We suggest you figure out how long the robot can run at full power, and how long it can run at 10% of this. Actual run time will be somewhere between these numbers, based on how hard the robot is working.

Intelligence for purposes of perception and problem solving is equal to one-quarter of the Tech Level (round down), plus the rating of the computer used for the purpose.

Education, Social Standing and Psi are irrelevant to robots.

Robots of any appreciable technology (TL9+) are assumed to have human-spectrum vision, hearing and touch. All other sensory enhancements are additional cost and volume, and would use the options available for space suits, augmented armor, or simple addition of any other item; assuming a volume of $1m^3$ per liter if no volume is specified for the item. Any special capabilities of the item can be selected by the on-board computer.

Equipment added to a robot usually has the normal cost and volume of that item, and is protected by the armor of the robot. Damage to robots can be simplified down to human level and applied to its physical characteristics, or it can be treated as a vehicle and use the vehicle damage rules, at GM preference.

I Can Get It For You Wholesale!

Characters engaging in merchant activity will want to buy low and sell high. If they are buying in quantity, odds are they can get a better price. If dealing with a distributor (someone who buys from a number of sources, and then sells small quantities of a large number of items), you can probably get a 30-40% discount in price for a class of items, provided you have a certain minimum order size. So, if you are interested in electronics, and you go to an electronics distributor, they won't sell you a computer at a discount, but they might sell you 10 or more at a discount. Of course, most distributors specialize in a category of goods, so if you want electronics, fabrics and pharmaceuticals, you have to go through three different distributors.

If you go straight to the manufacturer, you can probably get discounts of 50-60% off retail price, if the manufacturer doesn't have their own distribution net. If "product x" is unique, then the manufacturer can sell at retail and give minimal quantity discounts, because if you want it, you have to go through them. However, if the product is available from a hundred different companies, they will probably be more than happy to give you a 50% discount if you are going to buy a hundred or thousand of their product. All of this is abstracted into the normal trading and commerce rules, with the exception that regardless of where you are, if you are buying direct from the manufacturer, your cost of goods should get an additional -1,000Cr modifier, if there is more than one manufacturer/supplier of that item.

Selling The Goods

When you buy in quantity, you either sell in quantity at a discount, or sell individually and take your time about it. Goods sold offplanet can fetch a premium of whatever the market will bear. This can be fairly high for a sole-supplier of a unique good, but you can also make assumptions that turn out to be incorrect. That hot Brogandian Ale you bought 200 barrels of could have been sold at a 100% markup on Veltris 4, except someone else arrived last week with a tanker ship full of it. . .

Selling goods is as described under the basic rules. If you are selling goods of high value, then you can actually try to sell them, piecemeal (hawking watches on the street corner), in which case your success roll indicates your general ability to play the crowd.

Importing and Exporting

Almost all planets have their own import and export regulations, taxes and duties. Most new additions to the Imperium want to encourage trade for at least some items (or they wouldn't have joined), but still want to make a profit on the transactions. In addition, they will want to prevent undesirable goods from getting on planet, either from a legal, social or ecological standpoint. Some places may restrict biologicals, while others may censor information, and most have fairly stringent regulations regarding import of weapons. And remember, you are subject to local laws, not homeworld laws, so ask in advance.

Usually, all goods bound on- or off-planet have to go through a small number of transit points: on orbital stations if the planet has reached that level, or secured ground facilities otherwise (starports). Imperium worlds without orbital interdictment capability of their own will usually have a small Imperium-supplied naval presence for traffic control and monitoring, paid for by taxes on goods imported to that world. All goods are stored in secure warehouses until being loaded onto a ship, or loaded from the ship into secure warehouses. Planetary officials check the shipping manifest against the actual cargo, and often open or scan some or all of the containers to check for fraud or smuggling.

After the inspection process is complete and any possible waiting period has elapsed, the goods are released to the final purchaser. This waiting period depends on the type of item, as well as the technology of the planet in question, and can range from hours to weeks.

Sylea handles this process with the usual computerized efficiency, utilizing bulk cargo scanners and digital manifests. The central computer system also allows easy detection of Sylean items that are not supposed to be re-imported. For instance, if you buy a hundred Fusion+ units at the export discount rate, and then try to re-import them to Sylea a month later, their serial numbers would be picked up by the cargo scanner and immediately flag security that something improper is going on. Altering the serial numbers would require disassembling and re-chipping each unit, which would end up costing enough that it wouldn't be worth it, which defeats the point of this exercise.

Optional Trading rules

Goods in the basic game have a fairly narrow price range per ton, and any ship type can handle any cargo with equal facility and chance of turning a profit. Try adding the following:

Raw Materials	
Unprocessed ores	Standard cost, does not require pressure support/climate control.
Processed ores	Standard cost, does not require pressure support/climate control.
Radioactive ores	Standard cost, does not require pressure support/climate control. Cargo hold must be dedicated to radioactives or decontaminated after each run (100Cr per displacement ton)
Raw organics	Standard cost, requires pressure support and climate control, must pass quarantine or contaminant inspection. Cargo hold must be decontaminated before other organics can be loaded.
Waste materials	Standard cost, does not require pressure support/climate control. Usually requires extensive decontamination after each run (200Cr per displacement ton) unless ship is dedicated junk hauler.
Rare Materials	Rare materials have a cost per ton of 100x to 10000x the base amount, and are seldom available in quantities of more than a ton (in TL8 Earth prices, a metric ton of gold is worth 10-20MCr, and a 1Cr price difference per gram between buyer and seller is a 1MCr profit or loss). If available at the standard price, it means that the captain is only ferrying the cargo for someone else, and is simply being paid a flat cargo handling fee. In this case, the cargo may have its own security detachment to guard it.
Pharmaceuticals	Pharmaceuticals usually require climate control and life support, and have a cost of x100 per ton. Each planet may have different regulations regarding the import of pharmaceuticals or medical supplies. No one should attempt shipping them unless they are fairly sure there will be a market for them at the other end of the trip.
Novelties	Novelties usually require climate control, and sometimes pressure support. Price may vary by a factor of x1D. Roll 3D for the Actual Value table, and keep the 2D subset that is lowest or highest (ties go to lowest). For instance, a 3D roll of 2,3,6 would be a total of 5, while 1,5,5 would be a total of 10. The first time any class of manufactured good is imported to a planet, it is counted as a novelty to see what the consumer and trader reaction is. Exceptionally good or bad rolls may indicate permanent biases towards the item for good or ill.
Consumables	Consumables may be staples of daily living, or regularly consumed luxury goods like exotic wines. Cost of goods will vary by a factor of x2D. Due to the constant trade in them, the price of consumables does not fluctuate as much as other goods. Roll 3D for the Actual Value table, and keep the 2D subset that is closest to 7 (ties go to lowest). For instance, a 3D roll of 2,3,6 would be a total of 5, while 1,5,5 would be a total of 6.
High Technology	By its nature a highly processed item, the cost of goods for high technology cargo is x10. Normally it requires climate control, but not necessarily pressure support.
Creative Works	Normal cost if mass-produced, up to x1000 cost if individual/unique items (how much would the Mona Lisa cost?). Normally requires pressure support and climate control.

Raw Materials Continued...

Performances	As per the normal rules. However, while the most skilled performer is the money-maker, the broker gets a cut, the venue gets a cut, and all the support staff and other musicians also get salaries. The value for a "tour" is the net profit to the performer after about 3 months work. If the performer is acting as their own broker, halve both skills, as the setup and management of a tour takes a lot of time, which cannot then be devoted to tailoring the performance to the local audience. The minimum cargo size of a "performer" is 1 displacement ton per level of effective skill over 7, squared (minimum of 1). So, a performer with an effective skill of 10 will have equipment and entourage that takes up 9 displacement tons of cargo and stateroom space.
Raw Data	Data takes up a negligible amount of real space, and sale of pure information is a volatile market. However, raw data can also take the form of raw material such as pottery shards, core samples, fossils, preserved specimens and so on. These have the normal cost, and generally require pressure support and climate control.
Prototypes	By nature, these are not quantity goods, and the cost of goods is generally the cost of a single sample at x100 to x1000 to reflect the unique nature of the item. Likewise, the total amount available is the volume of one or two examples of the product. Captains may sometimes be approached to carry prototypes if their ship is equipped with specialize facilities needed for handing the item (ultracold freezers, radiation shielded cargo hold, etc.). In this case, a flat fee is paid for shipment and delivery.
Units of Exchange	Unless these are in the form of rare materials, electronic credit (like Solars) will usually be shipped by anonymous courier, who will travel high passage on the largest commercial ship going to the destination. If part of a space fleet, then the corporate owners, and captain may have knowledge of the credit transfer and have their own security people on board, but the normal crew will not be aware of this. Illegal credit transfers (smuggling) may take place on any ship, and hopefully no one but the courier knows. Currency transfers are another matter. Lower-tech worlds may hire higher-tech ones to mint counterfeit-proof currency, which then must be shipped to the destination world. Anonymous credit (referred to as "cash") can be stolen and used by anyone, and a supply sufficient for a global economy will take up significant cargo space (perhaps 5MCR per m3 for 10Cr notes). Smuggling these would be more difficult, and shipping them normally is always done with the highest security.

Unless cargo is in the form of something handled in bulk (garbage, ores, etc.), it is usually shipped in containers of some type, which are stacked in the hold as appropriate. For low-value goods, these containers may occasionally leak, burst or have other noxious side effects, so inspecting them before loading is always a good idea.

VEHICLE DESIGN

The following section is a modified version of the vehicle design system in Fire, Fusion and Steel, adjusted for T4, and limited to a subset of vehicle types likely to be encountered or designed by characters. It can be used to create non-spacecraft vehicles of most sizes, and while it incorporates much of the Standard Starship Design rules, it has some needed exceptions for extremely small vehicles.

Priorities

The steps you take to design a vehicle are determined by the type of vehicle you want, and what is the most important factor in its design.

Volume: If the vehicle has to fit a certain volume, like a cargo hold on a starship, then the volume you have available is fixed, and everything has to fit in it. Start with a volume for the hull if this is your priority.

Mass: The total mass of the vehicle is the most important factor. Set the mass for the vehicle at the maximum you would allow, then go to the next priority. Mass is often a factor for carrying the vehicle as well, or at lower TL's, the limits as to what roads and bridges can support.

Equipment: The vehicle must have certain equipment, and its mass and volume will be based on what it is carrying. Since the hull and surface of a vehicle usually do not have that much volume, designing a vehicle around its components and allowing about 10% of the total for structure will usually work.

Performance: The most important factor here is the acceleration and top speed of the vehicle. Set the mass of the vehicle, then buy the power plant and drive train required to get the level of performance desired.

Example: A standard car could be built in almost any order of these priorities, depending on what type of car you wanted. A sports car would stress performance. A passenger van would stress the "equipment" of a certain number of seats. All would have certain mass and volume limits to appeal to different segments of the market. Our sports car would probably be designed around performance (and mass), equipment, and volume. You would buy the power plant and drive train to get the performance for a certain level of mass, then add crew stations (seats) and other equipment, and then buy a structure sufficient to hold all of it. Unless your performance requirements are extremely rigid, your final mass can vary a little and you will still end up with the car you want.

Basic Equipment

Any commercial vehicle at any tech level will automatically come with any accessory that consumers at that culture demand. For personal land vehicles, the table below gives samples of this.

TL	Sample mandatory accessory
5	Headlights
6	Minimal entertainment radio receiver
7	Basic safety restraints
8	Airbags
9	Navigation computer
10	Roadgrid system
11	Voice response system
12	Local communication links

The exact features that come with a vehicle will depend on the vehicle and the culture involved. These accessories have no cost, and are factored into the overall cost of the vehicle.

Volume & Body

All vehicles will start with an internal volume. Like starships, in the end this will be measured in displacement tons ($14m^3$), and when the term displacement is used, remember that it refers to volume, not mass. Within this volume, different components will have different densities, so one vehicle with a volume of 2 displacement tons may mass 14 metric tons, another might mass 25 metric tons. We use both numbers because cubic meters are a little more intuitive, but displacement tons help you figure out whether you can carry it in the hold of your ship.

If the vehicle has wings, it is an "airframe" configuration, and will have more area than a simply streamlined version of the configuration. This extra area may be considered a separate "facing" for armor purposes, that is, you can have an airplane with wings that are armored more or less than the fuselage. Airframe vehicles can fly with an acceleration from power plants of less than local gravity, by using lift provided by these wings. Airframe configurations are assumed to be streamlined as well.

Vehicles that are simply streamlined may only fly if their acceleration is greater than that of local gravity, and vehicles must be streamlined to use high speeds effectively. A vehicle that is not using a streamlined configuration will take a -1DM to all maneuvering tasks due to turbulence for each multiple of 50 meters per second (300m/turn, 180kph) it is travelling, and vehicles that are streamlined but which have one or more facings open to a drag-inducing environment (air, water) will take this penalty as well. Unstreamlined open vehicles will take both. Divide these speeds by 10 for water vehicles, since the density of water, compared to air, makes streamlining much more important at low speeds. Unstreamlined or open-faced vehicles may never break the speed of sound in an atmosphere (≈1800m/turn, 1080kph) or be used for re-entry to an atmosphere from orbit.

First, find the approximate volume of the hull you want from the Volume Factor Table. This will give you the surface area that needs to be armored and the diameter of a spherical vehicle with that internal volume. Don't worry if your vehicle concept is longer than it is wide, we'll take care of that in a minute.

Now, choose the approximate body shape you want for the vehicle from the Configuration Table, then the numbers in the length, width, and height columns are multiplied by the diameter to get the approximate vehicle dimensions. For instance a small car volume (8.4m3) has a diameter of 2.5m. If it uses a box configuration, it will be about 2.5m x 1.25 = 3.1m long, and 2.5m x .65 = 1.6m wide and high. A medium car would be 3.5 x 1.8 x 1.8m and a large car would be about 3.8m x 1.9m x 1.9m. You can play with these numbers a little bit.

To get the chassis or structure volume of the vehicle, multiply its maximum acceleration in G's by the number in the Structure column on the Configuration Table, the Hull Factor from the Volume Factor Table, then divide this by the toughness of the chassis material. This is the internal volume taken up by vehicle structural elements. The chassis or structure mass is the volume times the density of the material. The cost of the chassis or structure is the cost of the appropriate volume of structural material times the Price column on the Configuration Table, to represent the difficulty of fashioning the appropriate framework.

For instance, our small car (8.4m^3) has a maximum acceleration of .5G. The Structure number for a box configuration is 1.2, the Hull Factor for an 8.4m^3 vehicle is .200, and it is made of fiber laminate, which has a toughness of 2. So, the chassis volume is 1.2 x .2 x .5 / 2 = .06m^3. Since fiber laminate has a density of 1, the chassis has a mass of .06m3 x 1 = .06t, or 60 kilograms. This covers the minimum structural support to attach things to. If it were made of soft steel, the volume would be .03m^3 and the mass would be .24t or 240kg. This does not count wheels, windows, body or anything else, just the minimum structure needed to attach vehicle components to. The internal structure of the vehicle does not have to be made of the same material as the armor. A soft steel chassis can mount laminated surface panels, and a wooden-framed ship can have iron plates as armor.

The maximum acceleration of a vehicle is not just the acceleration provided by its power plant, but how intensely it can maneuver. A fighter plane with a 1G structure because it has a 1G power plant is not built to handle 8G turns. If you want the agility to pull these high-stress maneuvers off, the vehicle must be built to withstand them. This is important, as vehicles with lift surfaces can have higher accelerations for combat maneuvering purposes than their straight line acceleration figure. Airframe vehicles can have a maximum acceleration for agility purposes of whatever their chassis can handle, or 5 times their basic acceleration, whichever is lower. This maximum effective acceleration cannot exceed what the crew is able to withstand. Most vehicles should be designed to handle at least 1G.

Armor is a separate mass and volume from the structure of the vehicle. The volume of the armor is the base surface area of the vehicle in square meters, times the number in the Surface column from Configuration Table, times the thickness of the armor in centimeters, divided by 100. The cost of surfacing or armoring the vehicle is total volume of the armor, times the cost of the material per cubic meter.

For instance, our small car has a base surface area of 20.0m2, times 1.2 for a box configuration is 24m^2. If made of fiber laminate, the minimum armor of .3cm, for an armor volume of 24m^2 x .3cm / 100 = .072m^3 and armor mass of .072m^3 x 1 = .072t or 72kg. If faced with soft steel, the minimum thickness would be .1cm, so the volume would be 24m^2 x .3cm / 100 = .072m^3, and the mass would be .072m^3 x 8 = .576t or 576kg. The fiber laminate body would cost .072m^3 x .030MCr = 2160Cr, while the soft steel body would cost .072m^3 x .016MCr = 1152Cr, and the 1008Cr difference is probably why cars continued to be made with soft steel bodies long after fiber laminates became available.

Wings

If designing a lift vehicle, the difference between the area of a Streamlined configuration and an Airframe configuration is the wing area. In general, the square root of this area times 2 is the total wing width on a high performance aircraft, and times 3 is the wing width on regular aircraft.

VOLUME FACTOR TABLE

Displacement	Hull Volume	Factor	Hull Area	Diameter	Normal Mass	Typical For:
.05 (USP5)	.7m3	.038	3.8m2	1.1m	.1-.7m ton	Recon drone
.10 (USP5)	1.4m3	.061	6.1m2	1.4m	.3-1.5 m ton	Motorcycle
.20 (USP6)	2.8m3	.096	9.6m2	1.7m	.6-3 metric ton	Security robot
.40 (USP6)	5.6m3	.153	15.3m2	2.2m	1-5 metric ton	Ultracompact car
.60 (USP6)	8.4m3	.200	20.0m2	2.5m	1.5-8 metric ton	Small car
.80 (USP6)	11.2m3	.242	24.2m2	2.8m	2-10 metric ton	Medium car
1.0 (USP6)	14.0m3	.281	28.1m2	3.0m	3-15 metric ton	Large grav car/car
1.5 (USP7)	21.0m3	.368	36.8m2	3.4m	4-21 metric ton	Cargo truck
2.0 (USP7)	28.0m3	.445	44.5m2	3.7m	6-30 metric ton	Medium tank
3.0 (USP7)	42.0m3	.584	58.4m2	4.3m	8-50 metric ton	Heavy tank
4.0 (USP7)	56m3	.707	70.7m2	4.7m	10-60 metric ton	
5.0 (USP7)	70m3	.820	82.0m2	5.1m	12-70 metric ton	
7.0 (USP7)	98m3	1.03	103m2	5.7m	18-100 metric ton	
10.0 (USP7)	140m3	1.30	130m2	6.4m	50-150 metric ton	Small ship's boat

CONFIGURATION TABLE

Form	Length	Width	Height	Struc	Surf	Price	Example
Open Frame	3.5	.50	.50	2.0	1.0	0.3	
Needle	3.0	.42	.42	1.3	1.3	0.7	
Needle Streamlined	3.0	.42	.42	1.3	1.3	0.8	Missile
Needle Airframe	3.0	.42	.42	1.3	1.69	1.2	Supersonic transport
Wedge	2.5	1.0	.64	1.5	1.5	0.5	
Wedge Streamlined	2.5	1.0	.64	1.5	1.5	0.7	Speedboat
Wedge Airframe	2.5	1.0	.64	1.5	1.95	1.5	
Cylinder	2.0	.58	.58	1.1	1.1	0.6	
Cylinder Streamlined	2.0	.58	.58	1.1	1.1	0.8	Submarine, missile
Cylinder Airframe	2.0	.58	.58	1.1	1.43	2.0	Subsonic aircraft
Box	1.25	.65	.65	1.2	1.2	0.4	Automobile, tank
Box Streamlined	1.25	.65	.65	1.2	1.2	0.6	Sports car, grav car
Sphere	1.0	1.0	1.0	1.0	1.0	0.8	
Sphere Streamlined	1.0	1.0	1.0	1.0	1.0	1.0	Hover drone
Disk	1.5	1.5	.30	1.2	1.2	1.4	
Disk Streamlined	1.5	1.5	.30	1.2	1.2	1.6	UFO, motorcycle/rider
Disk Airframe	1.5	1.5	.30	1.2	1.56	1.2	Flying wing
Close Structure	1.75	1.3	.30	1.4	1.4	0.3	
Slab	2.75	.80	.25	1.5	1.5	0.5	Turretless tank
Slab Streamlined	2.75	.80	.25	1.5	1.5	0.7	Race car
Slab Airframe	2.75	.80	.25	1.5	1.95	1.5	

For instance, a wing area of 64m2 would be a $64^{.5}$ x 2 = 16m extra wingspan on a high-performance aircraft, and $64^{.5}$ x 3 = 24m on a regular aircraft. This adds to total vehicle width in case you need to know. This is one case in which you may end up with an aircraft with a lot of unused volume, as a certain size is needed to give the vehicle wings large enough to have a low takeoff speed. You may be able to design the equivalent of a flying tank, but it won't do you any good if it has to reach 700kph before it can get off the ground! Optionally, you may divide the minimum takeoff speed and maximum speed for a non-military aircraft by 1.5 to represent a design optimized for less energetic uses.

Buoyancy

A vehicle will float if its total mass in metric tons is less than its total volume in cubic meters. To make watercraft design easy, ships should have a total mass in metric tons of 50% or less their volume in cubic meters. Vehicles that are amphibious and able to make short crossings of fairly calm water can have a mass in metric tons of up to 80% of their volume in cubic meters. Submarines and submersibles should be designed with a loaded mass in metric tons equal to their volume in cubic meters, which they adjust for diving or surfacing by filling ballast tanks with water. Assume 20% of total vehicle volume is required for these at a mass of 1 ton per cubic meter — a volume that may not be used for any other purpose. Submarines of TL7- use compressed air for emptying tanks, and can only do so TL times before needing to surface and refill them. TL8+ submarines with nuclear power plants can extract air from water and store this as needed.

Modular Vehicles

A vehicle designed to have large, easily replaceable chunks will have double the structure cost and mass. In addition, each "module" will suffer a 10% volume penalty and cost 50% more than normal. That is, the total volume of the components in the module is increased by 10%, and their total cost is increased by 50%. These disadvantages are offset by the ability to replace modules in short order (25% of the equivalent "repair" time) to meet a given need. For instance, an exploration vehicle could have a number of specialized laboratory modules. A cargo carrier could replace a cargo module with a fuel tank for extended trips, or a tank chassis could mount different turrets for different missions.

Vehicle Storage

Many vehicles will be transported by starship to their ultimate destination. Unless a cargo hold is especially configured for a particular vehicle when the ship is built, the vehicle will require double its actual volume in cargo hold space for a cramped hold, and quadruple the volume for the vehicle to easily drive in and out of. The only way to get around this wasted space is to use all the open space around the vehicle for small flexible cargo items, stuffing them under the chassis, on the hood, and so on, completely burying the vehicle in other stuff. While this is permissible, it still does not reduce the volume required, it just makes the extra volume around the vehicle usable for other cargo. It may also take hours to extricate the vehicle, during which all the other material must be stored elsewhere, since there is no extra cargo space to put them. This could be in hallways, staterooms or outside on the ground if conditions permit. Take these factors into account if you have paying passengers who would be offended by sacks of Rigellian marbles littering the corridors while they try to disembark.

Armor

Not all vehicles are "armored", but a minimum armor rating of "1" is needed if a body facing has any protection at all (any vehicle can have a zero mass coating like a tarp stapled to it, but it has no structural or streamlining effect). Vehicles may have body panels with an armor of 1, which is sufficient for protection from weather and minor dings, but does not have much effect vs. weapons. Low tech (TL3-8) vehicles may have an armor of 2-3, just from their massive body panels and supporting framework. Many high-tech civilian cars will have an effective armor of 1, especially if weight is a major consideration. Unless a material is completely supported by a complex internal framework, it must be at least .3cm thick or have a toughness of 1 to be self-supporting, whichever is greater.

Armor Facings

Many vehicles will not have uniform armor. If you have a shape, such as a box, that is easy to determine the area of particular facings, you can calculate this normally for each face. If it is unclear or has too much calculation, assume that the front or rear facings are 10% of the area each, the sides are 15% each and the top and bottom are 25% each.

Vehicles with open top or sides will simply be open to the wind and the only protection is that of any structural elements of the vehicle, which if applicable or needed would be counted like the armor rating of an open frame configuration.

Example: An open-topped vehicle with a total of 10m2 of area and 1cm of armor will be counted as having 75% of the normal armor mass, and hits from the top provide no armor to occupants or vehicle subsystems. If the designer wants to put extra armor on the front, the front is 10% of the total area, or 1m2, and the mass and volume of extra thickness there can be calculated.

Vehicles with Open Frame configuration may not be armored at all (it is by nature an open network of girders and trusses). These vehicles are counted as having the armor of .1cm of the structural material used for the first $1m^3$ of volume, and doubled each time the volume is increased by a factor of 10 (round down). This armor rating only applies to structure hits on the vehicle.

Example: A $100m^3$ open frame vehicle would be counted as having .4cm of armor protecting the "structure" of the vehicle.

Armor Sloping

Armor may be sloped to increase its apparent thickness from normal angles of attack. The mass of the armor is not increased, but the available volume of the vehicle is decreased.

Armor Slope	Effective Thickness	Volume Penalty for One Facing
Moderate	x1.5	-10%
Radical	x2.0	-20%

Example: A vehicle of 10m3 with radically sloped front armor and moderately sloped right and left side armor will have its internal volume reduced by 40%, to 6m3.

The top and bottom of a vehicle may normally not be sloped.

Stealth Structures

If a vehicle is designed to be stealthy, and evade detection by active and passive sensors, this must be designed into the shape and structure of the vehicle, and cannot be retrofitted. In general, a stealthy vehicle is -3DM to be spotted by military sen-

sors of the same or lower TL as the vehicle design, and by civilian sensors of the vehicle's TL+1, but has no effect vs. sensors of higher TL's. Both the structure and armor of a stealthy vehicle are 5 times normal cost, and the configuration must be a Streamlined or Airframe type so that it has no jarring edges or surface gaps that would reflect signals or let internal energy escape. A stealthy vehicle is obviously different in appearance .

Cockpit Armor

In some cases, it is not practical to armor an entire vehicle, but it is desired to protect the crew from harm. Armored seating arrangements will protect the occupant from hazards in

TL	Material	Toughness of 1cm	Density	Mass per m3	price per m3
1	Heavy wood*	1	1	1t	.001MCr
1	Stone*	2	2	2t	.001MCr
3	Soft steel*	4	8	8t	.016MCr
5	Hard steel	6	8	8t	.020MCr
6	Light alloy	3	3	3t	.040MCr
6	Fiber laminate*	2	1	1t	.030MCr
7	Light composite	6	7	7t	.070MCr
8	Composite laminate	7	7	7t	.080MCr
10	Crystaliron	9	10	10t	.090MCr
11	Structurecomp*	3	1	1t	.040MCr
12	Superdense	11	15	15t	.140MCr
14	Bonded sd	14	15	15t	.280MCr
17	Coherent sd	16	15	15t	.350MCr

*These materials are commonly used as civilian structural materials until 1-2TL's after the introduction of the next one. They usually have limitations that render them impractical as heavy armor (flammable, etc.). Flexible spacesuits are considered to be fiber laminate or structurecomp with a -1 to the toughness, and rigid spacesuits are usually structurecomp. Note that stone is not a vehicle material, but is listed solely for figuring out how tough a stone wall of a given thickness is. Like glass or other brittle solids, stone will shatter and lose armor rating based on the strength of the attack.

Armor does not increase linearly with thickness. Rather, check the table below to get the total thickness of the armor, and then use the multiplier on the base toughness, rounding fractions down. The result is the effective armor rating.

Thickness	Multiplier	Thickness	Multiplier
.01cm	x.2	18.1cm	x2.6
.03cm	x.3	20.3cm	x2.7
.06cm	x.4	22.7cm	x2.8
.12cm	x.5	25.2cm	x2.9
.21cm	x.6	27.9cm	x3.0
.34cm	x.7	30.8cm	x3.1
.51cm	x.8	33.9cm	x3.2
.73cm	x.9	37.3cm	x3.3
1.0cm	x1.0	40.8cm	x3.4
1.3cm	x1.1	44.5cm	x3.5
1.7cm	x1.2	48.5cm	x3.6
2.2cm	x1.3	52.7cm	x3.7
2.8cm	x1.4	57.1cm	x3.8
3.4cm	x1.5	61.8cm	x3.9
4.2cm	x1.6	66.8cm	x4.0
5.0cm	x1.7	71.9cm	x4.1
5.9cm	x1.8	77.4cm	x4.2
7.0cm	x1.9	83.1cm	x4.3
8.2cm	x2.0	89.1cm	x4.4
9.5cm	x2.1	95.4cm	x4.5
10.9cm	x2.2	102cm	x4.6
12.5cm	x2.3	109cm	x4.7
14.2cm	x2.4	116cm	x4.8
16.1cm	x2.5	123cm	x4.9
		131cm	x5.0

Example: A TL7 anti-tank rocket has a damage rating of around 18. This is about x1.63 times the base rating of superdense, so about 4.2cm of superdense is enough to stop it. A damage rating of 18 is about x3.0 times the base rating of hard steel, so we can see that 27.9cm of hard steel is needed. A 1cm plank of heavy wood has a rating of 1. A medium pistol with a damage rating of 2 would go through 8.2cm of this material, and a 5 damage rating assault rifle would require 131cm to stop it (it seems like a lot, but it does match real-world data). On the other hand, a tenth of a millimeter of superdense would stop the pistol, and barely more than a millimeter would stop the assault rifle. Just so you know, the sheet of paper you are reading is approximately a tenth of a millimeter thick, and if made of superdense would mass about .1kg. A piece the same size that would stop a TL8 assault rifle (damage rating 4) would be about as thick as six sheets of paper and mass almost half a kilogram.

Note: For conversion to starship USP armor, divide the armor value by 6 to get the equivalent multiplier for armor steel, and then compare the thickness or hard steel corresponding to the multiplier on the appropriate chart in the Starships book.

Example: An 8.2cm thickness of superdense has an armor rating of 22. So, 22/6 = 3.66, which corresponds to the multiplier for between 48.5 to 52.7cm of armor steel. Checking Starships, this is a USP value of 2. The heavy plasma cannon in the weapon list has a damage rating of 81, which would barely be stopped by a USP value of <??>. Now, before you drool over shooting down starships, note that its power requirement is in megawatt-hours per turn of use. That is, to charge the weapon requires the listed amount of power be applied for an hour. To charge it in a lesser amount of time requires proportionately more. It takes 720 times as much power to charge it in a turn, and so to fire the heavy plasma cannon each turn would require a reactor with 720 x 3.6Mw hour per turn = 2592 megawatts of output.

Gearheads Only: The multiplier for armor thickness is (thickness in cm)^.33. So, if you really need to know what the multiplier is for 27 meters of armor, you can calculate that it is x29.

most directions, and have a volume of .1m^2 inside the vehicle. This allows for up to 4cm of armor to protect the person in that seat from any non-area attack from all but one arc (usually the front). This armor is not cumulative with personal armor. Use only the highest of personal or cockpit armor to resist damages from crew or passenger hits.

Note: There is no easy way to "layer" armor in Traveller. The only way to get an accurate value is to figure the total thickness of all armor, and generate an armor rating from that. For instance, a person armored in .5cm of superdense behind a tank armor of 25cm of superdense has got 25.5cm of superdense, not the armor rating of each added together. Using only the highest applicable armor is the easiest way to handle this.

Turrets

A turret is used to mount weapons or optional equipment. A turret will have the same armor on its facings as the appropriate vehicle facing (except for the bottom, of course). This includes any bonus due to sloped armor. The volume of the equipment is multiplied by the Turret Multiple to get the actual internal volume taken. If the equipment is required to only face a given direction, the volume taken by the equipment is counted as though the turret were one TL higher. Fixed elevation or non-traverse mount (60° total movement) are also counted as one TL higher for purposes of internal volume.

Note: Many guns or other long-barreled weapons mounted in a turret only have half their volume inside the turret. The rest protrudes outside the vehicle and is not protected by the vehicle's armor. If the weapon is in a fixed elevation or non-traverse mount, it may be entirely under armor if desired. Vehicles with externally mounted weaponry need only dedicated volume for the crew of these weapons (1m^3 per person), but the volume of the weaponry will add to the storage requirements and dimensions of the vehicle.

TL	Turret Multiple
6-	x4
7	x3
8	x2
9+	x1.5

Example: A gun with 1m3 of normal internal volume is put in a TL8 limited traverse turret. The gun will take up 1.5m3 of internal volume, plus the crew requirements.

Altering Turret Armor

Some vehicles may have turrets armored to a different level than the appropriate vehicle facing. If you wish to do this, you will have to compared the turret volume to total vehicle volume, and adjust armor mass appropriately for each facing to get the level desired.

Example: If your turret is 25% of vehicle volume, then assume it also has 25% of vehicle surface area. If the front armor is 10% of a vehicle's surface area, then the turret front is 10% of 25%, or 2.5% of total vehicle surface area. So, you can now figure out how much extra mass and thickness you can put on the turret front, and adjust the armor rating accordingly. For combat purposes, the GM will have to make a call as to whether a hit is to the turret or the body of the vehicle, usually assisted by the roll to see what internal component was hit (an engine hit is the hull, while a weapon hit is probably the turret).

Hardpoints

A hardpoint is an accessible part of the vehicle structure to which fixed-facing external weapons can be mounted. All vehicles are considered to have hardpoints or their equivalent, but non-military vehicles will have them in inconvenient spots. Weapons mounted on hardpoints still count towards internal vehicle volume, but military hardpoints always use TL9+ turret multiple volume, and retrofitted civilian ones always use TL8 turret multiple volume. There is no crew requirement in that volume, but any crew required to operate the weapon must be located elsewhere in the vehicle. Hardpoints allow a flexibility that an internal turret does not, since weapons can be easily dismounted and changed for different roles. Hardpoints may not be used on any vehicle that must survive atmospheric re-entry or has a top speed of more than 5000 meters per turn or 3000kph.

Example: A TL8 jet with 6 hardpoints and fire control for each weapon type it can carry can have six interchangeable slots for weapons requiring 1 crew, and all can be controlled by one person, such as the pilot or dedicated weapons crewman. The total weapon volume carried cannot cause the jet to exceed its designed volume. Since the mass of these carried weapons will vary, the actual performance of the jet will need to be determined for its likely maximum combat load, and if carrying nothing at all, to give you a performance range if needed.

Armor Modifiers

Aside from requiring life support, a vehicle designed to operate in an insidious or corrosive atmosphere will have double the armor and structure cost (each). Much of this is testing to make sure the vehicle is proof against the environment, while the rest is in the form of special coatings and sealants. These coatings and sealants protect all surface-mounted equipment such as windows, antennae, etc.

Vehicles with a closed body and life support are automatically counted as having pressure support for a 1 atmosphere differential, which permits safe vacuum use, and underwater operation to a depth of 10m. Increased pressure support requires +3 armor rating for 10 atmospheres of pressure, and each time this is multiplied by 10 (100, 1000, etc.).

Example: A research submarine capable of withstanding 100 atmospheres of pressure (1,000m depth) will be required to have an armor rating of at least 7.

Armor cost for extra pressure support is increased by x10. This takes into account expensive pressure seals on any part of the vehicle that could admit the outside environment (hatches, windows, viable sensors, important fuel ports, propulsion links, etc.)

Nuclear Dampers

These become available at TL12, and inhibit certain low-level nuclear reactions, and are most often used to prevent runaway chain reactions, like those in fusion and fission warheads, while allowing the normal operation of power plants. In enclosed volumes, it can inhibit almost all radioactive decay, and is used for the storage of short-lived isotopes. The minimum interference range of a damper field is approximately 1 kilometer, and may be increased linearly with power input and damper field size. Count as a Regional range weapon if used in a vehicle or land installation. Damper fields are fired as a point defense task at incoming targets, with the note that only one target per field is allowed until such time as the target impacts harmlessly, is destroyed or detonates unsuccessfully.

Magnetic Shielding (Optional)

Magnetic shielding is a precursor to the technologies used in bonded and coherent superdense, and may be used in combination with any armor of TL12 or better. Superconducting lattices

Damper	Power per km	Range	Min volume	Mass	Cost
TL12	.0005Mw	5m3	power input x 5m3	1 ton per m3	.13MCr per Mw
TL13	.0003Mw	3m3	power input x 8m3	1 ton per m3	.3MCr per Mw
TL14	.0002Mw	2m3	power input x 10m3	1 ton per m3	.67MCr per Mw
TL15	.0001Mw	1m3	power input x 11m3	1 ton per m3	1.5MCr per Mw

Example: A minimum size installation will have the following stats:

	Power	Range	Volume	Mass	Cost
TL12	1Mw	2,000km	5m3	5t	.130MCr
TL13	.375Mw	1,250km	3m3	3t	.113MCr
TL14	.200Mw	1,000km	2m3	2t	.134MCr
TL15	.091Mw	910km	1m3	1t	.137MCr

Damper boxes have an empty mass of .25 tons per m3 of box, which has an internal capacity of .8m3. They have a power requirement of .001Mw per m3 of damper box, and cost .03MCr per m3 of damper box, with a minimum practical size of 1m3.

are integrated into the armor, capable of holding an extremely intense magnetic field with minimal (but still significant) interference with normal vehicle operation. Once charged, this lattice stays charged due to the superconductors, and acts against any charged particles, ferromagnetic, paramagnetic or diamagnetic material that intersects it. This includes lead, aluminum, iron, steel or crystaliron projectiles, HEAP warheads or plasma cannon. When such an attack hits the vehicle, it first intersects the magnetic field, which deflects and spreads it before it strikes the physical surface of the vehicle. The result is that instead of a hole in vehicle armor, you more often end up with a fan-shaped crater. In the case of plasma cannon, deflection of the beam often generates secondary x-rays, which may necessitate vehicle decontamination at a later date. Deflecting these attacks depletes the superconductor lattice on that vehicle facing, and it must be recharged before it can be of further effect.

In game terms, any TL12+ vehicle may have magnetic shielding as a part of its armor. This doubles the cost of the armor, and requires a power input to charge it of .01Mw/seconds per m2 per point of "armor" provided, squared. That is, an armor of 2 costs four times as much energy as an armor of 1, and an armor of 10 costs a hundred times as much energy to charge. This armor is in addition to the normal rating, so a tank with a front armor of 30 and 10 points of magnetic shielding would be rated as 30(40). Due to stresses in the armor material from the intense magnetic field strength and the need for crew protection from same, the maximum armor bonus is half the regular armor rating on that facing. Fast-discharge batteries are the preferred means of recharging magnetic shields.

Side Effects: The rating of magnetic shielding is reduced by the value of any attack hitting it, unless it is an attack that the shielding is useless against (like lasers), or the penetration of the attack is half or less the shielding value. Vehicle power plants or batteries may be used to recharge a depleted facing, and this takes at least a turn to complete, so multiple attacks in quick succession can be a useful tactic (the first hit depletes the field, the second hits unprotected armor). Unfortunate side effects of this level of magnetic field are interference with vehicle mobility, sensors and concealment. Any form of active magnetic shielding is a +1DM to maneuver the vehicle through or on anything denser than regular atmosphere, a +1DM to fire from the vehicle and +1DM to sensor use. In addition, all attempts to spot the vehicle with sensors are at -1DM due to the local electromagnetic havoc these fields create. Magnetic shielding is illegal on civilian vehicles due to the health hazard. The field extends a few cm from the vehicle, and the interaction of the field with human hemoglobin is sufficient to instantly coagulate any body part touching a shielded vehicle (1D lethal injury) or fry most unshielded electronic devices.

Example: A USP3.0 vehicle ($56m^3$) has a surface area of 70.08m2 in the box configuration. To have a +5 magnetic shield on the entire surface area of thevehicle would double its armor cost, and require 70.08m2 x .01Mw per m2 x 5^2 = 17.52Mw/sec of power to charge it up. This could be a 10Mw power plant for 1.7 seconds, a 1Mw plant for 17.5 seconds or anything that generates the appropriate power total, so long as it is noted that the shielding is not on until at least the turn after it is activated or depleted.

Weapons

Vehicle weaponry will be covered in more detail in the Third Imperium Weapons supplement, but until that time, this book contains a short list of vehicular weaponry. Weapons will have a volume of $.5m^3$ per ton, and require crew space for the listed number of people at 1m3 per crew member. Vehicles with a fire control system for a weapon may have remote or semi-remote turrets, which require one less crew member, allowing things like remotely operated machinegun turrets. Weapons up to .1 ton may be crew-served for a 25% increase in mass to account for tripods, carrying cases, etc., and may be broken down into 1-4 man-portable loads. Weapons listed as "half volume external" may have extended barrels that may be outside the armor protection of the vehicle. This halves the volume that takes any turret multiple, but leaves the weapon partially vulnerable to area effect attacks. In this case, assume the weapon itself has an armor rating of half its TL (round down) or twice its mass in tons (round up), whichever is greater.

Conventional weapon reloads are generally a small fraction of weapon cost, depending on quantity of shots and sophistication of the ammunition. Single shot reloads are about 1%, magazines of up to 200 shots are about 5%, up to 1000 shots are 10% and over 1000 shots are 15% of weapon cost. Double the cost if projectile uses advanced materials, rocket propellant, or explosives, and by a factor of twice the TL if it includes guidance electronics. So, a TL8 guided missile with a HEAT warhead would cost 1% x 2 x 2 x (TL8 x 2) = 64% of the cost of the launcher.

Missiles are "generic" at this point, but should be specified as to type when bought, usually one of the following categories: unguided, unguided indirect fire, guided anti-land vehicle, guided anti-air vehicle, or guided anti-ship. Guided missiles will only be effective vs. their designated type of targets. Unguided missiles can be fired at any target, but only get the fire control DM of the firing vehicle. Guided missile reloads are half the cost of the weapon, while unguided missiles are a tenth the cost of the weapon.

Weapons with a power requirement use the listed amount of battery power in megawatt-hours per turn of active use, and have one turn's worth of energy stored in the weapon on "standby." To get the power plant requirement for use each turn (instead of batteries), multiply by 720. For instance, the VRF point defense laser requires .0004 x 720 = .288Mw of power

VEHICLE WEAPONS TABLE

Weapon	Dam. Rating	Range	Shots	Mass	Reload	Cost	Crew	Note
Autocannon, Light-8 (200kJ, 30mm)	9	Long	100	.200t	.120t	.013MC	1	Half volume external
Autocannon, RF lt.-8 (200kJ, 30mm)	9	Long	1000	1.50t	1.20t	.021MC	1	
Autocannon, Light-11 (500kJ, 30mm)	11	V.long	100	.300t	.185t	.032MC	1	Half volume external
Autocannon, RF lt.-11 (500kJ, 30mm)	11	V.long	1000	2.20t	1.85t	.047MC	1	
Bomb, Unguided-5	55 expl.	Contac	1	.250t	.250t	.001MC	1	
Bomb, Unguided-8	58 expl.	Contac	1	.250t	.250t	.001MC	1	
Cannon, Heavy-3 (HE)	14 (15 expl.)	Short	1	.654t	.036t	.018MC	3	
Cannon, Heavy-5 (HE)	17 (16 expl.)	V.long	1	1.34t	.040t	.050MC	3	Half volume external
Cannon, Heavy-8 (HE)	19 (17 expl.)	V.long	1	1.20t	.040t	.118MC	2	Half volume external
(HEAT)	23 (15 expl.)	Long		.030t				
Cannon, Heavy-11(HE)	21 (18 expl.)	V.long	1	1.15t	.045t	.110MC	1	Half volume external
(HEAT)	24 (15 expl.)	Long			.035t			
Cannon, Light-3 (500kJ,110mm)	8	V.shrt	1	.120t	.008t	.004MC	2	
Cannon, Light-5 (200kJ, 30mm)	9	Long	1	.080t	.001t	.005MC	2	Half volume external
Laser, RF-11	8	Long	-	.053t	-	.017MC	1	.018Mw/hr/turn
Laser, RF-13	9	Long	-	.043t	-	.028MC	1	.026Mw/hr/turn
Laser, RF Point Defense-12	3	Short	-	.003t	-	.002MC	1	.0002Mw/hr/turn
Laser, VRF Point Defense-14	4	Medium	-	.004t	-	.006MC	1	.0004Mw/hr/turn
Machinegun, Medium-5 (2kJ,7mm)	4	Long	200	.009t	.003t	.0005M	1	
Machinegun, Medium-8 (4kJ,7mm)	5	Long	200	.011t	.004t	.001MC	1	
Machinegun, RF Gauss-11	9	Long	3000	.037t	.013t	.015MC	1	.008Mw/hr/turn
Machinegun, RF Gauss-13	11	V.long	3000	.033t	.013t	.035MC	1	.010Mw/hr/turn
MG, VRF Medium-11 (13kJ,10/3mm)	7	V.long	2000	.100t	.075t	.005MC	1	Half volume external
Missile, Heavy-5	25 (16 expl.)	Long	1	.040t	.015t	.003MC	2	Unguided
Missile, Heavy-8	34 (22 expl.)	Long	1	.093t	.055t	.004MC	1	Dexterity 4, +2DM
Missile, Heavy-11	41 (27 expl.)	V.long	1	.160t	.116t	.011MC	1	Dexterity 5, +4DM
Missile, Light-5	18 (11 expl.)	Short	1	.014t	.004t	.001MC	1	Unguided
Missile, Light-8	22 (14 expl.)	Medium	1	.019t	.008t	.001MC	1	Unguided
Missile, Light-11	26 (16 expl.)	Long	1	.025t	.013t	.002MC	1	Dexterity 5, +2DM
Plasma Cannon, Hvy. Veh.-11	61 (15 expl.)	E.long	-	6.14t	-	4.88MC	1	Half vol. ext.,1.1Mw/hr/shot
Plasma Cannon, Hvy. Veh.-13	81 (20 expl.)	Subreg	-	11.4t	-	16.2MC	1	Half vol. ext.,3.6Mw/hr/shot
Plasma Cannon, Lt. Veh.-11	44 (11 expl.)	E.long	-	.540t	-	.995MC	1	Half vol. ext.,.06Mw/hr/shot
Plasma Cannon, Lt. Veh.-13	48 (12 expl.)	Subreg	-	.355t	-	1.47MC	1	Half vol. ext.,.04Mw/hr/shot

plant output to be used on a continuous basis, but can be charged up over a longer period of time by a smaller power plant.

Fire Control

Normally, each weapon will have a crew requirement, and a volume of 1m3 must be dedicated to a crew station for that weapon per crew needed. Mass for this station is subsumed in the structure mass of the vehicle, but equipment like sensors will be an additional mass and volume which may be required in the turret as well. For turreted weapons, this crew space is in the turret, and is in addition to the multiplied amount for the weapon itself (multiply weapon volume, but not crew volume). So, a vehicle with two weapons requiring 3 crew each will have 6m^3 of crew stations. Vehicles with a fire control system (TL6+) for a weapon can reduce the effective crew requirements for a weapon by 1 crewman. Weapons normally requiring 1 crew may be set on "automatic" as appropriate for the TL of the vehicle, or 1 crew station can control any number of "zero crew" weapons. This is normally how a remote machinegun turret or point defense weapon would be operated.

Fire Control Systems

These are described in full later, but they give a positive DM of TL/2 (round down) to certain fire from a particular weapon, and cost DM x 10KCr. Their mass and volume is subsumed in the weapon, and is an added cost per weapon type on the vehicle.

Power Plant

All vehicles will have some form of power plant. The Power Plant Tables cover most historical and hypothetical power plants. The efficiency of the power plants does not include losses from turning the raw output into useful form, such as mechanical transmission losses. This is covered by the locomotion part of design.

Fuel

Different power plants use different types of fuel. The volume of fuel will vary with type. The Fuel Cost Table refers to the cost for the final volume.

FUEL COST TABLE

TL	Fuel type	Volume x	Cost per m3
1+	Wood	x2.0	50Cr
2+	Coal	x.5	100Cr
3+	Liquid hcarb	x1.0	250Cr
5+	H.grade hydrc	x1.0	500Cr
6+	Liquid hydrog	x14	1000Cr
6+	Fission fuel	x.05	.7MCr
7+	Deuterium	x1.0	.15MCr
7+	Enrich. water	x1.0	7000Cr

Example: A 1m3 TL4 steam engine consumes .3m3 fuel per 100 hours. If that fuel is coal, this is multiplied by .5 to get .15m3 per 100 hours. If coal was unavailable and wood was used, it would be multiplied by 2 to get .60m3 per 100 hours. The coal would cost 15Cr, and the wood would cost 30Cr. On the other hand, a 100m3 TL8 fission reactor consumes 100m3 x .001m3 = .1m3 of fuel per 100 hours, or about 8.0m3 per year (8000 hours). Fission fuel has a volume multiple of .05, so the actual fuel consumption is 8.0 x .05 = .40m3 of fuel per year, at a cost of around .28MCr (767Cr per day). Of course, for this price you are getting 100 megawatts of power. . .

Fuel mass is a base of 1 ton per m3, but the mass is conserved as the volume is reduced. Our steam engine had .3m3 of fuel, for a mass of .3 tons. In the form of coal, those .3 tons took up .15m3, and the wood took up .6m3. The fuel for the fission reactor was 8.0m3, for a mass of 8 tons, but its density meant those 8 tons only took up .4m3.

POWER PLANTS TABLES

TL	Description	Pow/ m3	Mass/ m3	Min m3 & Output m3	Cost/ per m3	Area	100hr Fuel/m3	Fuel	Maint
TL1	Rowers	.005Mw	1.0t	.100/.005Mw	-	1.0m2	.10m3	food	-
TL1	Sail	.15Mw	1.0t	.015/.002Mw	.001MCr	20.0m2	-	wind	600hr
TL3	Early Steam	.10Mw	2.0t	.250/.025Mw	.002MCr	.90m2	1.00m3	wood	600hr
TL4	Steam	.20Mw	2.0t	.150/.030Mw	.002MCr	.70m2	1.50m3	coal	3000hr
TL4	Int. Combust.	.30Mw	1.0t	.015/.045Mw	.004MCr	2.0m2	3.00m3	hcarb	600hr
TL5	Turbine, Steam	.35Mw	2.0t	.200/.070Mw	.008MCr	.60m2	2.50m3	hcarb	3000hr
TL5	Imp. Int Comb.	.40Mw	1.0t	.003/.001Mw	.008MCr	1.0m2	5.00m3	imhyd	3000hr
TL7	Turbine, Gas	.50Mw	.50t	.500/.250Mw	.020MCr	.40m2	7.50m3	imhyd	3000hr
TL8	Turbine, MHD	.60Mw	.50t	.500/.300Mw	.060MCr	.50m2	6.00m3	imhyd	3000hr

All of the above power plants require external oxygen sources, and cannot operate in vacuum or atmospheres lacking oxygen unless on-board stores are available. If on-board liquid oxygen is used (TL6+), use double the listed fuel consumption as being required for the oxygen (total of triple normal fuel volume). This does mean you can use internal combustion engines underwater if the vehicle is properly designed, and such specialized power plants are double normal cost.

TL7	Fuel cell	.40Mw	1.0t	.003/.001Mw	.020MCr	-	24.2m3	lhyd	9000hr
TL12	Fuel cell	.75Mw	1.0t	.003/.002Mw	.020MCr	-	18.7m3	lhyd	9000hr
TL14	Fuel cell	1.5Mw	1.0t	.002/.003Mw	.020MCr	-	3.00m3	lhyd	9000hr

All fuel cells produce liquid water as a byproduct in quantities equal to total fuel used.

TL6	Photoelectric	.001Mw	2.0t	-	.005MCr	12.0m2	-	-	-
TL7	Photoelectric	.0015M	2.0t	-	.006MCr	12.0m2	-	-	-
TL8	Photoelectric	.002Mw	2.0t	-	.006MCr	12.0m2	-	-	-
TL9	Photoelectric	.0025M	2.0t	-	.006MCr	12.0m2	-	-	-
TL10	Photoelectric	.003Mw	2.0t	-	.006MCr	12.0m2	-	-	-
TL11+	Photoelectric	.004Mw	2.0t	-	.007MCr	12.0m2	-	-	-

In the case of solar panels, the area figure represents the panels themselves, which must be oriented to face the sun, and thus are limited to a maximum power output equal to the area of the largest face of the vehicle that can be facing the sun.

TL6	Fission	.30Mw	6.0t	40.0/12.0Mw	.200MCr	2.0m2	.001m3	radioa	9000hr
TL7	Fission	.60Mw	6.0t	20.0/12.0Mw	.150MCr	1.5m2	.001m3	radioa	9000hr
TL8	Fission	1.0Mw	6.0t	10.0/10.0Mw	.100MCr	1.0m2	.001m3	radioa	9000hr
TL9	Fusion	2.0Mw	4.0t	1250/2500Mw	.200MCr	2.0m2	.003m3	deuter	9000hr
TL10	Fusion	2.0Mw	4.0t	500/1000Mw	.200MCr	2.0m2	.003m3	deuter	9000hr
TL10	Fusion+	3.0Mw	2.0t	.020/.060Mw	.010MCr	3.0m2	.150m3	water	600hr
TL11	Fusion	2.0Mw	4.0t	250/500Mw	.200MCr	2.0m2	.003m3	deuter	9000hr
TL11	Fusion+	3.8Mw	2.0t	.015/.057Mw	.010MCr	3.8m2	.150m3	water	1200hr
TL12	Fusion	2.0Mw	4.0t	12.5/25.0Mw	.200MCr	2.0m2	.003m3	deuter	9000hr
TL12	Fusion+	4.8Mw	2.0t	.010/.050Mw	.010MCr	4.8m2	.150m3	water	1800hr
TL13	Fusion	3.0Mw	3.0t	1.70/5.0Mw	.200MCr	3.0m2	.003m3	deuter	9000hr
TL13	Fusion+	6.0Mw	1.5t	.007/.042Mw	.010MCr	6.0m2	.150m3	water	2400hr
TL14	Fusion	3.0Mw	3.0t	1.70/5.0Mw	.200MCr	3.0m2	.003m3	deuter	9000hr
TL14	Fusion+	7.7Mw	1.5t	.006/.046Mw	.010MCr	7.7m2	.150m3	water	3000hr
TL15	Fusion	6.3Mw	2.0t	.800/5.0Mw	.200MCr	6.3m2	.003m3	deuter	9000hr
TL15	Fusion+	9.8Mw	1.0t	.004/.039Mw	.010MCr	9.8m2	.150m3	water	3000hr

TL: The TL the power plant is introduced at. It can be used at higher TL's, and is generally more reliable since it has the bugs worked out, but not more efficient.
Description: The simple description of the power plant type.
Power per m3: The power output in megawatts per m3 of power plant.
Mass per m3: The mass in metric tons of 1m3 of power plant.
Minimum Disp/Output: The minimum size (in m3) the power plant can be constructed at, and the output it has at that size. A dash means that the power plant can be made extremely small and has no practical minimum size.
Cost per m3: The cost in MCr of 1m3 of power plant
Area: The external vehicle surface required for cooling radiators for 1m3 of power plant. For stationary installations, this is irrelevant if there is sufficient space for the radiators. If there is a nearby source of pumpable fluids, radiator area is quartered. Note that this will usually apply to water vehicles. For use in vacuum, the cooling area is multiplied by 2, since heat transfer by radiation is less efficient than by conduction. This means that a power plant with atmospheric radiators can only be used at 50% output in vacuum conditions, if it can be used at all.
Fuel/m3: The amount of fuel consumed per 100 hours (4 days) of full power output, per 1m3 of power plant. The actual volume of fuel will depend on its type, and this figure usually applies to fuels of approximately the same density of water, such as liquid hydrocarbons.

Maintenance

The time between scheduled maintenance for the power plant. A dash means the power plant is essentially maintenance free (check it out once every 10 years or so). Neglecting maintenance will lead to power plant failure on a 2D roll of 2–, which will result in a 10% drop in power output and a cumulative +1DM on future maintenance rolls. Maintenance takes 10 hours per displacement ton of power plant, and costs 5% of power plant cost. Repairing a power plant failure costs 2D times 5% of power plant cost.

Maint Time	Equivalent
300 hr	≈2 weeks
600 hr	1 month
3000 hr	4 months
9000 hr	1 year

Maintenance takes the mininum of 1 hour.
Note: Be sure to service your vehicle every 10 years or so.

Airless Operation

Some forms of power plant, usually internal combustion engines, can be operated in airless environments, like underwater or in the vacuum of space. This usually requires triple the fuel consumption to include an oxidizer like liquid oxygen, and double the power plant cost to include exhaust recirculators and scrubbers. This is usually only possible at TL5+, and is used in specialized cases from TL5-8 until fusion power plants become available.

Power Plant Descriptions

Fission: Fission reactors use the heat generated by radioactive decay to produce either electrical or mechanical power, often through heating water and powering a steam turbine. Due to their shielding requirements and heavy elements used, they are not mass efficient, but they are extremely fuel efficient. They are superseded entirely by fusion power at TL9+ except in the few TL9-12 applications where the smaller fission reactor is the only viable power source.

Fuel Cells: Fuel cells use a catalytic process to extract electrical power from the energy released during a chemical reaction, the most common of which uses oxygen and hydrogen, and has water as a byproduct.

Fusion: This is traditional "hot" fusion, a million-degree ball of fusing plasma that is contained by powerful magnetic fields. The heat from the plasma and heat generated by passage of subatomic particles through the reactor wall is used to either power some form of steam turbine, an MHD plant or both. Fusion plants normally require a fractional second startup pulse from storage banks equal to their output, and such a storage bank is included in the mass of any fusion plant.

Fusion+: Fusion+ is a variant of "cold fusion", using a solid-state matrix to fuse deuterium-enriched water and use the resultant heat flow to directly generate electricity with no moving parts. It actually runs at substantial temperatures (a few hundred degrees C), but is capable of producing substantial power within a minute of activation, and when not in use, its insulation retains heat for days, allowing near-instant startups.

Fusion+ is, in a nutshell, the technology that makes the Imperium possible. By Imperial year 0, any world with a civilization has learned how to be self-sufficient. The ones who couldn't, died. With the various cultures at approximately the same level of technology, and not having a need for other people's products, the incentive for interstellar trade is not that great.

Fusion+ changes all that. It is a size breakthrough in fusion power plants that opens up a whole new realm of technological possibilities. And Sylea is the only planet that has it. If you want it, you buy it from Sylea. And, if you're a Sylean trader looking to sell this hot commodity, the only place to get it is through Cleon Industries.

Internal Combustion: This is a broad class of engine, covering regular petrol engines, diesel engines, rotary engines and the like. Fuel injected into a confined space is ignited and the resulting mini-explosion is converted to mechanical energy by a moving piston.

Internal Combustion, Improved: A more advanced version of the internal combustion engine, which may include concepts like fuel injection, electronic ignition, multiple fuel valves and electronic sensors, depending on actual TL.

Photoelectric: Photoelectric cells convert light directly into electricity. They are not very efficient, but are maintenance-free, and require no mass for carried fuel, making them important for any long-duration application. The figures for solar panels assume they are integral to the surface of the vehicle, which provides the structural support and backing needed. If the panels are individually deployed like wings, the surface area may exceed the normal area of the vehicle body, but the panels will mass ten times as much per m^3, times the acceleration of the vehicle (minimum of 1). If these panels are retractable and can be stowed inside the vehicle, they mass twice as much per m^3.

Rowers: Any form of power provided by the muscles of living beings, such as rowers, draft animals, etc. Unlike other power plants, rowers can run without fuel (food) for a while, losing cumulative 10% of output per day until they collapse. Rowers can also double output for up to an hour, at the cost of half output for the next three.

Sail: Power provided by the wind, either against a stationary sail like a sail ship, or a rotary sail like a windmill. At TL3-, sails can only be used to go in the direction the wind is blowing to, plus or minus a bit. At TL4+, sail ships can sail against the wind at up to a quarter the wind velocity. The normal maximum speed of any sail vessel is 15% of the wind speed times the TL of the sails and hull for water vehicles, and 25% of the wind speed times the TL of sails and chassis for land vehicles (assuming otherwise optimum conditions). Wind speeds of more than the TL x 3 in meters per second require a maintenance check per hour to avoid damage or failure. Note that the area of sails is external to the vehicle itself. In combat, the actual sail area is ignored and most hits are assumed to pass through with little effect. Hits that actually are rolled against the power plant are assumed to be against an armor of 1, and are hits to vital rigging components that will quickly affect performance.

Sail power may only be used in certain applications, which common sense will indicate. (No sail-powered contragrav vehicles, for instance.)

(Early) Steam: Steam engines are external combustion power plants, where an outside heat source heats a boiler of water, and the steam pressure generated is turned into mechanical energy. At TL3 they are not particularly efficient, but are the best that is available. They almost always run off of solid fuels like wood or coal.

Steam: A more advanced version of the steam engine, which may be designed to run off a particular class of fuel (solid or liquid). Steam engines at TL4+ can, with some modification, use just about any combustible material as fuel.

Turbine, Gas: Similar in concept to a steam turbine, except that the expanding hot gas from burning fuel is used to power the turbine. Gas turbines can be adjusted to run off almost any type of gaseous or liquid combustible material.

Turbine, MHD: Magnetohydrodynamic power is running the hot combustion gases through a series of magnetic fields to directly extract electrical power. The hot exhaust is somewhat cooled by the extraction of energy, and the remainder is run through a conventional turbine to generate mechanical energy which often powers a regular generator. It requires advanced materials to withstand the high operating temperatures used. MHD turbines can be adjusted to run off of almost any type of gaseous or liquid combustible material.

Turbine, Steam: Instead of using reciprocating pistons, a steam turbine takes the expanding steam and runs it through a series of turbine blades, converting the steam pressure directly into rotary motion. This will be run through a gearbox to get whatever final power or revolutions per minute is desired.

What's the Difference? (Fusion+ vs. Fusion)

Compared to "hot fusion", Fusion+ is more efficient in terms of cost and mass/power ratios. However, it has drawbacks that make it less practical for starship use. First, it is not very fuel efficient, consuming several times the fuel a regular fusion plant would. A great deal of this is required for cooling purposes, and is boiled off

STORAGE BANKS TABLE

TL	Description	Pow/ m3	Mass/ m3	Min m3 &output	Cost/ m3	Area per m3	100hr Fuel/m3	Fuel	Maint
TL4	Storage bank	.04Mw/hr	2.0t	-	.001MCr	-	-	-	500hr
TL5	Storage bank	.06Mw/hr	2.0t	-	.001MCr	-	-	-	1000hr
TL6	Storage bank	.08Mw/hr	2.0t	-	.001MCr	-	-	-	2000hr
TL7	Storage bank	.10Mw/hr	2.0t	-	.001MCr	-	-	-	3000hr
TL8	Storage bank	.20Mw/hr	2.0t	-	.001MCr	-	-	-	6000hr
TL9	Storage bank	.40Mw/hr	2.0t	-	.002MCr	-	-	-	9000hr
TL10	Storage bank	.80Mw/hr	2.0t	-	.003MCr	-	-	-	18khr
TL11	Storage bank	1.0Mw/hr	2.0t	-	.004MCr	-	-	-	27khr
TL12	Storage bank	1.5Mw/hr	2.0t	-	.005MCr	-	-	-	36khr
TL13	Storage bank	2.0Mw/hr	2.5t	-	.008MCr	-	-	-	-
TL14	Storage bank	2.5Mw/hr	2.5t	-	.010MCr	-	-	-	-
TL15	Storage bank	3.0Mw/hr	2.5t	-	.015MCr	-	-	-	-

TL	Discharge time	Cost multiple
4+	.1 hour	x1
5+	30 seconds	x2
6+	3 seconds	x4
7+	3 seconds	x9
8+	.03 seconds	x16
9+	.003 seconds	x25

Example: A vehicle at TL10 has 1 metric ton of storage banks (chemical batteries). These contain .80 megawatt hours of energy per metric ton. These are used to power an energy weapon, and are bought with the minimum possible discharge time, for a cost multiple of x25. The total cost of the storage banks is therefore .003MCr per metric ton x 1 ton x 25 for discharge multiple = .075MCr.

Remember that there is a difference between powering an energy weapon and charging one. All energy weapons listed on the Vehicle Weapons Table have the capacity to fire once from their on-board storage banks, which must be recharged for the next shot, or the weapon can be fired from fast-discharge batteries. But, if cost or TL is an issue, you can use TL5 battery technology to charge a TL15 energy weapon. It just means that you will have to spend 30 seconds between shots.

as a small steam plume. The break point in mass is around 6 months of operation, while the break point in volume is less than 3 months. Short-duration ships like fighters may find it more practical, but long-haul ships will end up paying more in the long run. Last, Fusion+ requires regular maintenance and replacement of the solid-state cores, which become polluted and degraded by constant bombardment of fusion byproducts. At the first maintenance interval a Fusion+ unit needs to roll 2– on 2D to fail. If it happens, output is reduced by 10% and the failure roll gets a cumulative +1DM. Apply another +1DM if questionable fuel was used at any time during that interval. Failure usually takes the form of rapidly varying power output, and excessive operating temperature, which if left unchecked will damage the core and cause an automatic shutdown. The final stages of this failure usually take several minutes to cascade to their ultimate outcome.

Fusion+ units were originally manufactured starting in year -28 at TL11 levels of output. Until year 3, the only place a unit could be serviced was on Sylea (5% of power plant cost). On other worlds, maintenance was handled by core replacement (10% power plant cost). The reason for this is that all units were "factory sealed" encapsulated units, with a great deal of effort put into preventing reverse-engineering of the units, usually involving non-explosive self-destruction of the unit and the critically important monitoring and feedback hardware. Eventually, of course, someone managed to reverse-engineer and duplicate the technology either at TL10 or TL11 levels of efficiency, at which point Cleon Industries released the TL12 version to keep its competitive lead. Of course, there will be incremental increases in capability and features, but for the most point, the early Third Imperium will be using TL10-12 Fusion+ units.

Cleon is willing to take some financial risks to expand the Imperium, sacrificing short-term profit for long-term gain. To this end, several "standard" Fusion+ models are available, in the following power output:

Cleon Industries Standard (TL12)

Output	Mass	Volume	Cost	Area	Fuel/Maint.
.05Mw	21kg	.01m3	75Cr	.05m2	.0015m3/1.5kg 1800 hours
.20Mw	83kg	.04m3	300Cr	.20m2	.0060m3/6kg 1800 hours
1.0Mw	.42t	.21m3	1.5KCr	1.0m2	.031m3/31kg 1800 hours
2.0Mw	.83t	.42m3	3.0KCr	2.0m2	.063m3/63kg 1800 hours
5.0Mw	2.1t	1.05m3	7.5KCr	5.0m2	.157m3/157kg 1800 hours

You'll note that the retail price of these units is 25% less than the standard price, and pretty much undercuts what any less-advanced culture can produce, decreasing competition for the product, even taking into account interstellar transport costs. Wholesalers can get the standard discount on these prices, and can choose to make as much profit on them as the market will bear. Sylean vehicle manufacturers take advantage of these units wherever possible, as the standardization of parts makes acquisition and maintenance a simple proposition.

For general trade purposes, Fusion+ units can be considered high-tech goods, and early in the history of the Third Imperium, they can be considered unique as well.

Storage Banks

The difference between a power plant and a storage bank is that the storage bank holds a fixed quantity of energy, while power plants have a constant output. For instance, a storage bank that holds 1 megawatt-hour can supply 1 megawatt for 1 hour, .1 megawatts for 10 hours or 10 megawatts for .1 hours, multiplying the output by the time in each case to get a power x time of 1. Storage banks can be recharged from a power plant at the same rate as they are discharged. Normally, a storage bank can be completely discharged in 1 hour, and the increased cost will represent technologies that can discharge faster, such as capacitors or homopolar generators. Only the absolute shortest time on the chart can be used for the high-speed pulses needed for energy weapons.

Power Plant Options

Afterburners: Many power plant types can be temporarily boosted to unsafe levels of performance. This could be through adding extra fuel or oxidizer, running at dangerously high temperatures, etc. If a power plant is deemed capable of this behavior, it can double power output for x5 fuel consumption, and must immediately undergo a maintenance check for engine failure when this is attempted. If the power plant does not fail, there are no ill effects in terms of performance or future DM's, but if it fails, it does so catastrophically. This rule can be used multiple times at your own peril to simulate rocket engines. For instance, a 1 ton "TL7 gas turbine" with 6 levels of "afterburner" would have x64 output (32Mw!) and x15,625 fuel consumption (3.9m^3 per minute!). If attached to a 15-ton TL7 high-performance aircraft, it would end up with an acceleration of 1.5G. A 120 second fuel load would carry the vehicle a distance of 108 kilometers, at the end of which it would have a speed of Mach 6, more than a TL7 aircraft could actually handle. However, it would make a nifty rocket plane if you allowed it to reach these speeds once it left the lower atmosphere.

Multiple Power Plants: A vehicle may have multiple power plants driving the propulsion system. This may be because of the safety of redundancy, the inability to make a single power plant large enough for the vehicle, or the cost savings of using a standard power plant produced by someone else. Multiple power plants will be x1.2 propulsion cost per power plant. The only exception to this is rowers, where the "power plant" is usually many living beings. For example, a twin-engine jet will have x1.2 the propulsion system cost for the power output of both engines.

Give Me POWER!

Once fusion is available, even without Fusion+, the things you can do are absolutely amazing. Even using thruster plates and regular fusion (i.e. regular starship design rules), it is trivial to make a TL12 5 displacement ton (70m3) vehicle with a mass of less than 140 tons and a thrust of 1000 tons capable of managing the Terra-Luna trip in 80 minutes on a cup of deuterium (75Cr). The relatively cheap and portable nature of energy in the TL12+ world will make many conventional vehicle strategies obsolete. Why have a bulky, complex mechanical transmission and power train when you can simply feed power from a fusion plant into a contragrav unit, and avoid moving parts, wear and any pesky terrain in your way at the same time?

GM's should be aware of the implications of these two technologies. Grav vehicles are an order of magnitude cheaper than in previous incarnations of Traveller, and have considerably better performance. After all, technology is several thousand years ahead of where we are now. Even without inexpensive contragrav, the power provided by Fusion+ would allow similar performance by ducted fan vehicles running on super-efficient electric motors, and it turns out the most expensive components of most vehicles are not the engines, but the sensors, weapons and electronics. Making things move is easy, keeping them alive in combat is hard.

If you want to restrict cheap and easy grav transport while still keeping the Traveller feel, you can do one of two things. First, you can multiply contragrav prices by a factor of 10. This will drastically increase the cost of the vehicles. Second, you can state that the active technology of your choice scrambles the complex nuclear interactions required in the generation of contragrav. The more robust thruster plates work on a different quantum level and are therefore unaffected. So, for instance, you could say that a mil-spec communicator bought as a gravitic "jammer" would adversely affect any contragrav use in its range, applying penalty DM's to maneuvering and affecting performance. If this were the case, no one would want to use contragrav for military purposes, and have to use the more expensive and power-hungry thruster plates.

Propulsion

This is the broad category that covers how the power plant makes the vehicle move. The design system here will not go into as much detail as Fire, Fusion & Steel, but it will enable you to make a vehicle a lot faster than before. The base velocity of vehicle in meters per turn is (megawatts of power/mass in metric tons), x 3000, and this only applies in cases where there is a drag on the vehicle, such as wind resistance, surface friction, or water turbulence. Contragrav vehicles multiply their top speed by half their acceleration, with a minimum multiple of x1. High performance or regular aircraft bought with a "high-altitude" propulsion system option can double their speed in the thin upper layers of an atmosphere.

Performance

The base acceleration of a non-contragrav vehicle in G's is the square root of (megawatts of power/mass in metric tons), rounding to nearest .1. Contragrav vehicles simply divide tons of thrust by tons of mass to get acceleration in G's (round to nearest .1). The propulsive machinery also includes volume for the controls (including power plant controls), and special surfaces for that means of propulsion (a rudder for water vehicles, for instance). The mass of all propulsion systems is 1.0 metric tons per m3 of volume, with the exception of high-performance aircraft, which are .5 metric tons per m3 of volume.

Example: A vehicle with a 1Mw power plant and a mass of 50 metric tons will have a base velocity of (1/50) x 3000 = 60 meters per combat turn and an acceleration of (1/50).5 = .1G.

To convert to real world units, divide meters per turn by 1.66 to get kilometers per hour. For instance, the vehicle in the above example has a base speed of 60/1.66 = 36kph. Conversely, if you have the performance of a vehicle in kph, multiply by 1.66 to get meters per turn, or by .111 to get outdoor squares per turn.

Range

The range of a vehicle in kilometers is its top speed in meters per turn, times its hours of fuel capacity, times .6.

Example: A vehicle with a top speed of 60 meters per turn and an endurance of 10 hours has a maximum range of 60 x 10 x .6 = 360 kilometers.

Range assumes ideal conditions. Anything that reduces the top speed of a vehicle will usually reduce the range as well. If extremely poor road conditions reduced top speed by 50%, the range would be reduced by an equal amount.

Mass Multiples

Non-contragrav vehicles heavier than 10 metric tons will get a multiplier on their final top speed and acceleration:

10-20 metric tons	x1.2
20-40 metric tons	x1.5
40-80 metric tons	x1.9
80-160 metric tons	x2.4

This takes into account the increased momentum and volume to area ratio of large vehicles, making them less susceptible to drag and other effects. These multiples are required to get realistic performance figures for vehicles of more than 10 metric tons because of this and the complex real-world vagaries of mass, power/mass ratios and other tidbits.

PROPULSION SYSTEMS TABLE

TL	Description	Cost per m3	Volume/Mw	Speed	Area per Mw
4-	Aircraft	.380MCr	4.6m3	x.80	-
5	Aircraft	.340MCr	3.6m3	x1.0	-
5	H.perf aircr.	1.35MCr	4.3m3	x1.2	-
6	Aircraft	.310MCr	2.8m3	x1.1	-
6	H.perf aircr.	1.25MCr	3.4m3	x1.4	-
7	Aircraft	.280MCr	2.1m3	x1.2	-
7	H.perf aircr.	1.10MCr	2.5m3	x1.6	-
8	Aircraft	.250MCr	1.5m3	x1.3	-
8	H.perf aircr.	1.00MCr	1.8m3	x1.9	-
9	Aircraft	.230MCr	1.1m3	x1.5	-
9	H.perf aircr.	.900MCr	1.3m3	x2.2	-
10+	Aircraft	.200MCr	0.8m3	x1.6	-
10+	H.perf aircr.	.800MCr	1.0m3	x2.6	-
9+	Contragrav*	-	-	-	-
5-	Helicopter	.250MCr	1.1m3	x.60	-
6	Helicopter	.220MCr	0.9m3	x.70	-
7	Helicopter	.180MCr	0.7m3	x.90	-
8	Helicopter	.150MCr	0.5m3	x1.1	-
9+	Helicopter	.120MCr	0.4m3	x1.2	-
5-	Hoverskirt	.020MCr	4.1m3	x.20	25m2
6	Hoverskirt	.017MCr	3.2m3	x.30	20m2
7	Hoverskirt	.013MCr	2.5m3	x.40	15m2
8+	Hoverskirt	.010MCr	2.0m3	x.50	10m2
8-	Legs	.080MCr	7.7m3	x.10	22m2
9	Legs	.060MCr	4.2m3	x.20	18m2
10+	Legs	.045MCr	2.8m3	x.30	15m2
4+	Lighter-than-air†				
4-	Prop.(water)	.085MCr	.7m3	x.08	2.1m2
5	Prop.(water)	.070MCr	.6m3	x.10	1.7m2
5	H.perf water	.210MCr	1.0m3	x.15	3.5m2
6	Prop.(water)	.055MCr	.4m3	x.12	1.4m2
6	H.perf water	.165MCr	.6m3	x.20	2.9m2
7	Prop.(water)	.045MCr	.3m3	x.15	1.2m2
7	H.perf water	.135MCr	.5m3	x.25	2.4m2
8	Prop.(water)	.035MCr	.2m3	x.20	1.0m2
8	H.perf water	.105MCr	.3m3	x.30	2.0m2
9+	Prop.(water)	.025MCr	.1m3	x.25	.8m2
9+	H.perf water	.075MCr	.2m3	x.35	1.6m2
4-	Tracks	.165MCr	4.9m3	x.30	17m2
5	Tracks	.140MCr	3.6m3	x.40	14m2
6	Tracks	.115MCr	2.8m3	x.45	12m2
7	Tracks	.095MCr	2.1m3	x.50	10m2
8+	Tracks	.080MCr	1.5m3	x.55	9m2
4-	Wheels	.050MCr	2.8m3	x.40	12m2
5	Wheels	.045MCr	2.2m3	x.45	10m2
6	Wheels	.035MCr	1.8m3	x.50	8m2
7	Wheels	.030MCr	1.4m3	x.60	6m2
8+	Wheels	.025MCr	1.0m3	x.70	5m2

† See text.

* Contravgrav is a direct energy-thrust conversion with no intermediate steps. See Contragrav section.

* Flying vehicles that rely on aerodynamic forces for lift will need to be able to reach a speed of (mass in metric tons/total wing area) x 400 in meters per turn in order to become airborne. This will be the minimum flying speed of the vehicle. This would be doubled in thin atmosphere environments.

High Efficiency Contragrav Plates

TL	Thrust per m3	Pow per m3	Mass per m3	Min v/min Thrust*	Cost per m3	Area per m3
TL9	33t	.60Mw	1.25t	.10m3/3.3t	.004MCr	.60m2
TL10	50t	.70Mw	1.00t	.05m3/2.5t	.008MCr	1.0m2
TL11	50t	.70Mw	1.00t	.02m3/1.0t	.008MCr	1.0m2
TL12+	50t	.35Mw	0.65t	.01m3/.50t	.010MCr	1.0m2

Thruster Plates

TL	Thrust per m3	Pow per m3	Mass per m3	Min v/min thrust*	Cost per m3	Area per m3
TL11+	40t	1.00Mw	2.00t	10.0m3/400t	.250MCr	.20m2

* While the minimum volume is a solid lower boundary, the thrust can be manipulated to lower levels by rapidly cycling the drive on and off, a process requiring an on-board computer and inertial sensors to prevent undesirable oscillations. The sensitivity of thrust adjustment depends on how much computing power you want to throw at it, but a Level 3 unit is sufficient to allow a stable hover in most conditions.

Propulsion Systems

The Propulsion Systems Table lists most of the propulsion systems you will need for a vehicle. The Volume per Megawatt is how much volume is needed for the propulsion system per megawatt of input power; Cost is how many MCr each $1m^3$ of propulsion system costs; Area per Megawatt is the area taken by the propulsion machinery: how much of the vehicle's surface area must be dedicated to the propulsion system, and is thus unavailable for communication antenna, power plant heat sinks, and so on. This includes not only the parts touching the ground (in the case of land vehicles), but also open areas inside fender wells and any surface that cannot mount other machinery due to proximity to other moving parts. This area is usually restricted to no more than half the total vehicle surface area (putting wheels on the top of a car wouldn't do much good). Vehicles like hovercraft or legged vehicles may have up to 75% of the total area, and sometimes need this much area for their propulsion systems. Most vehicles will never have a problem with using up their available surface area, and you can usually ignore it for everything except hovercraft, legged vehicles, and vehicles with large power plants designed for vacuum use.

Speed is the multiple to the base speed of the vehicle which you calculated a few paragraphs back. Speed multiples of less than x1.0 will also apply to the acceleration of the vehicle. So, for instance, a 10 ton high-performance aircraft will have a better acceleration than a 10 ton combat walker with the same amount of power.

Propulsion Descriptions

Aircraft/High-Performance Aircraft: A typical aircraft, with either a propeller or jet engine of some type. Much of the large volume requirement of an aircraft is dedicated to wing structures and control linkages. High-performance aircraft have more of these and more wasted volume due to streamlining needs. Only high-performance aircraft are capable of supersonic speeds (330m/sec or 2000m/turn), and this level of performance is usually not achieved until TL6. The maximum speed of a high performance aircraft is 1 Mach (multiple of the speed of sound) per TL over 5, e.g. a TL8 high performance aircraft is capable of speeds of up to Mach 3.

Contragrav and Thruster Plates: Both operate on the same general principles. The difference is at the quantum gravitational level. The high-efficiency contragrav only works in a strong gravitational gradient, while thruster plates can work in minuscule gradients. High-efficiency contragrav becomes all but useless (1% output) within 1 diameter of a world, while thruster plates work out to around 1,000 diameters, and can operate off a solar diameter instead of a planetary diameter.

Combined with Fusion+, small scale long-endurance contragrav vehicles become practical for the first time during Cleon's reign (and thus also a valuable trade commodity). Even low-efficiency contragrav vehicles easily have the potential to reach orbit, and while they don't have the interplanetary capability of a normal ship's gig, they are also a lot more affordable, an important consideration when you look at monthly operating costs.

Contragrav plates require a certain area, which represents the thrust plates and their integral heat dissipation sinks. The former can be inside the vehicle, protected by armor, and the latter are designed to be part of the outer surface of the vehicle, and share the characteristics of that material (armor, etc.). Contragrav shares the visible blue-white effect caused by gravitic decay byproducts, and will appear on or near the surface of the vehicle that has the contragrav plates.

Note that if you are designing a vehicle with contragrav plates, you usually need a thrust at least equal to the vehicle mass to offset gravity. Any thrust after this can apply to forward acceleration of the vehicle. For determining the top speed of a contragrav vehicle in atmosphere, simply use the power input to the contragrav drive left over after countering gravity, with a speed multiplier of x(2/power per m3 of plates). For instance, a TL12 contragrav vehicle has a top speed in atmosphere based on its mass, the power left after accelerating 1G, times (2/.35).

Helicopter: A mechanically complex system where a rotating wing surface provides both lift and forward propulsion to the vehicle. It is fairly expensive, and has lower top speed than regular aircraft, but has the advantage of having no minimum speed, and can hover, fly sideways or backwards as needed (at a quarter of forward speed). Helicopters may not have a movement of more than 900 meters per turn (540kph), regardless of TL or power available.

Hoverskirt: A system where the power plant creates an air cushion underneath the vehicle, and activates fans to provide forward thrust. It has low mechanical complexity, but takes up a lot of vehicle surface area. The bottom surface of the vehicle must have at least as much area as the propulsion system area, which places limits on vehicle dimensions. Also, since a lot of power is used to maintain the air cushion, it has less available for forward thrust. Hoverskirt vehicles have the advantage of being immune to the effects of any type of flat terrain, and function equally well on snow, ice or water. A "hoverskirt" vehicle with a final acceleration of 1G or more may be considered a ducted fan vehicle, capable of vertical takeoff and landing. If the vehicle also has wings and an aircraft propulsion system, it may switch from one mode to the other. Note that a ducted fan vehicle does not have the same appearance as a hovercraft, but is just using a special case of the hoverskirt propulsion system rules. Hoverskirt propulsion systems can never use more than 75% of the vehicle's surface area for this system.

Legs: The vehicle has individually-powered articulated legs that allow it to walk much like a person, insect or animal, depending on vehicle configuration and size. It has excellent mobility on broken ground, but has a low top speed and large mechanical requirements. A leg propulsion system can also be used to model an articulated vehicle arm. The effective strength of the arm would be based on the power input, with a default Dexterity of a quarter the TL, rounding down. Any Battle Dress, Heavy Weapons, or Robotics skill could be used to add to this, and the total is the maximum effective Dexterity. If the manipulator is kept the same size, but effective power for Strength purposes is halved, the extra space not required for strength can be used for precision, giving +1 Dexterity. This may be done as often as desired, so long as the manipulator has a final Strength of at least 1. The default length of a manipulator is a quarter the vehicle length. Each time this is doubled, the effective power of the arm for Strength purposes is halved, as the arm has less leverage to use.

Lighter-Than-Air: Balloons or blimps have special requirements. The surplus lifting capacity of a lighter-than-air vehicle is approximately .2t per ton of gas envelope, plus .02t for each TL over 3, and reduced by .02t for each .1 of surface modifier for its configuration greater than 1. Add .02t to lift per ton if hydrogen is used, and subtract .02t if hot air is used. Both of these are available at TL3-4, and helium is available at TL5+. Helium is available on 50% of habitable worlds with a TL of 5+. Hot air requires fuel as for 1m3 of any type of available power plant per 1000m of gas envelope. Lighter than air gases can be stored in compressed or liquefied form at 1 ton per 1m3 of storage volume, with a compression ratio of TL^2:1 (e.g. a TL8 gas cylinder will hold 8x8=64 times its volume in compressed gas). The cost of a gas envelope is 10KCr per ton, times the configuration modifier on price.

If you assume that the total volume of the gas envelope is approximately 1000m^3 per ton, it won't be too far off, and the dimensions of the gas envelope depend on its configuration. Lighter than air vehicles with an airframe configuration have double the lift per ton of envelope (after modifiers are taken into account), but have a minimum takeoff speed as for normal aircraft if loaded to a level where they are heavier than air.

For example, a sphere has a surface configuration modifier of 1.0, so the surplus lift of a 1 ton TL13 envelope would be .2t, plus .2t for 10 TL's past TL3, for a total of .4 tons of surplus lift. If it were a cylinder configuration, it would lose .02t and drop to .38 tons of surplus lift, since a cylinder has a surface multiplier of 1.1. A cylinder airframe would lose .086t and drop to .314 tons of lift per ton of envelope, but this would be doubled to .628 tons of lift when the craft was moving at "takeoff speed" or more.

The top speed of a lighter-than-air vehicle is figured as for a normal aircraft at that TL, with a maximum speed in meters per turn of 10 times the TL of the vehicle, times the length modifier for its configuration. The propulsion system used is the same as an aircraft at that TL, but with a multiplier of x.2 on volume required. Acceleration for lighter-than-air vehicles is always less than 1G. For instance, a sphere configuration has a length modifier of 1.0, for no adjustment to speed, while a cylinder would multiply top speed by its length modifier of 2.0. Lighter-than-air vehicles may not have a gas envelope that is not streamlined, unless it is a balloon (unstreamlined sphere). Vertical acceleration is equal to the surplus lift after the vehicle is loaded, divided by the total vehicle mass (including gas envelope). The vessel can usually be tilted up or down to use up to half of any horizontal acceleration to boost or retard this as needed.

For combat targeting, use the USP size equivalent of the gas envelope for determining the chance to be hit, which will usually be 1 point higher than the rest of the vehicle. Hits that strike the vehicle exactly hit the gondola or other carried items, and all other hits are to the gas envelope, which is counted as having an armor of 1. Aside from slow loss of lift gases, most envelope hits will have no effect unless a) explosive weapons are used, or b) hydrogen is used for lift and the attack has a heat or fire component. In either case, roll for "system damage" for each such attack. Any explosive damage to a gas envelope that results in penalties will immediately collapse one or more subcells, and the vehicle will lose .1t x 1D of lift. Any heat or fire-based penalty on a hydrogen-filled gas envelope will result in immediate and irreversible ignition of the gas envelope, and all occupants have 2D turns to escape a fiery death.

Propeller (Water): This covers any means of water propulsion, including paddlewheels, waterjets and propellers, depending on TL. High performance watercraft are usually hydrofoils, and the increased volume and surface area is largely due to these structures.

Tracks: The power plant turns an endless belt with a large amount of ground contact, usually with one belt on either side of the vehicle, though very large vehicles may have multiple belts on each side, or independent units on each corner of the vehicle. It gives excellent traction and off-road performance, but is extremely noisy and relatively slow.

Wheels: A typical wheeled system as found on an automobile or motorcycle.

Propulsion System Options

Adverse Condition Propulsion System: This is any modification to the propulsion system that allows the vehicle to operate effectively in conditions that would otherwise be difficult for that propulsion system. Examples would be a supercharger for high-altitude aircraft, anti-fouling props and weed guards for swamp boats, skid plates and extra-heavy suspension for off-road vehicles, etc. Each of these modifications is a extra x.2 multiple to volume of the propulsion system (and therefore its cost), and may be applied multiple times as needed.

Secondary Propulsion System: This is an add-on to the basic propulsion system that allows very limited use in a subset of the vehicle's normal environment. It enables movement and acceleration of x.1 the normal speed in normally impassable conditions. An example would be waterjets and floatation screens for an armored personnel carrier, so that it can traverse rivers, or a boat with very limited submarine capability. This is an extra x.2 multiple to the volume of the propulsion system (and therefore its cost), and must be reasonable and strictly defined. (Crossing a river is reasonable for an APC. Crossing a canyon is not.) For instance, a tracked vehicle with "off-road" capability and waterjets would multiply propulsion system volume by x1.4.

Crew and Passenger Stations

A control station for a human-piloted vehicle is 1m^3 in volume, and assumes a loaded mass of .1t (100kg). This volume may in some cases (motorcycles) be external to the volume of the vehicle itself, in which case .2m^3 is used, but the driver has no armor or structure protection. Side or top protection adds .2m^3 per side, and front or back protection is .1m3 per facing. So, a motorcycle where the rider gets the protection of the front armor (windscreen) would have .3m3 dedicated to internal volume. A passenger behind a motorcycle rider only requires .2m3, regardless of protection, but is limited in movement by being snugged up against the rider.

Passenger seats require 1m^3 of volume, unless the passenger is hanging onto the vehicle, in which case they require zero volume (but do add to the external dimensions of the vehicle). This would be considered "cramped" seating, with very little in the way of access aisles. Roomy seating takes 2m3 per passenger and includes enough room for aisles, headroom and a small amount of storage for personal possessions. If designed as such, roomy seating can be reconfigured for other purposes, such as bunks or dining space. Most small personal vehicles have cramped seating, while most commercial passenger vehicles have roomy seating, as do recreational vehicles like motorhomes.

Bunks or other minimum vehicle accommodations require 2m3 per person. For very short-term use (a few days at most), cramped passenger seats can fold back to form a sleeping area, provided there is 1m3 of unused cargo volume behind each seat to make up the difference. Regular quarters and starship quality accommodations are figured as in starship design, which includes accessways and other space needed to reach these quarters. Vehicles designed with "hot bunking" in mind (same bunk used by 2-3 people on rotating shifts) need to allot +1m3 per bunk for extra storage of person items. Vehicles with minimal personal living space will also have very cramped access spaces, such as narrow doors, hallways where you have to turn sideways to pass an incoming person, and lots of low ceilings and protrusions to bang shins and heads on.

Life Support

Vehicles operating in hostile environments will need life-support for shirt-sleeve working conditions. This requires a vehicle that is fully enclosed (obviously), and a vehicle retrofitted to use life support at a later date will require modifications costing the same as the structure or armor of the vehicle, whichever is greater.

Basic Life Support

TL	Volume Supported per m3	Mass per m3	Power per m3	Cost per m3
8	1400m3	1.0t	.05Mw	.06MCr
9	1700m3	1.0t	.04Mw	.06MCr
10	2100m3	1.0t	.03Mw	.06MCr
11	2500m3	1.0t	.02Mw	.06MCr
12	3000m3	1.0t	.02Mw	.06MCr
13	3600m3	1.0t	.02Mw	.06MCr
14	4300m3	1.0t	.02Mw	.06MCr
15	5200m3	1.0t	.02Mw	.06MCr

Standard Life Support

TL	Volume Supported per m3	Mass per m3	Power per m3	Cost per m3
8	850m3	1.0t	.10Mw	.06MCr
9	1000m3	1.0t	.07Mw	.06MCr
10	1200m3	1.0t	.05Mw	.06MCr
11	1450m3	1.0t	.04Mw	.06MCr
12	1750m3	1.0t	.03Mw	.06MCr
13	2100m3	1.0t	.03Mw	.06MCr
14	2500m3	1.0t	.03Mw	.06MCr
15	3000m3	1.0t	.03Mw	.06MCr

Basic life support includes atmosphere recirculation, temperature and humidity control. Standard life support includes basic life support and also provides water and waste handling on any vehicle large enough to dedicate an extra $1m^3$ to these facilities (usually per 20 passengers or crew). If an extra $2m^3$ is dedicated to life support, it can include a shower or other means of cleaning up (vehicles with a decontamination lock can route regular water through the system to use it as a shower if needed). Vehicles at TL7- do not have regenerative life support, and must use consumables for each passenger per day of operation. Use the TL8 numbers for mass, power, volume and cost, but add consumables of .01t per day per passenger per TL below 8. An exception can be made for TL7 submarines, which can extract oxygen from water. They can halve consumables by using double the power requirement. Life support for a vehicle has a minimum cost of 200Cr, and bathrooms/showers are a minimum of 200Cr each.

Vehicles with life support are "clunkier" than those without. Doors may require separate extra latches, window seals are thicker, external latches and controls are designed to be used by space-suited hands, and so forth. To take this into account, you may wish to use the "roof hatches" rule for all vehicle access points, not just extra ones. This will increase the cost of the vehicle and discourage too many doors and portals.

Airlocks

A vehicle with life support of any kind is assumed to be sealed, and to have environment-tight doors or portals. An absolute minimum airlock (1 person, cramped) has a volume of $1m^3$. A normal one-person airlock is 3m3. Neither has any appreciable mass or power requirements, but will cost an extra .001MCr for structure, sealing, etc. Airlocks usually require $2m^2$ of surface area for a person-sized door and airlock controls.

Decontamination Lock

Decontamination showers or apparatus may be added to an airlock for a volume of 1m3 and a mass of 1t. This is sufficient for 100m3 of decontamination, so the total number of decontamination cycles will be based on the internal volume of the airlock. Decontamination procedures generally take about 20 turns (1-2 minutes) to complete.

Grav Compensators

Vehicles with high accelerations often lead to hindered performance by the crew, and complaints from passengers. Vehicles at TL10+ may install gravity compensators to partially or completely negate accelerations due to a linked contragrav system. The

Grav Compensators

TL	Volume per g per m3	Protected Maximum	Mass per m3	Power per m3	Cost per m3
10	.0100m3	1G	2t	.70Mw	.05MCr
11	.0050m3	2G	2t	.70Mw	.05MCr
12	.0030m3	3G	2t	.70Mw	.05MCr
13	.0025m3	4G	2t	.70Mw	.05MCr
14	.0020m3	5G	2t	.70Mw	.05MCr
15	.0015m3	6G	2t	.70Mw	.05MCr

Optional: While not normally done for efficiency purposes, grav compensators can be "stacked" to generate more compensation than is practical with single units. To get greater grav compensation, take the desired level, divide by the maximum normally allowed, and cube the result. This is the multiple to the compensator volume required to get the compensation needed. This becomes prohibitively costly for starship-class vehicles, and in fact the process begins to break down on extremely large volumes. But for small civilian or military vehicles, it can be done without too much trouble. Assume that a minimum of 2m3 of compensated volume is required for military pilots to ensure that their ejection seat and all controls are within the compensated envelope.

Example: A TL12 grav car with 6m3 of passenger and cargo space wants compensation vs. 3g accelerations. This has a volume of 6m3 x 3g x .003m3 = .054m3, a mass of .108 tons, a power requirement of .0378Mw and a cost of .0027MCr. To boost this up to 6g of compensation would require (6/3)^3=8 times as much, or .432m3, .864 tons, .3024Mw and .0216MCr. Using similar math, we can get 10G of compensation for a TL12 fighter pilot for .666m3, 1.333 ton, .4667Mw and .0333MCr.

VEHICLE COMMUNICATORS TABLE				Tech Level					
Range	**Power Req.**	**Cost**	**5**	**6**	**7**	**8**	**10**	**12**	**14**
Subregional(10km)	.0001Mw 75Cr	.05m3	.01m3	.001m3	.0001m	.0001m	.0001m	.0001m3	
Regional(30km)	.001Mw	250Cr	.1m3	.05m3	.01m3	.001m3	.0001m	.0001m	.0001m3
Subcontinent(300km)	.01Mw	500Cr	.15m3	.1m3	.05m3	.01m3	.001m3	.0001m	.0001m3
Continent(3,000km)	.1Mw	5KCr	.3m3	.15m3	.1m3	.05m3	.01m3	.001m3	.0001m3
Orbital(30,000km)	1Mw	30KCr	.7m3	.3m3	.15m3	.1m3	.05m3	.01m3	.0001m
Far Orbit(300,000km)	10Mw	90KCr	-	.7m3	.3m3	.15m3	.1m3	.05m3	.01m3

Small Vehicle Communication Systems				Tech Level					
Range	**Power Req.**	**Cost**	**5**	**6**	**7**	**8**	**10**	**12**	**14**
Subregional(10km)	1 watt	40Cr	.005m3	.001m3	.0001m	.0001m	.0001m	.0001m	.0001m3
Regional(30km)	10 watts	125Cr	.01m3	.005m3	.001m3	.0001m	.0001m	.0001m	.0001m3
Subcontinent(300km)	100 watts	250Cr	.015m3	.01m3	.005m3	.001m3	.0001m	.0001m	.0001m3
Continent(3,000km)	1,000 watts	2.5KCr	.03m3	.015m3	.01m3	.005m3	.001m3	.0001m	.0001m3
Orbital(30,000km)	10,000 watts	15KCr	.07m3	.03m3	.015m3	.01m3	.005m3	.001m3	.0001m3
Far Orbit(300,000km)	100,000 watts	45KCr	-	.07m3	.03m3	.015m3	.01m3	.005m3	.001m3

Each .01m3 of communicator is about 20 kilograms. Power requirement for communication systems is peak load. Actual total draw may be significantly less, but the power supply used must be able to handle this level of peak output.

Communication between compatible units is automatic out to the listed range if they both have the same range and no interference is present. Otherwise, each level of range beyond the range of the less capable unit is an increased difficulty rank (first range band is Average), and would be rolled vs. Intelligence or Communications skill.

Example: A grav car with a regional range radio is trying to get a message through to a ship in far orbit. This would be a Formidable task, with a -2DM if the grav car was using a small vehicle system.

Skill with communications equipment represents the ability to tweak the equipment or find ways of cutting through interference, ranging from twiddling knobs to extreme measures like using simple on-off codes to send a low-speed binary message.

Full vehicle grade systems are assumed to be of military quality: rugged, protected against electromagnetic disruption, and well-encrypted to prevent eavesdropping if so desired. Small vehicles generally do not have all these options.

system relies on precise communication between the two units, both to ensure maximum effect, and to prevent catastrophic injury to the passengers should the compensators fail. Compensators have mass and power requirements as below, but their thrust is applied only to the total compensated mass, and cannot exceed the acceleration of the vehicle on this unit. That is, you can never compensate more acceleration than the vehicle is currently experiencing due to its own contragrav.

Starships can apply the same technology if desired, and gravity compensation on passenger ships is a major cost, both in terms of volume, power and credits. Whether or not a small vehicle can exceed the compensation allowed in the starship design rules is a matter of preference.

Electronics

Vehicle electronics serve much the same function as the same items on starships, but with substantially less range and capabilities. Electronics and sensors have a power requirement that is usually small compared to the needs of the propulsion system, but when you consider that a 1000 watt communicator is taking the equivalent of 1.33 horsepower from the power plant, large communicators or sensors on small vehicles can be a significant drain.

Communicators

These allow transmission and reception between compatible units. Higher tech units are more likely to be able to adapt to the signals of lower tech units than vice versa. Signals at TL5-6 are voice, at TL7-8 may be voice or video, and at TL9+ are flat or three-dimensional video. Communicators have a mass of 2t per 1m3, a cost of .5MCr per 1m3 and require an antenna area equal to ten times the power requirement in Mw (included in cost). These numbers are for full capability starship-equivalent units, capable of simultaneously transmitting and receiving on up to TL^2 channels at once. For instance, a TL10 orbital range communication system can handle 100 simultaneous video phone calls, and has a size and power requirement to match.

"Small vehicle" systems are less capable. They have the same frequency range and type of communication, but can handle a maximum of TL simultaneous signals, and sometimes only handle one or two. The cost of "small vehicle" electronics will be lower by a factor of 2, volume will be lower by a factor of 10, and power reduced by a factor of 100 due to not having to be integrated with other vehicle systems. Any task that is not automatic for a communication system is at -2DM is using a small vehicle system.

Communicator Options

Directional Antenna: This increases the effective range of the communicator by one band, provided you can accurately aim the antenna at the intended recipient of the message, and decreases it by one in all other directions. This adds .1MCr per 1m3 of communicator volume.

Direction Finder: This allows accurate bearings to be taken on the source of a signal, and aside from being able to track down signals, it is also required for aiming a directional antenna at a moving target. This adds .1MCr per 1m3 of communicator volume.

Military Grade: Military grade communicators are protected much more thoroughly against electromagnetic pulses, and have stronger encryption than similar TL civilian units by 2 points (civilian communicators can have encryption if you want privacy). The dedicated encryption hardware and ruggedization multiplies the cost of the unit by ten.

Communicator Types

Vehicle communicators can operate on different frequencies, and a vehicle may have multiple communicators or different types and capabilities if so desired, as long as antenna area is available for all of them.

Jammers: A communicator may be bought as a jammer to subtract one range band from any one communicator's rating within that distance. If blocking a particular, known signal, it can subtract two range bands. Each 2 TL's of the jammer that is greater or less than the communicator being jammed adds or

SENSORS TABLE			Tech Level						
Range	**Power Req.**	**Cost**	**5**	**6**	**7**	**8**	**10**	**12**	**14**
Subregional(10km)	.0001Mw	.03MCr	.150m3	.090m3	.050m3	.030m3	.010m3	.005m3	.002m3
Regional(30km)	.001Mw	.08MCr	.450m3	.300m3	.150m3	.090m3	.030m3	.010m3	.005m3
Subcontinent(300km)	.01Mw	.25MCr	1.40m3	.800m3	.450m3	.300m3	.090m3	.030m3	.010m3
Continent(3,000km)	.1Mw	.80MCr	4.20m3	2.40m3	1.40m3	.800m3	.300m3	.080m3	.020m3
Orbital(30,000km)	1Mw	2.3MCr	12.6m3	7.30m3	4.20m3	2.10m3	.800m3	.200m3	.050m3
Far Orbit(300,000km)	10Mw	7.0MCr	33.0m3	19.0m3	11.0m3	6.30m3	2.10m3	.700m3	.250m3

subtracts one range band to the jamming effect. For example, a jammer bought as a subcontinental range communicator (300km) would subtract one range band from any communicator within 30km (regional range). If attempting to jam a particular signal, it would subtract two range bands from that communicator so long as it was within 30km (regional range).

Laser Communicators: These operate on visible or near visible wavelengths of light. Their advantage is that they are extremely difficult to intercept, but they must be precisely aimed at their target. Laser communicators are bought using the Small Vehicle Communication Systems Table, but are incompatible with normal communicators and are only possible at TL7+. Antenna area is one-tenth normal, and they may not have directional antenna or direction finder options.

Maser Communicators: These use a coherent radio beam to carry information. Like a laser, their advantage is that they are extremely difficult to intercept, but they must be precisely aimed at their target. Maser communicators are bought using double the mass on the Small Vehicle Communication Systems Table, but they are compatible with normal communicators (if aimed at them) and are only possible at TL7+. Antenna area is one-tenth normal.

Radio Communicators: This is the default, a system that uses various parts of the radio spectrum to transmit information.

Sensors

Small craft sensors do much the same as the varying starship sensors, but with less capability. They will be classified as active, passive, civilian and military. When sensors are bought, the designer will need to delineate what kind they are. If you want to keep things simple, just double the volume and cost of any TL10+ sensor and assume it is an active multi-spectrum device capable of picking up and categorizing most kinds of signals at the default resolution. Or, you may design vehicles with several sensor types.

Active Sensors: Active sensors work by emitting a signal and sorting the information provided by the delay and nature of the reflected signal. The quantity and quality of this information increases with TL. A TL5-6 sensor might only provide position of targets that reflect the signal. TL7-8 sensors have the ability to discriminate targets by size, direction of movement and velocity, and sometimes by specific type in the case of a trained operator and/or with access to a computer database of reflected signals. TL9+ sensors simply increase the detail available and increase the range and the conditions to gain such details. In general:

TL	Target Resolution
5	to within 10m per kilometer of range
6	to within 2m per kilometer of range
7	to within .5m per kilometer of range
8	to within .1m per kilometer of range
9	to within .02m per kilometer of range
10	to within .005m per kilometer of range
11	to within .001m per kilometer of range
12	to within .0002m per kilometer of range
13	to within .00005m per kilometer of range
14	to within .00002m per kilometer of range
15	to within .000005m per kilometer of range

Naturally, this resolution is only under optimum conditions, and the maximum TL a sensor has for resolution purposes depends on the nature of the sensor. Conditional DM's that affect spotting chance may also decrease the effective TL of the sensor for resolution purposes.

Example: A TL11 spy satellite orbiting at 100km can resolve ground targets down to .1m in size. However, if there is any atmospheric disturbance to give a +1DM for detection, it also drops the resolution to .5m if the target is spotted at all.

In starship terms, a 300,000km broad spectrum military small vehicle sensor is the equivalent of a "basic" sensor system, and the two have roughly the same size and power requirements at TL10-12. Doubling the volume of the 300,000km small vehicle sensor would upgrade it to "improved" level, and quadrupling volume and multiplying power requirements by eight would be roughly the same as a "small military" class starship sensor array.

Civilian Sensors: Sensors designed or approved for civilian use are generally meant to make life easier for the pilot or driver, as well as for the local governmental authorities. They generally do not and cannot be retrofitted to accept or transmit targeting data to or from weapons. They are built to standard specifications and interface well with other civilian sensors of the same TL, especially if from the same world. The cost of civilian sensors is one tenth the cost listed.

Military Sensors: Sensors designed for military use are designed to provide optimum information for pilots or weapon officers in combat. They may or may not be compatible with or conform to civilian electronics specifications, and may be custom designed for a specific application. A military sensor will be able to communicate with a compatible fire control system, allowing weapon use through obscured conditions or at ranges beyond naked-eye sighting (subregional or more). They generally are designed to accept or transmit to weapon systems, and are usually restricted or classified items at their TL of introduction. Military sensors cost as listed.

Passive Sensors: Passive sensors work by detecting and analyzing information emitted by a target or blocked by a target from other sources. This could be a heat signature, spatial distortions caused by thruster plates, stray nuclear emissions from a reactor, and so on. As with active sensors, the resolution of the information gathered is based on the TL and type of sensor. The range of a passive sensor is theoretically unlimited, but in practice is strongly dependent on the strength of the target signal. The "range" category of the passive sensor indicates its sensitivity and ability to discriminate extremely weak signals from the background noise. Passive sensors use x.01 the power of active sensors, but have the same mass and volume. Their biggest advantage is that an active sensor is easily spotted because of its emissions, while passive sensors do not betray their presence. The disadvantage is that passive sensors will never pick up something that isn't either emitting or blocking some other type of emission, and you can't "illuminate" a target to gain information on it.

For instance, a passive radar system would only be able to pick up targets that are emitting radar signals, obstructing radar signals, or reflecting someone else's radar signals. All of these

are limited in how much information you can get from the target. An active radar system could bounce various radar wavelengths off a target, possibly being able to determine its composition, shape, rotation and size with much greater facility. Or, in a much more down to earth case, a passive radar detector will tell you that police with radar guns are out there "somewhere." A police radar gun will tell the policeman exactly how fast you are going.

Sensor Options

Gravitic: This is a passive sensor type and maps out the distance and intensity of all gravitational fields, including contragrav and thruster plates, and may be used with varying effectiveness to internally map structures of varying density. Gravitic sensors have poor resolution, counted as 4 TL's lower than the actual sensor. They are possible at TL9+, reach maximum resolution potential at TL15, and have a minimum resolution of 10cm, regardless of how close you are. Gravitic sensors are only blocked by the presence of a larger gravitational source between the sensor and a target. Its cost is x5 and antenna area is x.1. For tactical use, gravitic sensors are next to useless to find or map features and objects on a planetary surface. They are used almost exclusively to pick out targets from an empty or homogenous environment, like ships in space, planes in the air or submarines in the water.

Jammers: A sensor may be bought as a jammer to subtract one range band from any one sensor's rating within that distance of the same type. If blocking a particular, known signal, it can subtract two range bands. Each 2 TL's of the jammer that is greater or less than the communicator being jammed adds or subtracts one range band to the jamming effect. Jammers are usually automatically visible to passive sensors of the appropriate type within their sensor range, but these passive sensors will still have all other signals jammed.

For instance, a jammer bought as a subcontinental range sensor (300km) would subtract one range band from any sensor of the same type within 30km (regional range). If attempting to jam a particular sensor, it would subtract two range bands from that sensor so long as it was within 30km (regional range).

Lidar: This uses reflected pulses of laser energy to gather information. The much shorter wavelength of light compared to radio waves gives Lidar a better resolution, and its resolution is counted as one TL higher than the actual TL of the unit. Lidar is possible at TL7+ and the maximum resolution potential is reached at TL13, with no effective minimum to resolution. Lidar will not penetrate any visually opaque substance, regardless of its thickness, but may be tuned to use frequency windows in atmospheres that may be opaque to visible wavelengths. Its cost is x2, and antenna area is x.1 normal.

Nuclear: This is a passive sensor type, and maps out the distance, distribution and intensity of subatomic particle sources. Nuclear sensors are possible at TL8+ and reach maximum resolution potential at TL11, with a minimum resolution of 10cm, regardless of how close you are. Nuclear sensors may be blocked by masses significant enough to absorb the radiation being searched for. Most reactors have sufficient shielding to block nuclear sensors, but fusion drives, radioactive cargo, or even cosmic rays interacting with hull material will give off detectable signals. Its cost is x10 and antenna area is normal.

Optical: This is a passive sensor type and simply provides a detailed visual image of long range targets, including infrared and ultraviolet wavelengths. It is normally used under computer control with sophisticated image processing software. Optical sensors are available at TL5+ and reach maximum resolution potential at TL13, with no effective minimum to resolution. Their resolution is counted as one TL higher than the actual TL of the unit. Optical sensors will be countered by any visually transparent or non-reflective substances, regardless of thickness, but may be able to detect wavelengths in atmospheres that are opaque to visible wavelengths. Optical sensors will also be able to pick up and analyze reaction engine plumes and can spot laser, particle beam or meson gun fire through the tiny fraction of the energy that is lost on the way to the target. Its cost is x2 and antenna area is x.1. A civilian vehicle system with subregional range (6KCr) is sufficient to qualify as a night-driving rig, and can range from a retractable set of goggles or a dashboard monitor at low TL's, to higher tech electronic coatings on the windscreen, which automatically compensate for varying light levels.

Radar: This is the default active sensor type, and is the reflection of a high-frequency radio signal off a target to gather information. Radar is possible at TL6+ and reaches maximum resolution potential at TL12, with a minimum resolution of 5cm, regardless of how close you are. Varying wavelengths can be used to penetrate certain types of non-metallic materials, and radar can be tuned to find shallow buried structures or terrain features covered by silt, sand, or shallow water. Its cost is the default.

Sensor Array, Dispersed: By doubling the antenna area of a sensor, you can increase the effective TL for resolution purposes by 1. However, you may not exceed the resolution for that class of sensor. This is especially effective for optical sensor arrays.

Sensor Array, Multiple: Doubling the number of linked identical sensors to form an array will give +1TL to the resolution of the array. However, you may not exceed the resolution for that class of sensor. This process does not increase the range of the sensor, just its resolution.

Sonar: This uses reflected ultrasonic sound to gather information, and is only useful in non-compressible mediums like water or other liquid atmospheres. Sonar is possible at TL5+ and reaches maximum resolution potential at TL8, with a minimum resolution of .1cm, regardless of how close you are. Its cost is x.5, and antenna area is normal. Unlike most other sensor types, sonar has a very slow response time, and even at relatively close ranges may take a fraction of a second to send/receive a signal.

Sensor Operation

Using sensors in play is a Formidable task vs. Sensors skill, increased in difficulty by 2 levels per range band outside the sensor, and decreased by 1 level per range band inside the sensor. That is, using a Orbital range sensor against a Far Orbital target would be an Impossible task, while using it against a Continental range target would be a Difficult task. DM's on the task are the USP size code of the target minus 6, -3DM if target is stealthy, -1DM for each TL a military target exceeds your sensor TL, and -1/2D DM for any condition that degrades the signal but does not block it entirely.

If a target is spotted, it stays spotted until it can make itself harder to be seen. If a target is hidden, it remains so until it is easier to be seen. In either case, a new spotting roll is attempted.

Example: A TL12 grav car is trying to evade a TL8 fighter with Subcontinental range radar. The range is currently Regional, so the fighter pilot has a Difficult task. The grav car is Size 6, for +0DM, but the grav car pilot is trying to hug the ground, for a -1/2D DM. If the pilot succeeds, he has sufficient target information to use weapons. If not, he loses them in the ground clutter.

Finding an item with vehicle sensors by criss-crossing a search grid is a time consuming task. Success is determined mainly by the patience of the searchers, and whether or not they are looking in the right place with sensors of sufficient resolution to pick up the object. Provided the searchers have a chance of finding the object of the search, it is usually a Formidable task on Sensors or Survey skill to correctly interpret the data or program

the computers to alert someone when objects matching search parameters are found. DM's apply for how much the object blends in with the background. In general, assume that a computer-directed search can cover up to 10 times the rating^2 square kilometers per minute (minimum of 1), divided by the TL of the resolution used, also squared.

Example: Looking for a companion's lifeboat from a radar-equipped TL12 grav car, the pilot flies up to 10km and sets the radar to TL9 resolution. At this height, the radar will be able to pick out objects as small as .2m, so the lifeboat or even a floating person should show up. The vehicle computer has a rating of 2, so the search area is 10 x 2^2/TL9^2=.5 square kilometers per minute, or 30 square kilometers per hour. This is not just sweeping the area looking for radar returns, but actually cataloging and classifying the returns from each .2m x .2m piece of ocean, over 750 million such returns in a hour.

Amenities, Options, and Safety

Access Panel (Sunroof)

Any vehicle with 1m2 or more of top surface can have an access panel large enough to climb out of (.5m^2). On a civilian vehicle, this is usually a sunroof, while on a military vehicle it is a hatch. In either case, it can have the full armor of the vehicle. A manually operated access panel will have a default cost of 100Cr x armor rating, and an automated one (electric, pneumatic, whatever) will cost 200Cr x armor rating. Either kind takes one turn to open or close, and automated ones have a Strength of 3 for civilian vehicles of most types, and armor rating/2 for military vehicles or ones more concerned with pressure integrity than the fingers of the occupants. These rules can be used for extra doors on most vehicle types.

Anti-Hijack System

Available at TL7+. Similar in concept to an anti-theft system, this hopefully deters would-be thieves from trying to bypass anti-theft devices by taking the vehicle with you still in it. On command, all access panels have their latches locked and electrified with a damage rating 2 of non-lethal jolt. An indelible skin dye sprays from concealed nozzles to identify the attacker later, and if any crew or passenger access doors are opened from the outside, the power plant will shut down in 5 turns and it will remain disabled for 100 more. An anti-hijack system generally costs around 1,000Cr and has a mass of 10kg and volume of .01m3.

Anti-Theft System

Any vehicle or TL5+ can be equipped with an anti-theft device or burglar alarm. The sophistication varies with TL. At TL7+ it may include power/fuel cutoffs, remote signaling to authorities, and remote engine start capability. It is a Formidable task to bypass an anti-theft system, with the following DM's:

Condition	DM
Each TL alarm exceeds tools/knowledge of thief	-2DM
Each TL alarm is below tools/knowledge of thief	+1DM
10 turns spent	+1DM
100 turns spent	+2DM
Each x2 cost spent on alarm	-1DM (up to -3DM)

Anti-theft systems have a base cost of 100Cr, which protects up to 5 access points (doors, hood, trunk, etc.). Extra access point protection is 20Cr per, which is also multiplied for extra system cost.

Cargo Compartment

Any space left over when a vehicle is designed may be designated as cargo, at no cost. On military vehicles this will likely be in a less useful amount of contiguous space than on a civilian vehicle, but it is still there. However, having area designated as cargo space implies it is being used for this, and all cargo space is assumed to be full for vehicle performance figures, at a mass of .5t per 1m3 of cargo. If a vehicle is not designated as having cargo space during the design process, it may not be retrofitted into this space at a later time.

Construction Equipment

A vehicle designed for specialized lifting, earthmoving or digging will require special tools to do so. Consider each type of tool to be a 1 ton, 1m3 weapon in a turret mounting, having an inherent armor rating of TL/2 (round up) and a cost of 5KCr per 1m3 of total volume. Lifting tools will have a maximum load of 1 ton per TL per ton of equipment, with a power requirement of .001Mw per ton of capacity. Earthmoving tools will move TL x 10 cubic meters of earth per hour per 1m3 of equipment with a power requirement like a crane of that mass. Digging tools can dig up to TL/2 meters down (round up) and excavate TL cubic meters of earth per hour per 1m3 of equipment with power like a crane of that mass .

Example: A 1 ton cargo crane on a TL10 truck will have a volume of .15m3, mass .1 ton and cost 750Cr, consuming .001Mw in operation. A 2 ton backhoe would have a volume of 3m^3, cost 15KCr, be able to dig holes up to 10 meters deep and move up to 20m3 of earth per hour, consuming .020Mw in operation.

Ejection Seats

Ejection seats or something similar are available at TL6+. They violently propel the occupant of the seat out of the vehicle, and then deploy some means of getting the occupant safely to the ground. In general, ejection seats give an occupant of a catastrophically destroyed vehicle a chance to escape with their lives. The base chance of success is a 2D roll of less than the TL of the ejection seat, with the following modifiers:

Condition	DM
Deliberate ejection by occupant	+3
Unfavorable vehicle position (too close to ground)	-3
Occupant has Pilot skill	+1/level

Success means the occupant takes 1D of wounds and makes it safely out of the vehicle before it disintegrates (if applicable). Failure means the stress of ejection killed the character (broken neck) or that the ejection seat failed in some way (parachute failure), and if the character isn't killed outright, they have taken 6D in wounds as a result.

Ejection seats have a volume of .2m^3, a mass of .1t and a cost of .1MCr each. For double this volume, mass and cost, an entire passenger or crew compartment (up to 6 crew/passenger's worth) may be ejected as a "pod". This is normally only a feature on vehicles that can expect to keep crew compartment integrity. It has the advantage that if intact, it keeps pressure support for the crew, an important feature if a high-altitude bailout is needed without a vac suit. It has the disadvantage that the fate of all involved rests on just one survival roll.

Entertainment Center

Any vehicle of TL7+ can have a sophisticated entertainment system, using whatever technology is appropriate for the TL, ranging from high-quality audio to flat-screen video to full holographic display. It generally occupies a total volume of .02m3, has a mass of 10kg and costs 1,000Cr.

Fire Suppression System

If an energy-intensive vehicle system suffers damage, there is always the possibility of fire igniting inside the vehicle (roll the vehicle's TL or greater on 3D). A vehicle fire suppression system will extinguish such fires within one turn on a 2D roll of the system's TL or less (portable fire extinguishers roll 3D vs. their TL to be effective). A vehicle fire suppression system has a volume of .001m^3 per 1m3 of vehicle volume, a mass of 500kg per 1m^3 and a cost of .050MCr per 1m3. The minimum system is .001m^3, .5kg and 50Cr.

Kitchen

A compact food preparation area will be 1m^3, 500Cr and mass 200kg empty, with capacity for up to 50kg of food or utensils. Exact features will depend on TL, and may include rough weather options for low-tech ocean vessels, zero-G options for pre-contragrav space vehicles, or refrigerator/freezers at TL6+. Each 1m3 provides cramped but usable space for preparation of up to four meals at a time. Each 1m3 of kitchen will consume .002Mw.

Labs

Space detailed for the study or experiments of a particular science has a mass of 500kg per 1m^3, and a cost of 5KCr per 1m^3. This can include any tools appropriate to the science in question, with any computing power in that space usually specialized towards the subject of study. "Labs" can represent machine shops, sick bays, libraries, brigs or any other specialized space not already covered.

Recreation Space

This is usually at a premium in small vehicles, and is generally a table and seating for several people to talk, eat or plan. It has no cost or mass, but occupies 1.5m^3 per person. Minimum bunk space can be assumed to be folding bunks, and recreation space can be created by converting bunk space to empty space for an extra .5m^3 of volume per bunk. Roomy seating can also be converted to recreation space.

Roadgrid

The remote vehicle operating system on Sylea is called Roadgrid, but similar concepts may occur on other worlds. Computer controlled remote vehicle operation is possible at TL6+, sophisticated enough to be usable at TL8+ and practical on a large scale at TL10+. The basic equipment interfaces with most vehicle control systems if installed during manufacture (retrofit is difficult), costs .1MCr per 1m^3 (minimum cost 500Cr), and has a volume of .001m^3 per 1m^3 of vehicle, with a mass of 500kg per 1m3. It allows a central traffic computer to monitor all vehicle vital signs, navigate the vehicle and communicate with the crew or passengers. All the passenger has to do is request a destination, and the computers will do the rest. By TL12, Sylean Roadgrid technology is extremely reliable, to the point where parents will trust children on unaccompanied trips, and businesspeople can call their empty cars to pick them up at a pre-determined time and place. Normal Roadgrid maintenance is handled by a distance surcharge that comes out to around 1Cr per 10 kilometers of travel.

Roadgrid is essentially the same as the Autopilot subsystem, with a built-in communicator, satellite navigation system, and large quantity discount price. Each vehicle in the TL11 roadgrid system is considered to be operated by a rating 4 computer.

Trailers

A trailer is designed as the same type of vehicle as the one towing it, and trailers are usually restricted to ground vehicles. The trailer should have the same level of structural support and propulsion system as the towing vehicle, but usually has no power plant of its own. Top speed and acceleration of the pair are based on total mass, and any maneuvering agility is halved (round down), and all pilot or driving tasks get a -1DM for each USP size of the vehicle+trailer total over 5. For instance, any driving task on a USP8 vehicle+trailer combo would be at -3DM. This would be doubled if the towing vehicle was not modified to handle pulling the load.

If part of the initial vehicle design, a towing or towed "hardpoint" will have a cost of 50Cr per ton of towed mass, and retrofitted arrangements will cost double. The mass of such a hardpoint is 1% of the towed mass, per vehicle. On the towing vehicle, this is the "trailer hitch", and on the towed vehicle it is the "tongue" of the trailer. Both vehicles will have the stress points anchored to the structure of the vehicle in the most efficient manner for that vehicle combination.

Wet Bar

Any vehicle can have a small food/beverage locker for .2m^3 of volume, 300Cr and 20kg (full). The actual amenities will depend on TL, but higher TL's will provide hot/cold water on demand, or have a part of the locker suitable for storing perishable goods.

Smart Coatings

The same technology that makes Screens possible can also be applied to vehicle surfaces. For corporations with a high public presence to maintain, this is a regular feature. Every Ontag Fruit Drink truck making deliveries to markets and stores will undoubtedly have animated displays extolling the virtues of their product, for instance. These display units are generally not up to broadcast quality standards, but are sufficient for most use. The technology can be applied on Sylea at any number of commercial outlets (off-world franchise opportunities available!) at around 50Cr per square meter, plus 200Cr for a central control unit which can interface with most computers or store pre-programmed visual loops. Add 10Cr per square meter if you want the display to be illuminated for night use.

The military camouflage applications are obvious, but are not that effective against high-tech forces. While the coatings can mask, confuse or alter the outline of a vehicle, hardly anyone relies solely on visual target acquisition at TL of 9+.

Black Hole-11

System defense boats and other purely deep-space craft often add a blackbody coat on top of any other stealth coat. This is a microporous deep black coating, with pits that trap incoming light and force several reflections in the microscopic pits, stopping a fraction of the already minuscule reflected light with each bounce. A vessel with such a coating appears to be a hole in space, if you can detect it at all, like someone removed a piece of reality and forgot to put it back. This coating is not that difficult to apply, and only costs 10Cr per square meter. Its drawback is that the coating is extremely fragile. Atmospheric re-entry will demolish it, any form of damage will remove it in spots, and even abrasion from space dust will "polish" it if the ship engages in extended high-G maneuvering. In game terms it provides an extra "edge" against optical sensors such as lidar and gives an extra –2DM to be spotted by any optical tracking device (including the naked eye).

This can be applied to personal armor and equipment, but its effects are extremely temporary in most cases. Treat it as a layer of wet black paint for purposes of durability.

TL11+ Small Craft Package

In order to qualify for a Sylean suborbital or orbital use license, a small craft must have the following equipment package in either normal or small vehicle types of equipment. The listed statistics are suitable for any vehicle of 140m^3 or less.

Equipment:
Continental range communicator (nominal 3,000km range)
Regional range (30km) civilian active sensors (radar)
Roadgrid remote operator system
Basic life support
One emergency wall patch per crew compartment
A whole-vehicle fire suppression system

Structure, etc.:
Front armor rating of 3
Other facings armor rating of 2
Acceleration of 1.5G or more (or .5G more than local gravity)
Backup battery power supply for contragrav if used (6 minutes)

The mass, volume and cost of this will vary depending on TL and vehicle size. If a vehicle is custom-built, analysis of the design files can be used to determine if the criteria have been met.

Combat Notes

Personal vehicles and small craft can be used in the same time and distance scale as personal combat, and there is a subset of vehicle actions that can be done in a turn just as there are personal actions.

Ranged Attack

Character may load (if necessary), or aim or fire a vehicle weapon. One character may usually be aiming a vehicle weapon while another is loading.

Evade

The driver or pilot of a vehicle may engage in evasive maneuvers.

Exit

Any passenger or crew may open an access port or door and exit the vehicle. Heavily armored or powered doors take a turn to open, and may be exited on the following turn.

Use Subsystem

Anyone with appropriate controls at hand may use, activate or deactivate a particular subsystem. This includes things like checking radar for targets, turning the power plant on or off, or using a communication device.

Attacks By Vehicle Weaponry

All vehicle mounted weapons of TL5+ may have fire control appropriate to their TL. A fire control system has a cost of DM x 10KCr, and can provide a maximum +DM equal to TL/2, rounding down. TL5 fire control systems may only be used if the vehicle is stationary. The mass and volume is subsumed in the weapon controlled. The fire control DM only applies to aimed fire from that weapon, and is in addition to any DM for the aiming characteristics of the weapon itself. Aimed fire is possible only if any penalty DM from evading and terrain is less than the bonus for fire control. For instance, a TL8 fire control system can allow aimed fire and give up to a +4DM, so long as the penalties for caroming along over rough terrain are less than a -4DM. Once these penalties reach or exceed a -4DM, the fire control can no longer keep the weapon on target, the +4DM is lost and the shot may not count as aimed fire. Fire control systems linked to vehicle sensors can track and fire at any targets within sensor range, either under manual control such as a joystick or slaved helmet sight, or on automatic, such as a point-defense weapon. The latter case can be programmed to shoot at targets matching a particular size, speed, emission or direction profile, in addition to recognizing friendly vehicle transponder codes.

Terrain

Most land or water vehicles will take additional penalty DM's on rough ground or in rough seas.

Terrain	DM's
Moving over even terrain	-1DM
Moving over uneven terrain	-3DM
Moving over extremely uneven terrain	-6DM
Evading	-1DM (minimum)
Moving over half maximum speed	-2DM

Water vehicles always count terrain as one level worse, so a stationary ship on smooth water still takes a -1DM.

Example: A TL8 land tank driving over rough terrain takes a -3DM for terrain. Its fire control DM is maximum at TL8/2 = +4DM, so it is capable of using aimed fire in these conditions and gets a net +1DM in addition to the aiming bonus. Someone standing in a hatchway firing a pintle-mounted machinegun would not get the fire control bonus, and would take the full terrain penalty, so they would have a -3DM, and would be unable to use normal aiming.

Automated Fire Control

At TL8+, vehicle weapons can be set on automatic. Through a computer, the fire control system can operate any linked military sensor and weapon with a skill of half its TL (round up), and engage any targets detected that meet pre-designated firing parameters ("shoot at incoming objects larger than 5cm", or "fire at any objects 5m or greater in size that come within 3km"). These firing parameters are limited by the resolution and abilities of the sensor. Automated fire control requires a computer dedicated to the task with a rating of 2, or a general purpose computer running appropriate software with a rating of 3. Each rating point less than this is a -2DM because of the lag in processing time, but each rating point in excess of what is needed is a +1DM. The weapon will use its regular rate of fire, and will use aimed fire only if programmed to, otherwise the DM is only used to counter movement penalties. These rules will apply for point-defense weapons of most types, and be sure to apply any autofire DM's as appropriate. Each point-defense attack after the first in a turn gets a -3DM.

Example: A TL9 point-defense system attached to a weapon with an adequate computer has a skill of 4 to shoot down incoming missiles, with any DM for rapid fire or very rapid fire weapons, and up a +4DM to counter the movement of the vehicle. If the point defense system is programmed to aim at incoming targets, it can apply this +4DM to itself instead, but only if the vehicle is not moving.

Autofire

It is covered as under the basic rules. If a weapon is capable of extremely rapid fire, it may get a bonus DM to offset the normal autofire penalties. Most weapons do not get this bonus. A rapid fire (RF) weapon will get a +2DM to autofire attacks, and a very

rapid fire (VRF) weapon will get a +4DM to autofire attacks. This corresponds to a rate of fire of approximately 100 shots or 200 shots per turn, respectively, and the weapon must expend this amount of ammunition or energy to qualify. RF and VRF weapons may use autofire at regular rates of ammunition consumption if desired.

Example: A VRF gauss rifle shooting at Medium Range (range number of 3) would take a -3DM to autofire for range, but would get a +4DM for its rate of fire, for a net +1DM. Adjacent targets would take a -6DM for range and +4DM for rate of fire, for a net -2DM.

Autopilot

A vehicle with a computer and a guidance system for accurate positional information (possible at TL6+) may have an autopilot for .1MCr per 1m3 (minimum cost 500Cr), and has a volume of .001m3 per 1m3 of vehicle, with a mass of 500kg per 1m3. An autopilot has a Pilot skill of half its TL (round down), plus twice the rating of the computer running its autopilot software. Most maneuvering tasks handled by an autopilot are Average tasks, with the following DM's:

Outside navigational aids (radio beacons, etc.)
+2DM

Maneuvering through cluttered environment
-2DM
(most ground vehicles)

Any DM a human pilot would take for conditions
as appropriate

Rolls would normally be needed for pre-flight maneuvering, takeoff, each course change, landing, and pot-flight maneuvering. Autopilots on air vehicles are also capable of terrain-following or nap-of-earth (NOE) flight. This counts as maneuvering through a cluttered environment, but if the total skill of the autopilot is equal or more than the TL of any sensors deployed against it, the vehicle is close enough to the ground to get the -1/2D DM for being lost in the ground clutter. An air vehicle can do NOE flight at 5% of its maximum speed per TL of the system.

For autonomous combat purposes, an autopilot has a skill of half its TL (round down), plus half the rating of its computer (round down). Most of the pre-designed vehicles are not listed as having computers, and GM's can install them to meet specific campaign needs.

Vehicle Evasion

A vehicle that is evading takes a penalty DM on all its vehicle-mounted weapons equal to the acceleration of the vehicle in G's (round fractions up). Hand-held weapons fired from a moving vehicle take double this penalty. This latter category includes pintle-mounted weapons, weapons used through firing ports and any weapon that is aimed entirely by direct muscle power. Vehicles using aerodynamic lift surfaces may have an acceleration for evading purposes up to the structural limits of their airframe, or 6G more than any internal gravity compensation. Uncompensated accelerations of more than 1G are extremely stressful on pilot and crew. Each turn of evading with uncompensated accelerations of more than 1G will give all vehicle occupants fatigue points equal to the number of excess G's (1 point for 2G, 2 points for 3G, etc.). G-suits may be used to counter 1G of this effect at TL9-, or 2G of this effect at TL10+.

Agility

All vehicles will have an agility rating for use on the scale of personal combat. This number is the USP size code of the vehicle, minus its maximum acceleration in G's (round nearest), minus 4. The result is the DM applied to all attacks against the vehicle when evading at maximum potential, and is in addition to any DM's for vehicle relative speed.

Displacement	USP size code
.1 to .99	5
1.0 to 9.9	6
10 to 99	7

Example: A 1 displacement ton grav car with an acceleration of 3G's will have an agility of 6 (size code) - 3G - 4 equals -1. All attacks against the vehicle while it is evading take a -1DM to hit.

Acceleration	Squares per Turn (turns to:)	10m/s	20m/s	30m/s	40m/s	50m/s	100m/s	200m/s	500m/s
.1G	1	2	4	6	8	10	20	40	100
.2G	2	1	2	3	4	5	10	20	50
.3G	3	<1	<2	2	<3	<4	<7	<14	<34
.4G	3	<1	1	<2	2	<3	5	10	25
.5G	4	-	<1	<2	<2	2	4	8	20
.6G	5	-	<1	1	<2	<2	<4	<7	<17
.7G	6	-	-	<1	<2	<2	<3	<6	<15
.8G	7	-	-	<1	1	<2	<3	5	<13
.9G	7	-	-	-	<1	<2	<3	<5	<12
1.0G	8	-	-	-	<1	1	2	4	10
1.5G	12	-	-	-	-	<1	<2	<3	<7
2.0G	17	-	-	-	-	<1	1	2	5
2.5G	21	-	-	-	-	-	<1	<2	4
3.0G	25	-	-	-	-	-	<1	<2	<4
3.5G	29	-	-	-	-	-	<1	<2	<3
4.0G	33	-	-	-	-	-	<1	1	<3
4.5G	37	-	-	-	-	-	-	<1	<3
5.0G	42	-	-	-	-	-	-	<1	2
6.0G	50	-	-	-	-	-	-	<1	<2
7.0G	58	-	-	-	-	-	-	<1	<2
8.0G	67	-	-	-	-	-	-	<1	<2
9.0G	75	-	-	-	-	-	-	<1	<2
10G	83	-	-	-	-	-	-	<1	1

Example: A TL8 jet fighter with an acceleration of 1G can go from a standing start to 8 squares in one turn, and if it has a takeoff speed of 100m/sec, it can reach that speed in 2 turns.

Airframe vehicles may use up to their structural limits when evading or using agility, but this amount of maneuvering acceleration will decrease the speed of the vehicle, and may be a penalty DM to piloting tasks if attempted in close conditions like NOE flying.

Acceleration and Combat

How does vehicle acceleration relate to the personal combat scale? Assuming each turn is 6 seconds, and each outdoor square is 15 meters, the following accelerations in G's will translate into a number of squares accelerated per turn. Note that acceleration adds to any existing velocity, so a vehicle that can accelerate 3 squares per turn will go 3 squares from a standing start, 6 squares the second turn, 9 the third turn and so on.

Advanced Damage Locations

When a vehicle is hit by an attack, roll 2D and consult the Damage Location Table for where it is hit. If a system is not applicable, roll again. If there are multiple systems matching that description, choose one randomly. Follow any notes regarding damage and armor effects. Certain attack types are unlikely to hit certain systems, and re-rolls may be appropriate in such cases (a land mine being unlikely to hit the sensors of a tank, for instance).

If you want to design vehicle-specific hit locations, or if a vehicle does not have certain systems, the easiest way to do this is to remove the system from the chart below, and replace it with the larger of the adjacent systems. For instance, if a vehicle does not have a weapon station, then replace it with "Power plant" since that is certainly the larger of the two adjacent systems. Now a roll of "3" or "4" is a power plant hit.

Anytime a weapon penetrates the armor of a vehicle and strikes a system, roll 2D with a DM of twice the amount that penetrated armor (a maximum of the original damage rating minus 1 if there is any armor at all). If the result is 12+, that system suffers damage and either takes a permanent -3DM to use, or loses half its current output or capability, whichever is more appropriate. If the result is 14+, the system is completely knocked out of commission or fails catastrophically in whatever manner is appropriate to that system. And, 1D is subtracted from the remaining damage and the remainder applied to a different system.

DAMAGE LOCATION TABLE

2D	System
2	Communications (halve armor rating before applying damage, round down)
3	Weapon station, weapon, ammunition or dedicated storage for energy weapon
4	Power plant
5	Fuel or non-weapon energy storage
6	Crew compartment
7	Passenger compartment
8	Vehicle structure (double armor rating or use 4, whichever is higher)
9	Cargo compartment
10	Propulsion (halve armor rating before applying dam age, round down)
11	Other system (life support, grav compensation, etc.)
12	Sensors (halve armor rating before applying damage, round down)

Example: If a damage rating 5 rifle bullet hits the power plant of a car with an armor of 2, 3 points got through armor. The system failure DM is twice the remaining penetration, or a maximum of the original damage rating–1, for a +4DM. On a 2D+4 roll of 12+, the power plant takes a -3DM to use, or as is more appropriate, loses half its power. On a 2D+4 roll of 14+, the power plant shuts down entirely, 1D is subtracted from the remaining damage rating of 3, and if there is anything left, it hits another vehicle system.

Optional: For large vehicles, systems may break down far too frequently. If appropriate, apply a –DM of 2x (the USP size of the vehicle minus 6). For instance, a USP size 8 vehicle would have a -4DM on all system damage rolls to represent that it has larger and harder to damage subsystems.

In the case of occupied compartments being hit, roll 5– for each occupant or appropriate cargo item, choosing randomly. The first occupant that gets 5– is hit by the residual damage. If damage remains after going through armor (twice), subtract 3 from it and roll for a second passenger hit. If no occupant rolls 5–, the damage penetrated the compartment with no ill effect other than breaching body integrity.

Due to the massive energies involved in vehicle weapons, what penetrates into the vehicle is significantly higher than just the damage rating minus armor. If a damage rating 20 weapon goes through an armor rating of 18, the residual energy is a lot more than a damage rating 2 pistol shot. This is why the residual damage after going through armor is doubled, unless of course it would make the damage equal or higher than the original shot.

Fire!

If an energy-intensive vehicle system suffers damage, or a flammable vehicle component is penetrated by fire or heat, there is always the possibility of fire igniting inside the vehicle (roll 3D of greater than or equal to the vehicle TL). A vehicle fire is assumed to be an attack against that vehicle location, with a damage roll based on the original attack. This is done once per turn for USP Size 6 vehicles, per 10 turns for USP Size 7 vehicles and once per 100 turns for USP Size 8 vehicles. If the system affected breaks down, roll again on the damage location table, ignoring vehicle armor. If the system targeted is also capable of burning, it checks for fire, and is treated as a damage rating 3 hit if it catches. If it fails to ignite, or the system targeted is not readily flammable, the fire burns itself out.

It Go Boom!

If a system with a large amount of stored energy (fuel, ammunition, batteries for energy weapons) spectacularly fails, it usually has collateral effects. Such systems generally apply 3D of damage per $1m^3$ of the failed system to another system (round damage up in 1D increments), which may in turn fail, and so on. If a vehicle ever has a catastrophic failure of its structure, it disintegrates or breaks into chunks. Any emergency safety measures will deploy, even if they won't do any good.

Surface breaches

Much of the time a damage from an anti-vehicle weapon has more important consequences than the hole it left behind. However, for unprotected individuals in a vehicle losing air to a vacuum, or the crew of a submarine looking at a high pressure stream of water filling their ship with watery doom, that hole can be very important indeed. Each turn after such an important surface breach, roll 2D. If the result is less than the residual damage rating of the weapon (or a roll of 2), everything in that section of the vehicle takes a -1DM to use if it is affected by the adverse external conditions (water, vacuum, corrosives, etc.). The roll is repeated based on the USP size of the vehicle: once per turn for vehicles of Size 6 or less, once per 10 turns for USP Size 7 vehicles, and once per 100 turns for USP Size 8 vehicles. When the DM equals the size of the vehicle, that vehicle subsystem is com-

pletely under the influence of the adverse conditions. Even if a vehicle system is unaffected by the conditions, it will make repair or maintenance of the system difficult until the breach is repaired and the atmosphere restored.

Example: A USP Size 8 vehicle is hit in the waterline by a shell with an after-armor damage rating of 6. On the turn after the hit, the vehicle needs to roll 6 or less on 2D to have any extra effect, and once again each 100 turns. Eventually (over perhaps an hour), the vehicle will take a total of -8DM, and that compartment of the vehicle will be considered completely flooded.

Explosive Effects

Vehicles attacked by explosives are generally considered sealed for purposes of protecting the occupants. Exceptions are usually obvious, like open trucks. If the explosive effect is as a result of a direct hit, like the side effects of a HEAT round, the effects are in addition to the HEAT effect. Apply the damage rating of the explosive to the sensors, communication, structure, and propulsion systems of the vehicle, since these are all external systems affected by a blast, and then roll one other hit location, which may be one of the ones previously listed. If the explosive effect is the result of a near miss, the damage rating of the blast is quartered before comparison.

If the explosive effect is actually greater than twice the vehicle armor, the vehicle is effectively destroyed, or a portion of a very large vehicle is destroyed. Gaping holes are rent in the body of the vehicle, it takes full surface breach effects immediately, structural members are buckled, sensors and communication antennae are blown off and the propulsive system is mangled beyond recognition. This brings us to. . .

Vehicle Repairs

Generally, replacing damaged parts of a vehicle is a matter of figuring the cost of the components needing to be replaced, and tripling it. If the characters are performing the repairs themselves, only double the component cost. Repairs will take a number of hours equal the USP size of the part times itself, divided by the TL of the tools available for the repair and whatever inconvenience factor the GM feels like throwing in. Replacing a 10 ton fusion reactor is problematic if the only TL12 tools you have are a set of screwdrivers. . . Repairs are usually an Average task, with a –DM of the part size. Failure usually just means the repair is taking longer than expected. The number of people required for the repair is at least half the size of the part, rounding up. More people do not speed the repair, but less will proportionately increase the time.

Example: A TL12 USP5 power plant will take 5 x 5 = 25 hours to replace it, divided by TL12 tools is 2.1 hours for 3 people, and an Average Mechanical task with a -5DM, rolled for by whoever is coordinating the repair. Without a garage, power tools and small crane, it will probably take a bit longer and possibly be a bit harder.

Trying to repair rather than replace a damaged component is harder and takes longer, since the damaged part still must be removed from the vehicle in most cases, repaired and then reinstalled. This takes an additional amount of time equal to that for parts replacement, and an extra task to complete it in that amount of time.

Sample Vehicles

The following vehicles are a fair sampling of what we can expect to find in operation within and around the Imperium. These are the standard vehicles based on official Imperial plans or templates or available models. Limited variations to these designs are tolerated to allow local manufacture.

All TL12+ Imperium military vehicles operate using fusion modules. They can operate on airless worlds and will have larger heat sinks if required to do so. Unless specifically stated that a vehicle has life support, the interior of the vehicle is not sealed for airless worlds, and occupants would need to wear vac suits on such worlds.

Aircraft, Ground-Attack, TL8

Displacement: 5.0 (USP7)	Volume	Mass	Area	Cost
Volume:	70.0m3	-	-	-
Configuration: Cylinder airframe	-	-	117.2m2	-
Wing area	-	-	27.06m2	-
Dimensions: 10.2m long x 3.0m high x 13.4m wide (approximate)				
Structural material: TL6 light alloy				
Chassis: 6g rated	1.804m3	5.412t	-	.144MCr
Armor: 1cm TL6 light alloy				
Armor rating: 3 on all surfaces	1.172m3	3.516t	-	.047MCr
Power plant: 2.0Mw TL7 gas turbine x 2	8.000m3	4.000t	3.200m2	.192MCr
Fuel consumption: 60.0m3 per 100 hours				
Fuel volume: x1 (high grade hydrocarbons)				
Fuel carried: 4 hours	2.400m3	2.400t	-	.001MCr
Propulsion: TL8 High perf. aircraft (x1.9 spd.),4.0Mw	7.200m3	3.600t	-	7.200MCr
Crew: 1 Pilot	1.000m3	.100t	-	-
Cockpit armor, 1.7cm TL8 comp.lam. (rat.9)	.085m3	.680t	-	.007MCr
TL8 Ejection seat	.200m3	.100t	-	.100MCr
Options: TL8 Subcontinental range (300km) comm.	.010m3	.020t	.100m3	.005MCr
TL8 Subcon. range (300km) mil. radar sensor	.300m3	.150t	.100m3	.250MCr
TL8 Regional range (30km) mil. opt. sens.	.090m3	.045t	-	.160MCr
TL8 fire control system (+4DM on autocannon)	-	-	-	.040MCr
TL8 RF light autocannon (x1.5 internal vol.)	1.125m3	1.500t	-	.021MCr
TL8 fire control system (+4DM on missiles)	-	-	-	.040MCr
TL8 Heavy missile x 8 (x1.5 volume hardpt.)	1.116m3	.558t	-	.032MCr
Total	23.96m3	22.08t	30.46m2	8.239MCr

Performance(loaded): acceleration .6G, top speed 1549m/turn (929kph), maximum range 3717km
(pilot only): acceleration .6G, top speed 1670m/turn (1002kph), maximum range 4008km
takeoff speed = 326m/turn (195kph).
Agility: +0DM to hit

Description: A lightly armored ground-attack aircraft, designed to engage armored ground targets with either a rapid-fire cannon or explosive guided missiles. The aircraft is designed to be durable and provide the pilot with a high degree of protection from ground fire. Its radar and optical sensor package give it all-weather capability, and it may carry bombs, larger missiles or fuel tanks on its hardpoints as needed.

ATV, Civilian, TL10

Displacement: 2 (USP7)	Volume	Mass	Area	Cost
Volume:	28.000m3	-	-	-
Configuration: Box	-	-	53.40m2	-
Dimensions: 3.93m long x 2.40m high x 2.40m wide (approximate)				
Structural material: TL8 Composite Laminate				
Chassis: 1g rated	.076m3	.534t	-	2.432KCr
Armor: .4cm TL8 Composite laminate				
Armor rating: 5 on all facings	.213m3	1.495t	-	17.040KCr
Power plant: TL12 Fusion+ unit (standardized .2Mw)	.040m3	.083t	-	.300KCr
Fuel consumption: .006m3 per 100 hours				
Fuel volume: x1 (enriched water)				
Fuel carried: 2000 hours	.120m3	.120t	-	.840KCr
Propulsion: TL8+ wheels, .200Mw (x.7 speed multiplier)	.200m3	.200t	1.000m2	5.000KCr
Adverse condition propulsion system	.040m3	.040t	.200m2	1.000KCr
Secondary propulsion system (waterjets)	.040m3	.040t	.200m2	1.000KCr
Crew: 1 Driver	1.000m3	.100t	-	-
1 Observer (in turret)	1.000m3	.100t	-	-
Roomy seating x 6	12.000m3	.600t	-	-
Options: Standard life support	.025m3	.025t	-	1.500KCr
Shower & toilet	3.000m3	-	-	.400KCr
Kitchen (8 meals at a time)	2.000m3	.400t	-	1.000KCr
Fire suppression system .054m3	.027t	-	2.715KCr	
Towing hitch (up to 10 tons)	.100m3	.100t	-	.500KCr
Airlock	3.000m3	-	2.000m2	1.000KCr
Medium machinegun-8 in turret	.008m3	.011t	-	1.000KCr
Machinegun reloads x 5	.010m3	.020t	-	.500KCr
Roof hatch x 2 (turret and roof)	-	-	1.000m2	1.000KCr
TL10 mil-spec small craft subcont. comm.	.001m3	.002t	.100m2	2.500KCr
Directional antenna	-	-	-	.100KCr
Direction finder	-	-	-	.100KCr
Recreation space (use as needed)	3.000m3	-	-	-
Cargo hold, 2m3	2.000m3	1.000t	-	-
Total	27.920m3	4.897t	5.500m2	51.206KCr

Performance(loaded): acceleration .1G, top speed 86m/turn (52kph), maximum range 103,200km
(driver only): acceleration .2G, top speed 100m/turn (60kph), maximum range 120,000km
Agility: +2DM to be hit

Description: An example of what some medium-tech worlds are doing with Fusion+ units. Depending on who the vehicle is being sold to, this is either a military command and control vehicle, or a fully configured civilian exploration vehicle, with the machinegun replaced by sensors or electronic gear.

Blimp, TL6

Displacement (gas envelope): 400.0 (USP8)	**Volume**	**Mass**	**Area**	**Cost**
Volume (gas envelope):	5600.0m3	5.600t	1524.95m2	44.800KCr
Configuration: Cylinder streamlined				
Dimensions: 44.06m long x 12.78m high x 12.78m wide (approximate)				
Total lift:		1.344t		
Displacement (gondola): .8 (USP6)				
Volume (gondola):				
Configuration: Cylinder streamlined	8.400m3	-	26.620m2	-
Dimensions: 5.60m long x 1.62m wide x 1.62m high				
Structural material: TL6 Fiber laminate				
Chassis: 1g rated	.080m3	.080t	-	1.916KCr
Armor: .3cm TL6 Fiber laminate				
Armor rating: 1 on all facings				
Power plant: TL6 Internal combustion, .2MW	.500m3	.500t	.500m2	4.000KCr
Fuel consumption: 2.5m3 per 100 hours				
Fuel volume: x1 (improved hydrocarbons)				
Fuel carried: 10 hours	.250m3	.250t	-	.125KCr
Propulsion: TL6 Aircraft (x1.1 spd.), .2Mw	.112m3	.112t	-	34.720KCr
Crew: Pilot	1.000m3	.100t	-	-
Passenger x 2 2.000m3 .200t - -				
Options: TL6 regional sm. veh. communicator	.005m3	.010t	-	.250KCr
Subtotal:	3.947m3	1.252t	500m2	41.011KCr
Total		6.852t		

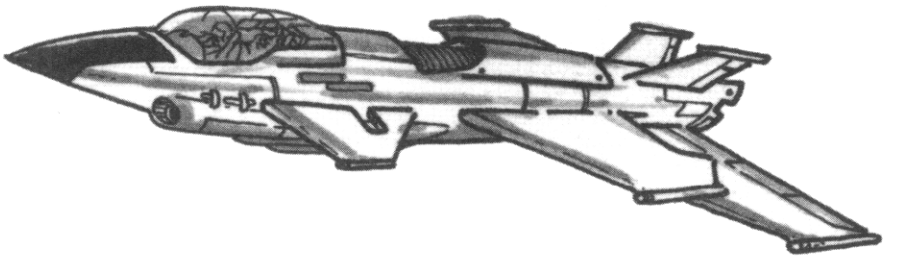
Performance(loaded): acceleration .2G, top speed 96m/turn (58kph), maximum range 576km
(pilot only): acceleration .2G, top speed 99m/turn (60kph), maximum range 594km
vertical acceleration: .013
Agility: +4DM to be hit (envelope), +2DM (gondola)
Description: A small commercial or military lighter-than-air craft. In commercial applications it would carry lightweight advertising banners, while in a military application it would carry a pair of 100kg bombs or depth charges to drop on enemy submarines. Its usefulness in this role is enhanced by its ability to float quietly for extended periods without using any power plant fuel, extending its flight duration to several days if necessary.

Bulldozer, TL6

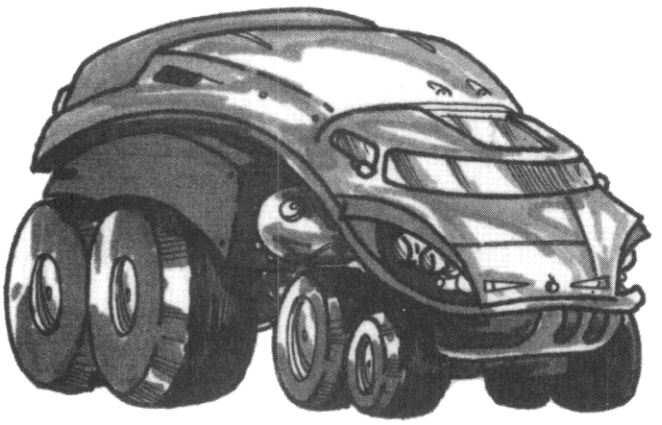
Displacement: 2.0 (USP7)	**Volume**	**Mass**	**Area**	**Cost**
Volume:	28.0m3	-	-	-
Configuration: Box	-	-	53.40m2	-
Dimensions: 4.63m long x 2.41m high x 2.41m wide (approximate)				
Structural material: TL3 Soft steel				
Chassis: 1g rated	.178m3	1.424t	-	1.139KCr
Armor: None - - - -				
Power plant: TL5 Imp. internal comb., .100Mw	.333m3	.333t	.333m2	2.664KCr
Fuel consumption: 1.665m3 per 100 hours				
Fuel volume: x1 (high grade hydrocarbons)				
Fuel carried: 20 hours	.333m3	.333t	-	.167KCr
Propulsion: TL5 tracks, .1Mw (x.45 speed multiplier)	.280m3	.280t	3.360m2	32.200KCr
Adverse condition propulsion system (off-road)	.028m3	.028t	.336m2	3.220KCr
Crew: 1 Driver 1.000m3 .1000t - -				
Options: TL6 earthmoving tools, 120m3 per hour	8.000m3	2.000t	16.000m2	10.000KCr
TL6 excavating tools, 6m3 per hour	4.000m3	1.000t	8.000m2	5.000KCr
Total:	14.152m3	5.498t	28.029m2	54.390KCr

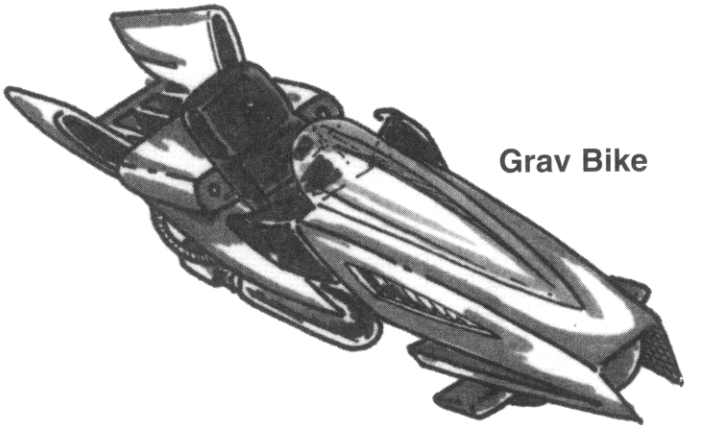
Performance: acceleration .1G, top speed 25m/turn (15kph), maximum range 300km
Agility: +2DM to be hit
Description: A generic earthmoving vehicle, with a bulldozer blade and backhoe, capable of digging holes or trenches up to 3m deep. Has absolutely no amenities or creature comforts for the driver.

Grav Fighter



Civilian ATV





Grav Bike

Grav Cycle, TL12

Displacement: .05 (USP5)	Volume	Mass	Area	Cost
Volume:	.700m3	-	-	-
Configuration: Disk streamlined	-	-	4.56m2	-
Dimensions: 1.65m long x 1.65m high x .33m wide (approximate)				
Structural material: TL11 Structurecomp				
Chassis: 3g rated	.046m3	.046t	-	2.944KCr
Armor: .3cm Structurecomp				
Armor rating: 2 on front only	.001m3	.001t	-	.052KCr
Power plant: TL12 Standard Fusion+, .05Mw x 1	.010m3	.021t	.050m2	.075KCr
Fuel consumption: .0015m3 per 100 hours				
Fuel volume: x1 (enriched water)				
Fuel carried: 200 hours	.003m3	.003t	-	.021KCr
Power plant: TL12 Storage bank, .003Mw/hr	.002m3	.004t	-	.010KCr
Propulsion: TL12 contragrav, .03Mw (4.3 tons thrust)	.086m3	.056t	.086m2	.860KCr
Crew: 1 Driver, front protection only	.300m3	.100t	-	-
1 passenger	.200m3	.100t	-	-
Options: Grav compensation, 3G (.002Mw)	.006m3	.013t	-	.315KCr
TL12 Small vehicle regional comm.	-	-	-	.125KCr
Roadgrid system	.001m3	-	-	.500KCr
Cargo box	.040m3	.020t	-	-
Total:	.695m3	.364t	.136m2	4.902KCr

Performance(loaded): acceleration after gravity 3G, top speed 1293m/turn (776kph), maximum range 258600km
(driver only): acceleration after gravity 3G, top speed 1772m/turn (1063kph), maximum range 212640km
Agility: -2DM to be hit

Description: Also known as "pocket rocket", the grav bike is rapidly gaining ground among the young and daring, who routinely are heavily fined for taking them off Roadgrid control in urban areas. Enough accidents, building collisions and grav bikes achieving orbit after their riders fell off have occurred that the Sylean government is considering banning them in the interest of public safety. Proponents of the fledgling grav-bike racing circuit are countering this with an aggressive public safety campaign to promote responsible use. Professional racing machines are about twice the size, with high-stress frames, excess grav compensation, fully enclosed cockpits and military-grade ejection seats. They also cost upwards of 200KCr each.

Grav Fighter, TL12

Displacement: 4.0 (USP7)	Volume	Mass	Area	Cost
Volume:	56.000m3	-	-	-
Configuration: Needle airframe	-	-	119.483m2	-
Dimensions: 14.10m long x 1.97m high x 12.47m wide (approximate)				
Structural material: TL11 Structurecomp				
Chassis: 20g rated	6.127m3	6.127t	-	.294MCr
Armor: 5.0cm TL11 Structurecomp				
Armor rating: 5 on all facings	5.974m3	5.974t	-	.239MCr
Power plant: TL12 Fusion+, 9.6Mw	2.000m3	4.000t	12.000m2	.020MCr
Fuel consumption: .30m3 per 100 hours				
Fuel volume: x1 (enriched water)				
Fuel carried: 100 hours	.300m3	.300t	-	.002MCr
Power plant: TL12 storage bank, weapon-grade, 3.0Mw/hr	2.000m3	4.000t	-	.125MCr
Propulsion: TL12+ contragrav, 800 tons thrust (5.6Mw)	16.000m3	10.400t	16.000m2	.160MCr
Crew: 1 Pilot	1.000m3	.100t	-	-
1 Observer/gunner	1.000m3	.100t	-	-
Options: Gravity compensation on 4m3 (crew), 11G	6.144m3	12.288t	-	.307MCr
(requires 4.3Mw at full output)				
Basic life support (crew compartment)	.001m3	.001t	-	.001MCr
Fire suppression system	.056m3	.028t	-	.003MCr
TL12 Ejection seat x 2	.400m3	.200t	-	.200MCr
TL12 fire control system (+6DM)	-	-	-	.060MCr
Light plasma cannon-11 (x1.5 fixed mount)	.270m3	.540t	-	.995MCr
(uses .06Mw/hr per shot)				
TL12 fire control system (+6DM)	-	-	-	.060MCr
Heavy missile-11 x 10 (x1.5 fixed mount)	1.200m3	1.600t	-	.110MCr
TL12 fire control system (+6DM)	-	-	-	.060MCr
RF Gauss MG-11 (x1.5 turret mount)	.028m3	.037t	-	.015MCr
(uses .008Mw/hr per turn)				
TL12 Mil-spec orbital range radio comm.	.010m3	.020t	10.000m2	.300MCr
TL12 Mil-spec orbital range laser comm.	.010m3	.020t	1.000m2	.300MCr
TL12 Orbital range active radar	.200m3	.400t	10.000m2	2.300MCr
TL12 Continental range active lidar	.080m3	.160t	.100m2	1.600MCr
Total	42.800m3	46.295t	49.100m2	7.151MCr

Performance(loaded): acceleration 17.3G, top speed 3712m/turn (2227kph), maximum range 222717km
(crew only): acceleration 17.7G, top speed 3808m/turn (2285kph), maximum range 228456km
Agility: -14DM to be hit (-8DM at limits of internal gravity compensation)

Description: An ultra-fast response near-space interceptor, capable of providing support anywhere on most planetary surfaces within 15 minutes by blasting out of the atmosphere and re-entering near the target site, thus bypassing atmospheric speed limits. Very lightly armored, and relies almost exclusively on its high agility to avoid being hit.

Grav Tank, TL12

Displacement: 4.0 (USP7)	Volume	Mass	Area	Cost
Volume:	56.00m3	-	-	-
Configuration: Disk streamlined	-	-	84.84m2	-
Dimensions: 7.05m long x 1.41m high x 7.05m wide (approximate)				
Structural material: TL12 Superdense				
Chassis: 3g rated	.231m3	3.471t	-	.052MCr
Armor: 8.2cm TL12 Superdense				
Modifiers: Front moderate sloped (x2 thickness)	5.600m3	-	-	-
Armor rating: 22 overall	6.957m3	104.353t	-	.974MCr
55 front (+6.714m3), 26 sides (+1.698m3)	8.412m3	126.180t	-	1.178MCr
Power plant: TL12 Fusion+, 4.8Mw x 2	2.000m3	4.000t	9.600m2	.024MCr
Fuel consumption: .300m3 per 100 hours				
Fuel volume: x1 (enriched water)				
Fuel carried: 250 hours	.750m3	.750t	-	.005MCr
Power plant: TL12 Storage bank, 7.5Mw/hr, weapon grade	5.000m3	10.000t	-	1.25MCr
Propulsion: TL12 contragrav, 3.5Mw (800 tons thrust)	16.000m3	10.400t	16.000m2	.160MCr
Crew: 1 Driver	1.000m3	.100t	-	-
1 Commander	1.000m3	.100t	-	-
1 Observer	1.000m3	.100t	-	-
Options: Ejection seats x 3	.600m3	.300t	-	.300MCr
Fire suppression system	.056m3	.028t	-	.003MCr
Powered roof hatches x 2 (driver/commander)	-	-	1.000m2	.009MCr
Basic life support	.019m3	.019t	-	.001MCr
Gravity compensation, 3G	.504m3	1.008t	-	.025MCr
TL12 Fire control system (+6DM)	-	-	-	.060MCr
Heavy plasma cannon-11 (1.1Mw/hr per shot)	4.605m3	6.140t	-	4.88MCr
TL12 Fire control system (+6DM)	-	-	-	.060MCr
RF point def. laser-12 x 2 (.0002Mw/hr/turn)	.002m3	.003t	-	.002MCr
TL12 Fire control system (+6DM)	-	-	-	.060MCr
RF laser-11 (.018Mw/hr/turn)	.040m3	.053t	-	.017MCr
Mil-spec orbital communications (radio)	.010m3	.020t	10.000m2	.300MCr
Subcontinental range radar sensor	.030m3	.060t	.100m2	.250MCr
Subcontinental range passive optical sensor	.030m3	.060t	.010m2	.500MCr
Regional range passive nuclear sensor	.010m3	.020t	.010m2	.800MCr
Regional range passive gravitic sensor	.010m3	.020t	.010m2	.400MCr
Total	53.866m3	267.185t	36.73m2	11.310MCr

Performance(loaded): acceleration after gravity 2G, top speed 150m/turn (90kph), maximum range 22500km
Agility: +1DM to be hit
Description: In Year 0, this is still an experimental vehicle type with the bugs to be worked out. Likely changes will be the replacement of the heavy plasma cannon with a less power-hungry model, and using the extra space to add orbital re-entry capability (adverse condition propulsion), or better contragrav performance. It appearance is disk-like, with a heavy turret set well to the rear, mounting the heavy plasma cannon, RF laser and one of the point-defense lasers, and a sloped front surface. The body has various sensor ports, and another point-defense laser set on the upper rear surface of the hull, behind the turret.

Grav Truck, TL12

Displacement: 1.0 (USP6)	Volume	Mass	Area	Cost
Volume:	14.0m3	-	-	-
Configuration: Box	-	-	33.72m2	-
Dimensions: 3.75m long x 1.95m high x 1.95m wide (approximate)				
Structural material: TL3 Soft steel				
Chassis: 1g rated	.084m3	.674t	-	.540KCr
Armor: .3cm TL3 soft steel				
Armor rating: 2 on all facings	.101m3	.809t	-	1.616KCr
Power plant: TL12 Fusion+ standard .2Mw unit	.040m3	.083t	.200m2	.300KCr
Fuel consumption: .006m3 per 100 hours				
Fuel volume: x1 (enriched water)				
Fuel carried: 2000 hours	.120m3	.120t	-	.840KCr
Power plant: TL9 battery, .015Mw/hr	.038m3	.075t	-	.076KCr
Propulsion: TL9 contragrav, 8.25 tons thrust (.15Mw)	.250m3	.313t	.150m2	1.000KCr
Adverse condition propulsion system (brush guards, skid plate)	.025m3	.031t	.015m2	.100KCr
Crew: 1 Driver	1.000m3	.100t	-	-
3 passenger	3.000m3	.300t	-	-
Options: Cargo hold	9.000m3	4.500t	-	-
Small vehicle regional comm.	-	-	-	.125KCr
Roadgrid system	.014m3	.007t	-	1.400KCr
Total:	13.658m3	7.012t	.365m2	5.997KCr

Performance(loaded): acceleration after gravity .2G, top speed 32m/turn (19kph), maximum range 38400km
(driver only): acceleration after gravity 1.0G, top speed 102m/turn (61kph), maximum range 122400km
Agility: +2DM to be hit (+1 if lightly loaded)
Description: The bottom-of-the-line contragrav vehicle, capable of computer-controlled flight on Sylea, able to cross any type of terrain, and able to carry twice its own weight in cargo. It is beginning to see common use as a delivery vehicle and some bulk sales as an export item, with the advertising slogan "needs maintenance when you fill the fuel tank. . . once a year."

Hovertank, TL9

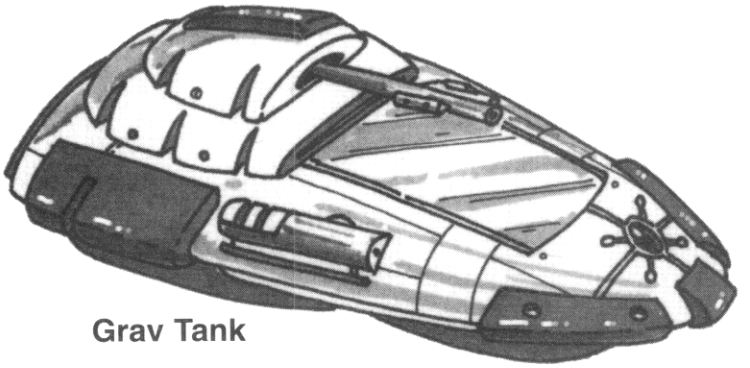
	Volume	Mass	Area	Cost
Displacement: 2 (USP7)				
Volume:	28.000m3	-	-	-
Configuration: Box streamlined	-	-	53.40m2	-
Dimensions: 3.93m long x 2.40m high x 2.40m wide (approximate)				
Structural material: TL8 Composite Laminate				
Chassis: 1g rated	.076m3	.534t	-	3.648KCr
Armor: 2.8cm TL8 Composite laminate				
Armor rating: 9 on all facings	1.495m3	10.465t	-	119.600KCr
Moderate slope on front & sides (+3 armor)	8.400m3	-	-	-
Power plant: TL8 MHD turbine, 1.8Mw	3.000m3	1.500t	1.500m2	180.000KCr
Fuel consumption: 18.0m3 per 100 hours				
Fuel volume: x1 (improved hydrocarbon)				
Fuel carried: 20 hours	3.600m3	3.600t	-	1.800KCr
Propulsion: TL8+ hoverskirt, 1.80Mw, x.5 spd. mult.	3.600m3	3.600t	18.000m2	360.000KCr
Adverse condition propulsion system (debris filters)	.720m3	.720t	1.800m2	36.000KCr
Crew: 1 Driver	1.000m3	.100t	-	-
1 Observer/gunner	1.000m3	.100t	-	-
1 Commander	1.000m3	.100t	-	-
Options: Standard life support	.025m3	.025t	-	1.500KCr
Fire suppression system	.054m3	.027t	-	2.715KCr
TL9 fire control system (+4DM)	-	-	-	40.000KCr
RF light autocannon-8 (x1.5 volume)	1.125m3	1.500t	-	21.000KCr
TL9 fire control system (+4DM)	-	-	-	40.000KCr
Heavy missile-8 x 4 in turret	.279m3	.372t	-	16.000KCr
Medium machinegun-8 in turret (x1.5 vol.)	.008m3	.011t	-	1.000KCr
Machinegun reloads x 5	.010m3	.020t	-	.500KCr
Roof hatch x 2 (driver/commander)	-	-	1.000m2	1.800KCr
Regional range TL8 active radar sensor	.090m3	.180t	.010m2	80.000KCr
Subregional range TL8 passive optical sens.	.030m3	.060t	-	60.000KCr
Continental mil-spec small craft comm.	.005m3	.010t	.010m2	25.000KCr
Direction finder	-	-	-	.500KCr
Total	25.517m3	22.924t	22.320m2	991.063KCr

Performance(loaded): acceleration .2G, top speed 177m/turn (106kph), maximum range 2124km
(crew only): acceleration .2G, top speed 189m/turn (113kph), maximum range 2268km
Agility: +3DM to be hit
Description: A light, fast vehicle designed for open, swamp or marine environments — the latter, of course, requiring solid ground to stage from, since the hovertank barely floats. Capable of destroying any armored vehicle at its TL and especially useful for hit-and-run tactical raids.

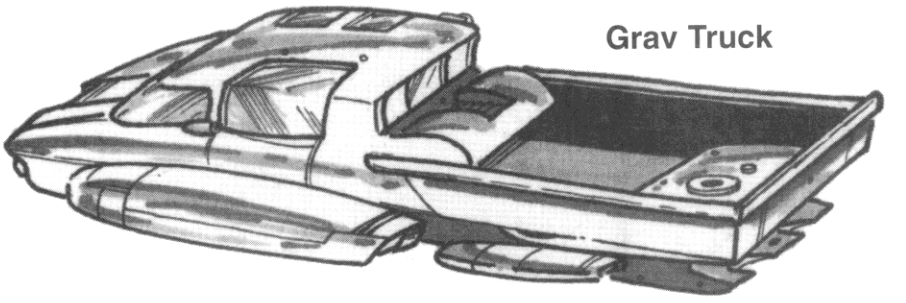
Motorcycle, High-Performance, TL11

	Volume	Mass	Area	Cost
Displacement: .1 (USP5)				
Volume:	1.400m3	-	-	-
Configuration: Disk Streamlined	-	-	7.32m2	-
Dimensions: 2.1m long x 2.1m high x .42m wide (approximate)				
Structural material: TL11 Structurecomp				
Chassis: 1g rated	.024m3	.024t	-	.960KCr
Armor: .34cm TL11 Structurecomp				
Armor rating: 2 on all but top and rear	.016m3	.016t	-	.640KCr
Power plant: TL7 gas turbine, .10Mw	.200m3	.100t	.160m2	4.00KCr
Fuel consumption: 1.50m3 per 100 hours				
Fuel volume: x1 (high grade hydrocarbons)				
Fuel carried: 5 hours	.075m3	.075t	-	.038KCr
Propulsion: TL8+ wheels (x.7 speed multiplier)	.100m3	.100t	.500m2	2.50KCr
Crew: 1 Driver, protected all but top and rear	.700m3	.100t	-	-
Options: TL11 Sm. veh. regional range (30km) comm.	-	-	-	.100KCr
Sylean roadgrid control	.005m3	.003t	-	.500KCr
TL11 anti-theft system (-1DM)	.001m3	.001t	-	.200KCr
Lockable cargo box (.20m3)	.200m3	.100t	-	-
Total:	1.32m3	.519t .660m2	8.938KCr	

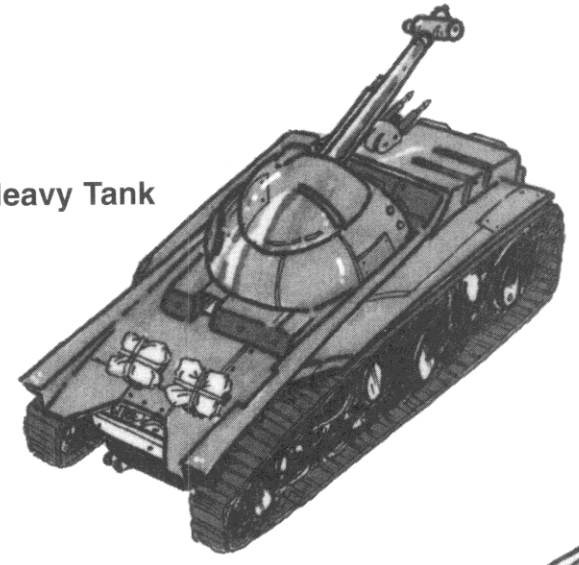
Performance(loaded): acceleration .3G, top speed 405m/turn (242kph), maximum range 1215km
(driver only): acceleration .3G, top speed 501m/turn (301kph), maximum range 1503km
Agility: +1DM to be hit
Description: A capable road machine, responsible for numerous fatalities on the limited-access high speed roads that link major metropolitan areas. Very few riders are bold enough to take these machines to the limits of their performance.



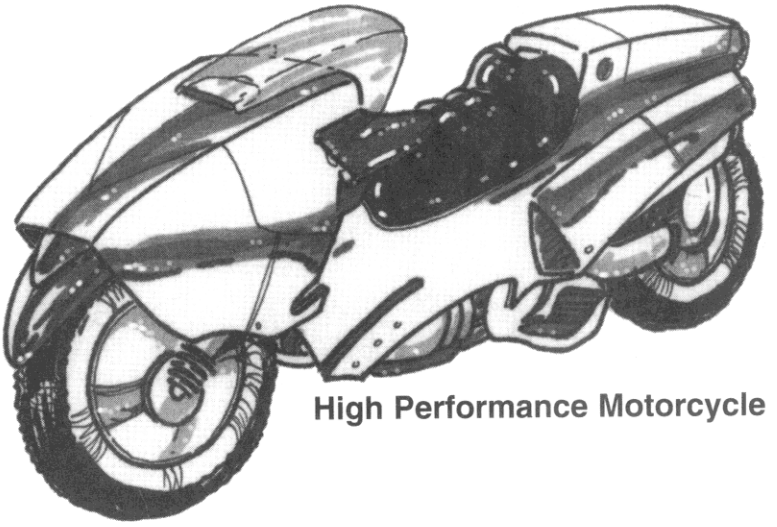
Grav Tank



Grav Truck



Heavy Tank



High Performance Motorcycle

Motorcycle, Off-Road, TL7

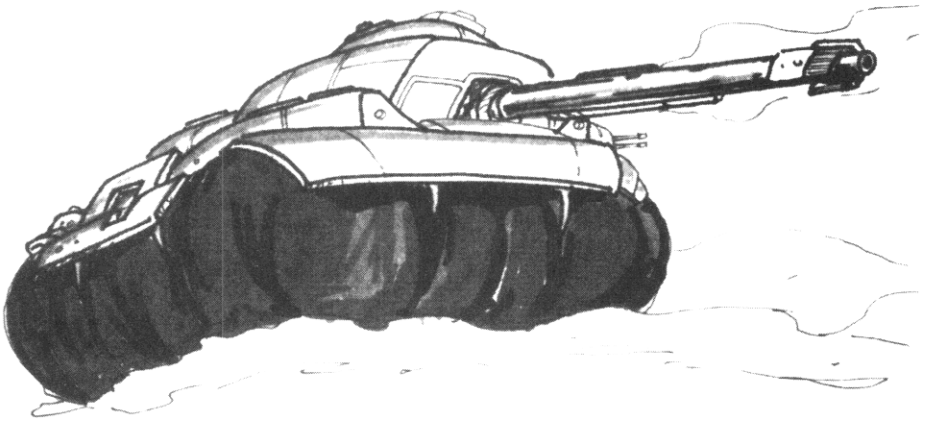
Displacement: .05 (USP5)	Volume	Mass	Area	Cost
Volume:	1.400m3	-	-	-
Configuration: Disk	-	-	7.32m2	-
Dimensions: 2.1m long x 2.1m high x .42m wide (approximate)				
Structural material: Soft steel				
Chassis: 1g rated	.018m3	.146t	-	.403KCr
Armor: .3cm TL6 fiber laminate				
Armor rating: 1 on front only (structure is 2)	.002m3	.002t	-	.066KCr
Power plant: TL5 Improved internal combustion, .02Mw	.050m3	.050t	.050m2	.400KCr
Fuel consumption: .25m3 per 100 hours				
Fuel volume: x1 (high grade hydrocarbons)				
Fuel carried: 4 hours	.010m3	.010t	-	.005KCr
Propulsion: TL7 Wheels (x.6 speed multiple)	.028m3	.028t	.168m2	.840KCr
Adverse condition propulsion (off-road)	.006m3	.006t	.034m2	.168KCr
Crew: 1 Driver, front protection only	.300m3	.100t	-	-
Options: Passenger seat (behind driver)	.200m3	.100t	-	-
Cargo panniers (2 at .1m3 each)	.200m3	.100t	-	-
Total	.814m3	.542t	.252m2	1.882KCr

Performance(loaded): acceleration .1G, top speed 67m/turn (40kph), maximum range 161km
(driver only): acceleration .2G, top speed 106m/turn (64kph), maximum range 254km
Agility: +1DM to be hit
Description: A low-tech recreational vehicle for off-road or wilderness use. The design is commonly available on TL7-9 worlds. Relatively short range, but economical to own and operate. May be used as a military recon vehicle on some worlds.

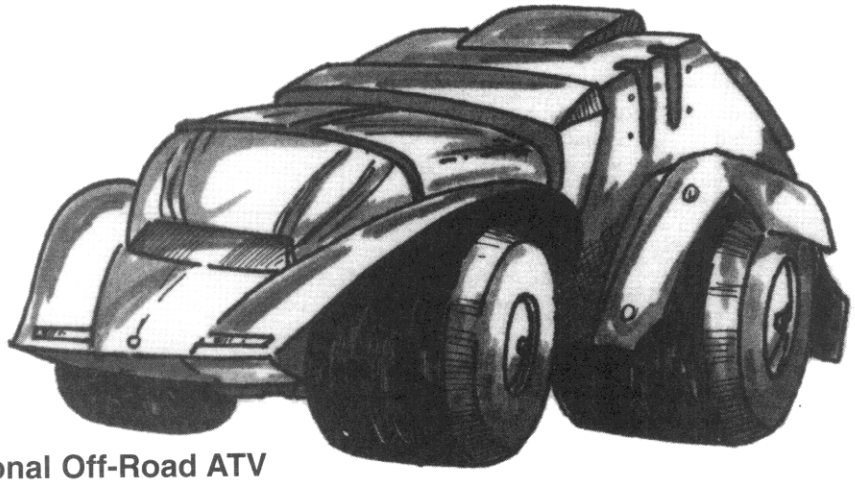
Off-Road Vehicle, Personal, TL11

Displacement: .2 (USP6)	Volume	Mass	Area	Cost
Volume:	2.800m3	-	-	-
Configuration: Box	-	-	11.52m2	-
Dimensions: 2.12m long x 1.11m high x 1.11m wide (approximate)				
Structural material: TL11 Structurecomp				
Chassis: 1g rated	.038m3	.038t	-	1.536KCr
Armor: 1cm TL11 Structurecomp				
Armor rating: 3 on all facings	.115m3	.115t	-	4.600KCr
Power plant: TL11 storage bank, .25Mw/hour power	.250m3	.500t	-	1.000KCr
Power plant duration: 5 hours				
Propulsion: TL8+ wheels, .050Mw (x.7 speed multiplier)	.050m3	.050t	.250m2	1.250KCr
Adverse condition propulsion system	.010m3	.010t	.050m2	.250KCr
Secondary propulsion system (special tires, floatation)	.010m3	.010t	.050m2	.250KCr
Crew: 1 Driver	1.000m3	.100t	-	-
Options: TL10 Sm. veh. subcont. range (300km) comm.	-	-	.001m2	.250KCr
TL10 Sub-regional range (10km) civ. radar	.010m3	.005t	.001m2	3.000KCr
Passenger seat	1.000m3	.100t	-	-
Cargo compartment	.300m3	.150t	-	-
Total:	2.783m3	1.078t	.352m2	12.136KCr

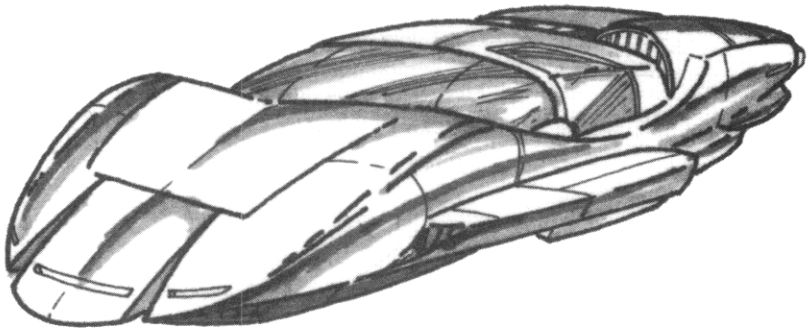
Performance(loaded): acceleration .2G, top speed 97m/turn (58kph), maximum range 291km
(driver only): acceleration .2G, top speed 127m/turn (76kph), maximum range 381km
Agility: +2DM to hit
Description: A fully enclosed but not environment-sealed 4-wheeled all-terrain vehicle. It has wide synthetic rubber tires for crossing soft terrain and to propel it through calm water. It has good ground clearance and is capable of normal operation in vacuum or non-oxygenated atmospheres. While not combat armored, its outer skin is tough enough to stop most environmental hazards. Prices of these vehicles will drop sharply after introduction of Fusion+ units, as the battery is neither commercially viable or necessary. Fusion+ units are lighter, have better cargo capacity and better overall performance. Many of the older units will be exported for resale off-world.



Hover Tank



Personal Off-Road ATV



Rolen Politesse

Patrol Boat, TL3

Displacement: 100.0 (USP8)	Volume	Mass	Area	Cost
Volume:	1400.0m3	-	-	-
Configuration: Cylinder	-	-	665.7m2	-
Dimensions: 27.76m long x 8.05m high x 8.05m wide (approximate)				
Structural material: TL1 Heavy wood				
Chassis: 1g rated	6.657m3	6.657t	-	.007MCr
Armor: 8.2cm TL1 heavy wood				
Armor rating: 2 on all facings	54.587m3	54.587t	-	.055MCr
Power plant: TL3 Early steam, 12.5Mw	125.000m3	250.000t	56.25m2	.250MCr
Fuel consumption: 125m3 per 100 hours				
Fuel volume: x.5 (coal)				
Fuel carried: 100 hours	62.500m3	125.000t	-	.006MCr
Propulsion: TL3 Water prop.,12.5Mw, x.08 spd mult.	8.75m3	8.750t	18.375m2	.744MCr
Crew: Captain	1.000m3	.100t	-	-
Secondary officers x 3	3.000m3	.300t	-	-
Crew x 12	12.000m3	1.200t	-	-
Options: Bunks x 14	28.000m3	-	-	-
Small stateroom x 3	84.000m3	-	-	.120MCr
Large stateroom x 1	56.000m3	-	-	.100MCr
Kitchen	4.000m3	.800t	-	.002MCr
Common area	40.000m3	-	-	-
Arms locker	4.000m3	2.000t	-	-
Cargo hold	100.000m3	50.000t	-	-
TL3 heavy deck gun (x2 volume), 3 crew	3.327m3	.654t	-	.018MCr
Reloads x 50	.900m3	1.8000t	-	.009MCr
TL3 light deck gun x 2 (x2 vol.), 4 crew	4.120m3	.240t	-	.008MCr
Reloads x 100	.400m3	.800t	-	.008MCr
Total:	598.241m3	502.88t	74.625m2	1.327MCr

Performance(loaded): acceleration .03G, top speed 14m/turn (9kph), maximum range 840km
Agility: +4DM to be hit
Description: A small primitive warship designed to patrol coastal or riverine areas, usually against more primitive opposition. The cannon are formidable against targets of similar tech levels, including itself if fired on by a similar vessel. The crude external combustion engine is noisy, smoky and prone to malfunctions, and lacks the power required to give the vessel the armor it needs, but allows it to operate against the wind or in a lack of wind, a significant maneuvering advantage vs. contemporary sail vessels.

Rolen Politesse, TL12

Displacement: 1.0 (USP7)	Volume	Mass	Area	Cost
Volume:	14.000m3	-	-	-
Configuration: Box streamlined	-	-	33.72m2	-
Dimensions: 3.75m long x 1.95m high x 1.95m wide (approximate)				
Structural material: TL11 Structurecomp				
Chassis: 10g rated	1.124m3	1.124t	-	26.976KCr
Armor: 2.4cm TL11 Structurecomp				
Armor rating: 4 on all facings	.809m3	.809t	-	32.371KCr
Power plant: TL12 Fusion+, 1.2Mw	.250m3	.500t	2.400m2	2.500KCr
Fuel consumption: .0375m3 per 100 hours				
Fuel volume: x1 (enriched water)				
Fuel carried: 400 hours	.150m3	.150t	-	1.050KCr
Power plant: TL12 storage bank, .042Mw/hr	.028m3	.056t	-	.140KCr
Propulsion: TL12+ contragrav, 60 tons thrust (.42Mw)	1.200m3	.780t	1.200m2	12.000KCr
Crew: 1 Pilot, roomy seating	2.000m3	.100t	-	-
3 Passengers, roomy seating	6.000m3	.300t	-	-
Options: Gravity comp. on 6m3 (crew+cargo), 6G (requires .60Mw at full output)	.864m3	1.728t	-	43.200KCr
Basic life support (crew compartment)	.004m3	.004t	-	.280KCr
Fire suppression system	.014m3	.007t	-	.700KCr
TL12 civilian continent range comm.	-	-	.001m2	2.500KCr
TL12 regional range radar	.010m3	.020t	.010m2	8.000KCr
Roadgrid system	.014m3	.007t	-	1.400KCr
Emergency wall patch	.001m3	.005t	-	.050KCr
Cargo compartment	.500m3	.250t	-	-
Total	12.968m3	5.840t	3.611m2	131.167KCr

Performance(loaded): acceleration after gravity 9.3G, top speed 1113m/turn (668kph), max range 445,200km
(pilot only): acceleration after gravity 10G, top speed 1241m/turn (745kph), max range 496,400km
Agility: -6DM to be hit (-3DM at limits of internal gravity compensation)
Description: A luxury grav car with all the options you want to put in it (designed with the new vehicle rules). The low-end model has much less thrust and only 3G of gravity compensation, but is built on the same chassis and uses the same power plant.

Tank, Heavy, TL5

Displacement: 2.0 (USP7)	Volume	Mass	Area	Cost
Volume:	28.0m3	-	-	-
Configuration: Box	-	-	53.40m2	-
Dimensions: 4.63m long x 2.41m high x 2.41m wide (approximate)				
Structural material: TL5 Hard steel				
Chassis: 1g rated	.089m3	.712t	-	2.000KCr
Armor: 1.7cm TL5 Hard steel	.908m3	7.262t	-	1.800KCr
Armor rating: 7 on all,18 front(+1.399m3),12 sides/rear(+1.388m3)	2.787m3	22.296t	-	55.700KCr
Power plant: TL5 Imp. internal comb., .800Mw x 2	4.000m3	4.000t	4.000m2	38.000KCr
Fuel consumption: 20.0m3 per 100 hours				
Fuel volume: x1 (high grade hydrocarbons)				
Fuel carried: 20 hours	4.000m3	4.000t	-	2.000KCr
Propulsion: TL5 tracks, 1.6Mw (x.4 speed multiplier)	5.760m3	5.760t	22.400m2	806.000KCr
Adverse condition propulsion system (off-road)	1.152m3	1.152t	4.480m2	161.200KCr
Crew: 1 Driver	1.000m3	.1000t	-	-
1 Weapon loader (turret)	1.000m3	.1000t	-	-
1 Observer (turret)	1.000m3	.1000t	-	-
1 Gunner (turret)	1.000m3	.1000t	-	-
Options: TL5 Fire control system (+2DM on cannon)	-	-	-	20.000KCr
Heavy cannon-5 in turret	1.340m3	1.340t	-	50.000KCr
(x4 volume, but only 1/2 weapon in turret)				
Medium machinegun-5 in turret (x4 volume)	.018m3	.009t	-	.500KCr
Medium machinegun-5 in fixed mount	.007m3	.009t	-	.500KCr
Heavy cannon ammunition x 50	2.00m3	4.000t	-	25.000KCr
Medium machinegun reloads x 5	.008m3	.015t	-	.250KCr
TL5 regional range (30km) comm.	.100m3	.200t	-	2.500KCr
Cargo racks	1.500m3	.500t	-	-
Roof hatch x 2 (observer & driver)	-	-	1.000m2	1.400KCr
Total:	27.667m3	51.646t	31.88m2	1.167MCr

Performance(loaded): acceleration .1G, top speed 71m/turn (43kph), maximum range 852km
(crew only): acceleration .1G, top speed 77m/turn (46kph), maximum range 924km
Agility: +3DM to hit
Description: A heavy assault vehicle, designed to engage infantry and armored units, moving from firing position to firing position. Heavily armed, but not as heavily armored, it relies on avoiding being hit. Due to lack of sensor equipment, it is unable to operate effectively at night or in obscured conditions. Note that its TL5 fire control system is incapable of operation while the vehicle is moving.

Truck, 5-Ton, TL7

Displacement: 1.0 (USP6)	Volume	Mass	Area	Cost
Volume:	14.0m3	-	-	-
Configuration: Box	-	-	33.72m2	-
Dimensions: 3.75m long x 1.95m high x 1.95m wide (approximate)				
Structural material: TL3 Soft steel				
Chassis: 1g rated	.084m3	.674t	-	.540KCr
Armor: .3cm TL3 soft steel				
Armor rating: 2 on all facings	.101m3	.809t	-	1.616KCr
Power plant: TL5 Internal combustion, .20Mw	.500m3	.500t	.500m2	4.000KCr
Fuel consumption: 2.50m3 per 100 hours				
Fuel volume: x1 (improved hydrocarbons)				
Fuel carried: 10 hours	.250m3	.250t	-	.125KCr
Propulsion: TL7 Wheels, .20Mw, x.6 speed mult.	.360m3	.360t	2.88m2	12.600KCr
Adverse condition propulsion system (six-wheel drive)	.036m3	.036t	.288m2	1.260KCr
Crew: 1 Driver	1.000m3	.100t	-	-
1 passenger	1.000m3	.100t	-	-
Options: Cargo hold	10.000m3	5.000t	-	-
TL7 Small vehicle regional comm.	.001m3	.002t	-	.125KCr
Total:	13.332m3	7.831t	3.668m2	20.266KCr

Performance(loaded): acceleration .1G, top speed 46m/turn (28kph), maximum range 276km
(driver only): acceleration .1G, top speed 132m/turn (79kph), maximum range 791km
Agility: +2DM to be hit
Description: A no-frills transport commonly used by low-tech military forces for logistics purposes. Designed for road use, but capable of limited off-road or unimproved road use. Body panels on the cargo area can be removed for carrying of oversized loads.

Vehicle Worksheet

Basic Vehicle Information

Vehicle Type: _____ Tech Level: _____
Displacement: USP Size: ___ Volume: ___m3
Hull Factor: _____ Surface Area: ____m2 Diameter: ___m
Configuration: Length Factor: x___ Width Factor: x___ Depth Factor: x___
Length: _____m Width: _____m Depth: _____m
Structure Factor: x_____ Surface Factor: x_____ Price Factor: x_____
Maximum Acceleration: _____g
Structure Material: _____ Base Toughness: ____ Density: ____ Price per m3: _____Cr
Structure Volume: Acceleration x Structure Factor x Hull Factor / Base Toughness of Struct. Matl = _____m3
Structure Mass: Structure Volume x Density = _____ tons
Armor Rating: Base Toughness of Armor Material x Thickness Multiplier = _____
Armor Volume: Surface Area x Surface Factor x Thickness in cm / 100 = _____m3
Individual Facing Area: Front: Surface Area x Surface Factor x .10 = _____m2
Rear: Surface Area x Surface Factor x .10 = _____m2
Right: Surface Area x Surface Factor x .15 = _____m2
Left: Surface Area x Surface Factor x .15 = _____m2
Top: Surface Area x Surface Factor x .25 = _____m2
Bottom: Surface Area x Surface Factor x .25 = _____m2
Armor Slope Effect: Moderate slope, per facing: Actual Thickness x 1.5
Front, Rear, Right, Left -10% Volume
Radical slope, per facing Actual Thickness x 2.0
-20% Volume
Airframe Area (lift vehicles only): (Surface Area x Surface Factor of Airframe Configuration) -
(Surface Area x Surface Factor of Streamlined Configuration) = _____m2

Power Plant

Tech Level: _____ Type: _____ Power per m3: _____Mw Mass per m3: _____tons
Cost per m3: _____MCr Area per m3: _____m2 Fuel per 100 Hours per m3: _____m3
Power Plant Mass: _____tons
Total Output: _____Mw
Power Plant Volume: _____m3
Power Plant Area: _____m2
Power Plant Cost: _____MCr
Base Fuel Capacity: _____m3 Duration of Fuel Capacity: _____ hours
Fuel Volume Multiplier: _____
Fuel Tankage: Fuel Volume Multiplier x Base Fuel Capacity = _____m3

Propulsion

Tech Level: _____ Type: _____ Cost per m3: _____MCr Volume per Mw: _____m3 Speed: x_____
Area per Mw: _____m2
Volume: Total Power Plant Output x Volume per Mw = _____m3
Cost: Volume x Cost per m3 = _____MCr
Vehicle Speed per Turn: Total Power Plant Output/Total Vehicle Mass x 3000 = _____ meters per turn
Acceleration: Square Root of (Total Power Plant Output/Total Vehicle Mass), round to nearest .1 = _____g
Takeoff Speed (lift vehicles only): (Total Vehicle Mass/Airframe Area) x 40 = _____ meters per turn

Weapons

Tech Level: _____ Weapon: _____ Weapon System Volume: _____m3
Weapon System Mass: _____tons Weapon System Cost: _____MCr
Turret Multiple: TL6 = 4 Limited Traverse: +1 effective TL
TL7 = 3
TL8 = 2
TL9+ = 1.5
Internal Weapon Space: Protected Weapon Volume x Turret Multiple = _____m3
Ammunition Space: Volume per Round x Number of Rounds = _____m3

Crew Stations

Driver: 1m3 Outside Driver: .2m3 with Front Protection: .3m3 with Front and Side Protection: .7m3
Passenger: 1m3 Outside Passenger: As for driver
Crew and Passenger Mass: .1 to .2 tons each

Grav compensation

Tech Level: _____ Volume per g per m3 Protected: ______m3 Maximum Compensation: Tech Level-9
Mass per m3: _2 tons_
Power per m3: _.70Mw_
Cost per m3: _.05MCr_
Volume Protected: _______m3
Acceleration Compensated: _____g
Excess Compensation Factor: (Acceleration Compensated - Max. Compensation), cubed (min. of 1)=x_____
Volume Req.: Volume Protected x Volume per g per m3 x Acceleration x Excess Compensation Factor = _____m3
Power Required: Volume x Power per m3 = _____Mw
Cost: Volume x Cost per m3: ______MCr

Sensors

Tech Level: _____ Type (active/passive): _____________ Range: ___________ Power Req.: _________Mw
Volume: _______m3 Area: Power Requirement x 10 = ______m2 Base Cost: ______MCr

Options:

Dispersed Sensor Array:	Area x 10 = ______m2	
Radar (active):	Area x 1 = ______m2	Cost x 1 = ______MCr
Lidar (active):	Area x .1 = ______m2	Cost x 2 = ______MCr
Sonar (active):	Area x 1 = ______m2	Cost x .5 = ______MCr
Nuclear (passive):	Area x 1 = ______m2	Cost x 10 = ______MCr
Gravitic (passive):	Area x .1 = ______m2	Cost x 5 = ______MCr
Optical (passive):	Area x .1 = ______m2	Cost x 2 = ______MCr

Communicators

Tech Level: _____ Type: _____________ Range: ___________ Power Req.: _________Mw
Volume: _______m3 Area: Power Requirement x 10 = ______m2 Base Cost: ______MCr

Options:

Directional Antenna:	.1MCr x volume = _____MCr
Direction Finder:	.1MCr x volume = _____MCr
Military Quality	(Base Cost + Options) x 10 = ______MCr

Other

Item: _____________	Tech Level: _____	Mass: ______tons	Volume: ______m3	Cost: ______MCr
Item: _____________	Tech Level: _____	Mass: ______tons	Volume: ______m3	Cost: ______MCr
Item: _____________	Tech Level: _____	Mass: ______tons	Volume: ______m3	Cost: ______MCr
Item: _____________	Tech Level: _____	Mass: ______tons	Volume: ______m3	Cost: ______MCr
Item: _____________	Tech Level: _____	Mass: ______tons	Volume: ______m3	Cost: ______MCr
Item: _____________	Tech Level: _____	Mass: ______tons	Volume: ______m3	Cost: ______MCr
Item: _____________	Tech Level: _____	Mass: ______tons	Volume: ______m3	Cost: ______MCr
Item: _____________	Tech Level: _____	Mass: ______tons	Volume: ______m3	Cost: ______MCr

Notes

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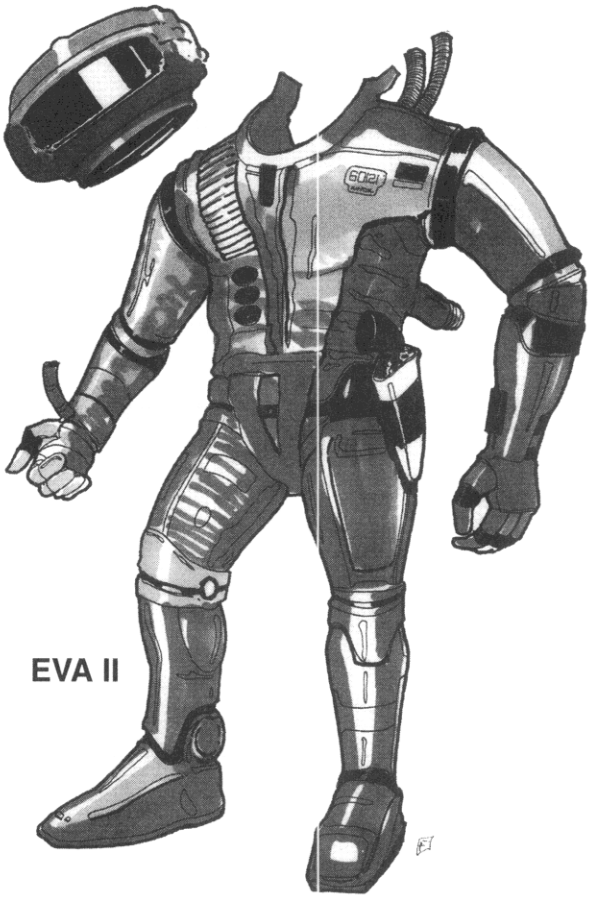
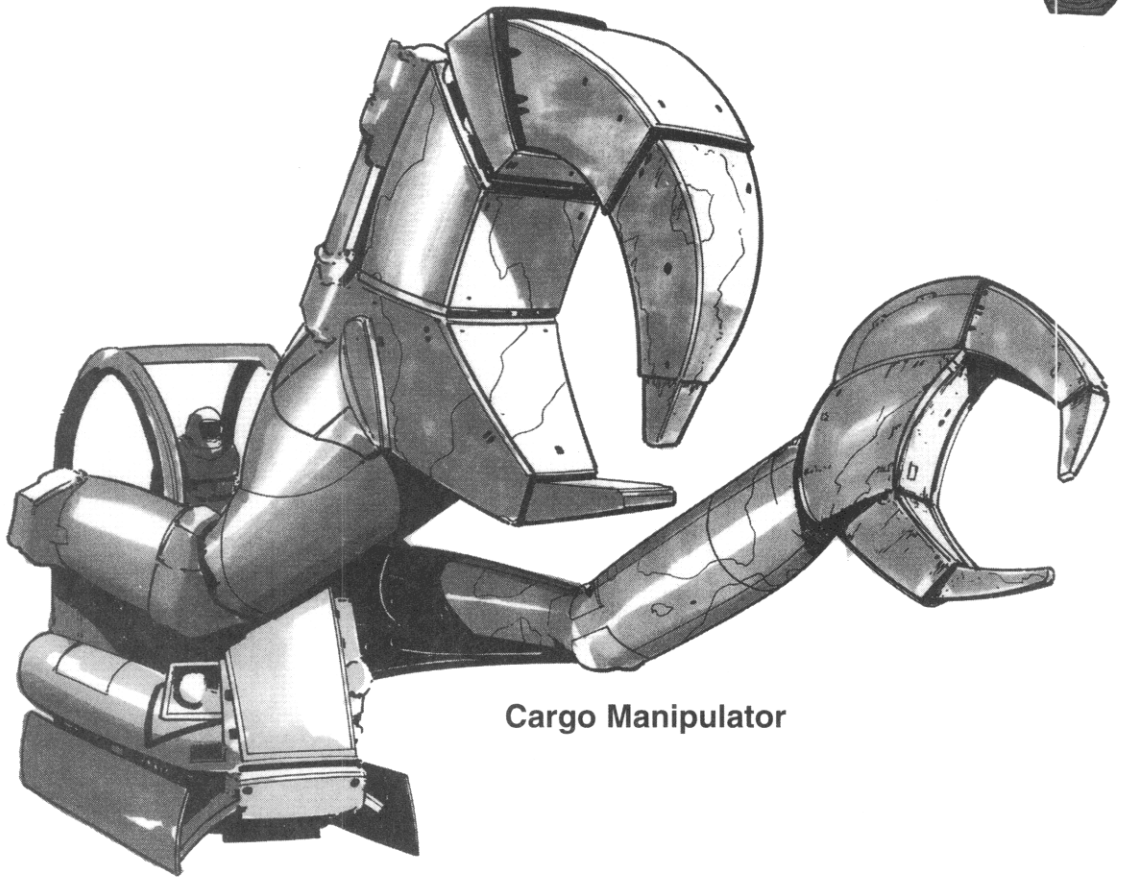
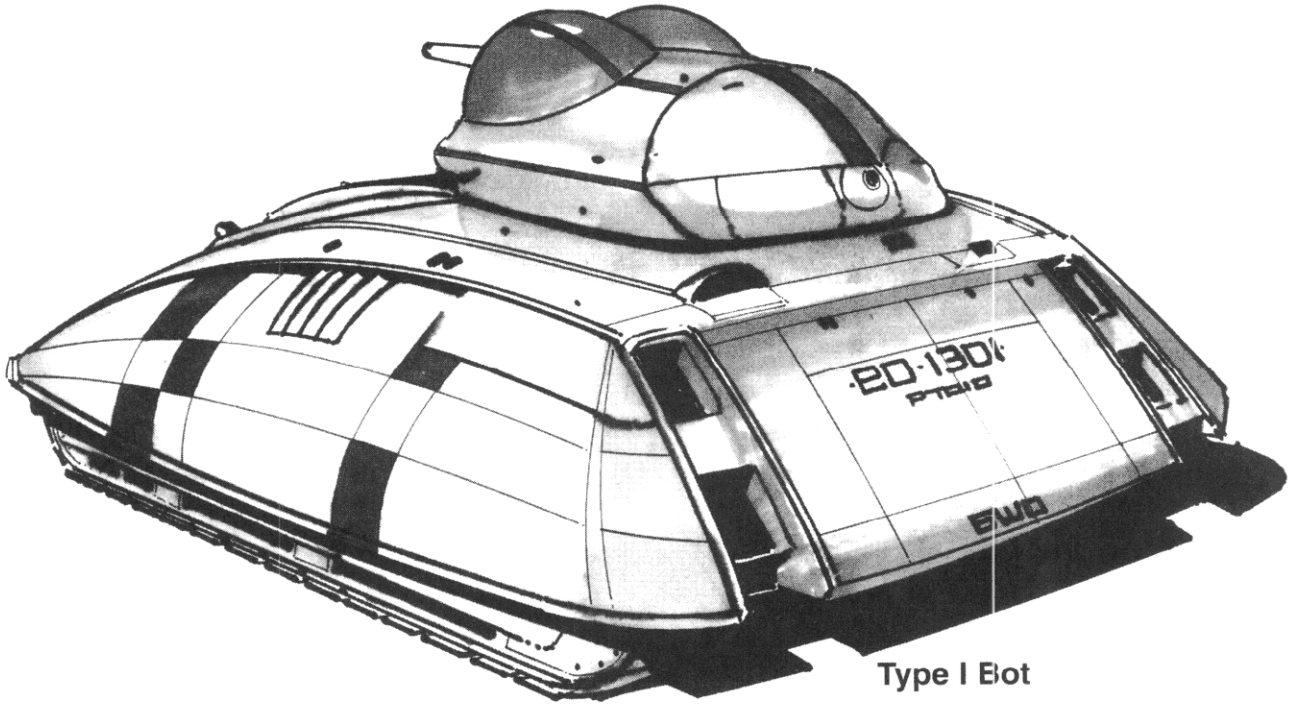
"Amaze The Natives" Kit



EVA II

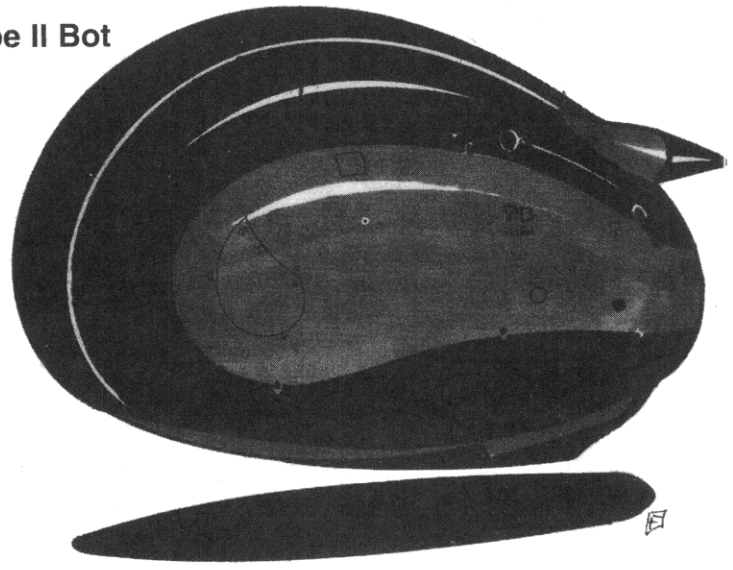


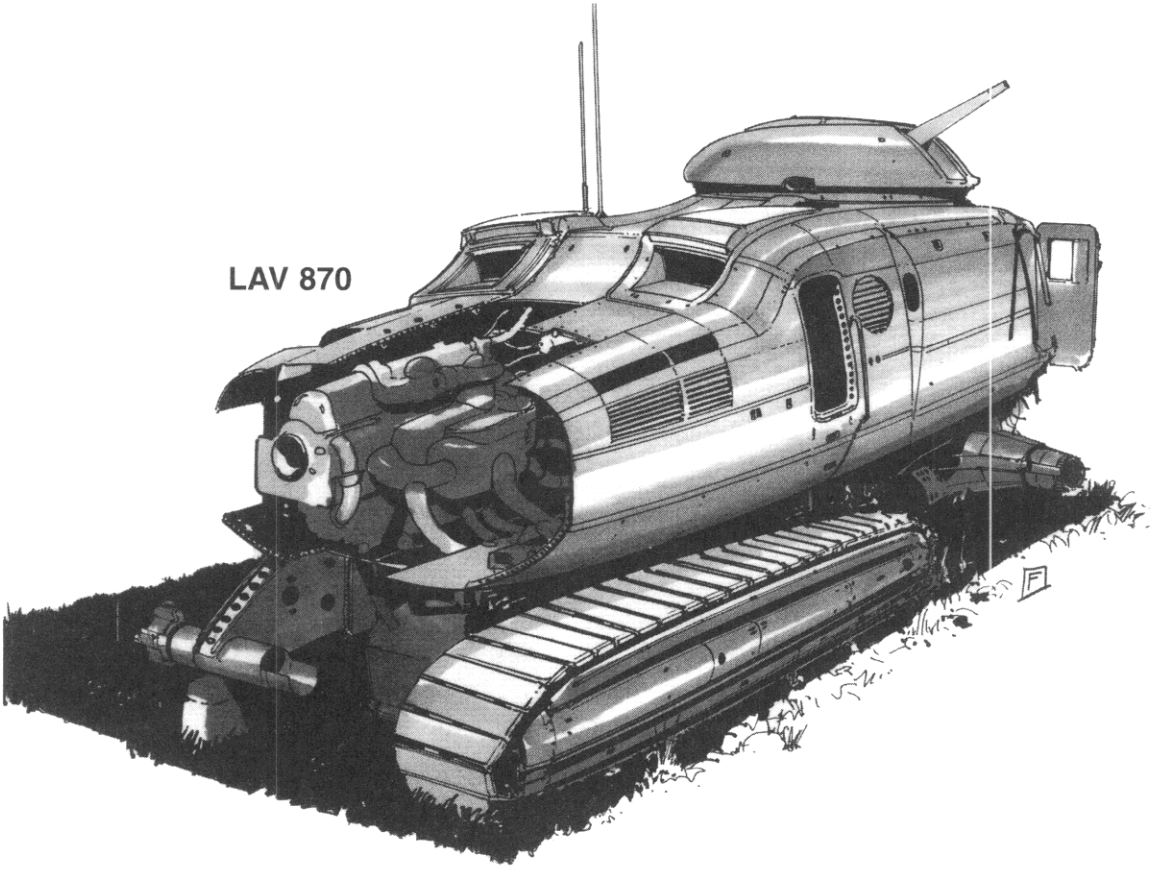
Cargo Manipulator



Type I Bot

Type II Bot





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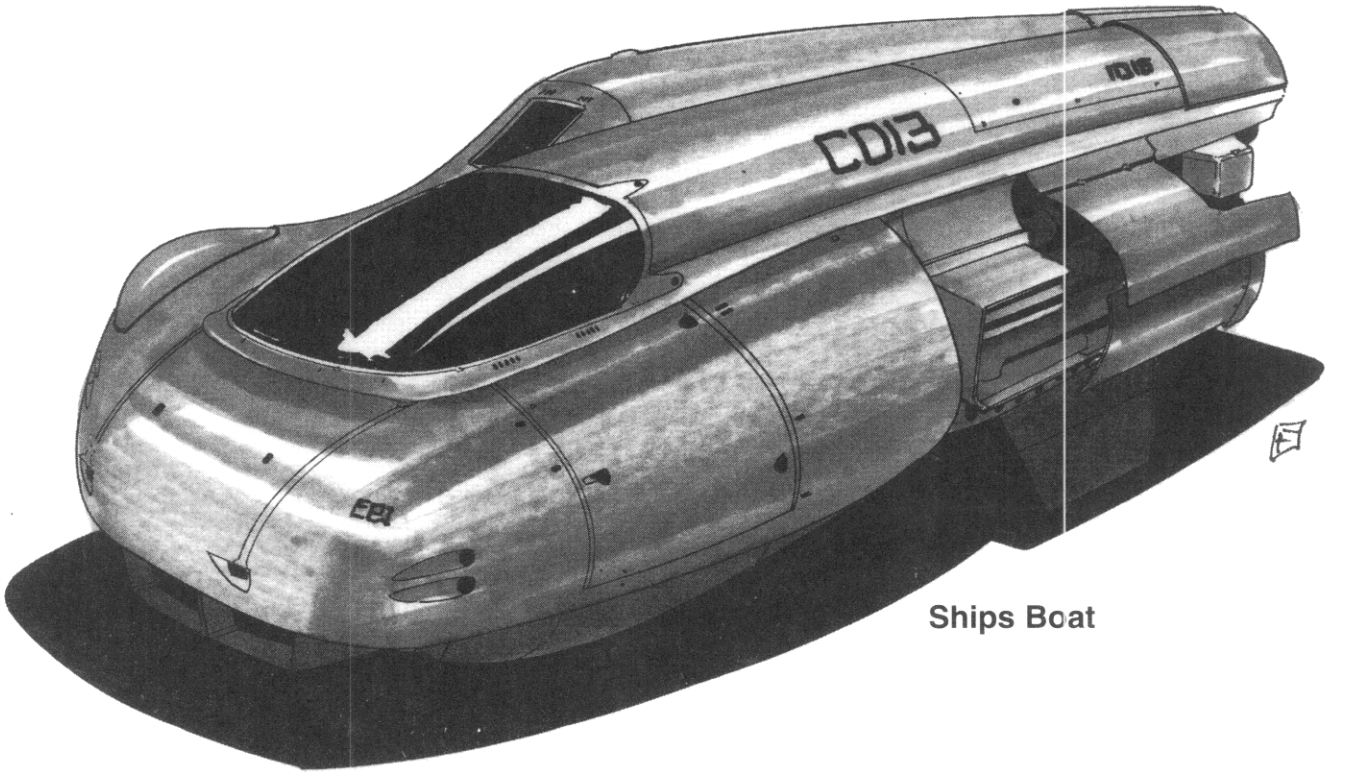
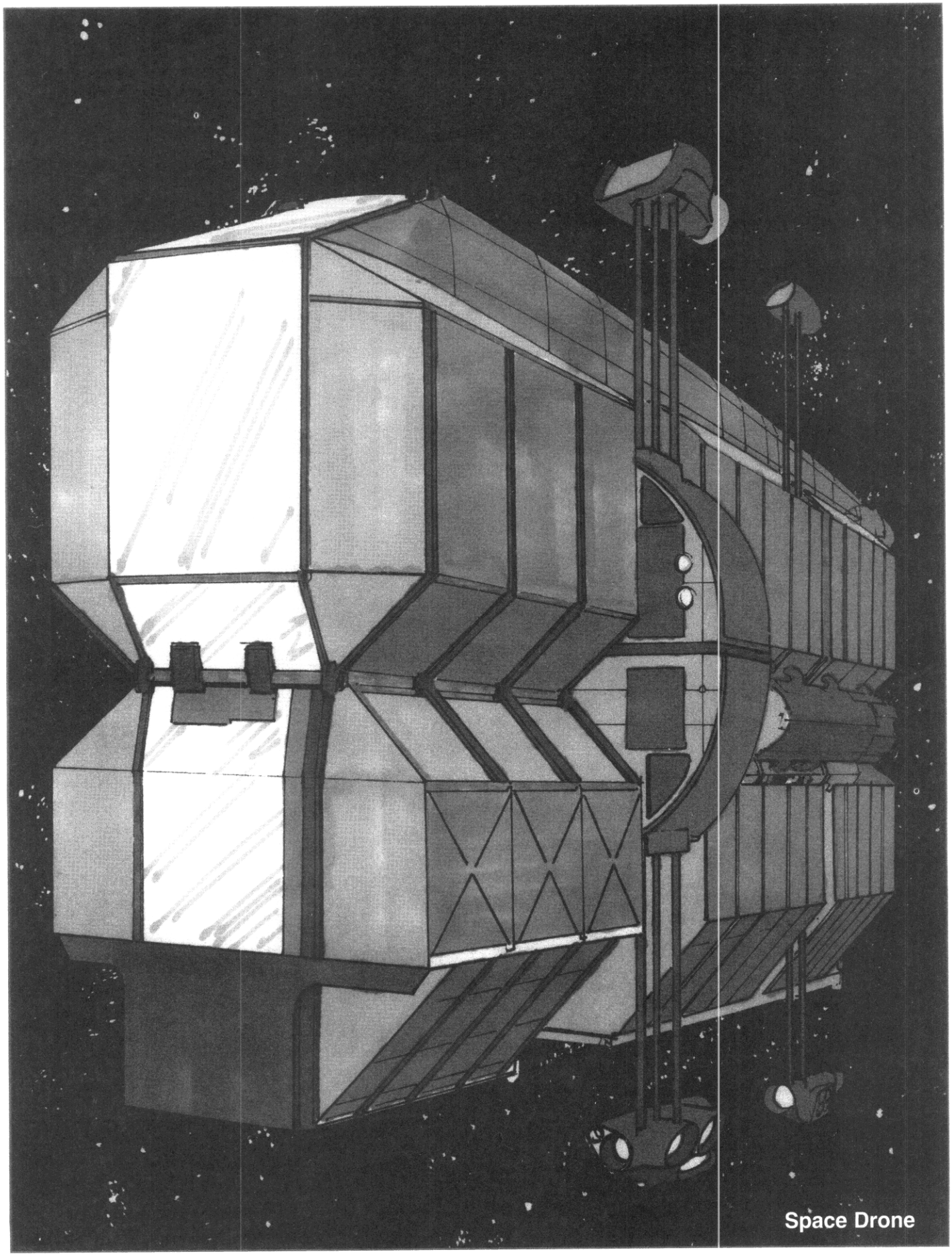


Ships Boat



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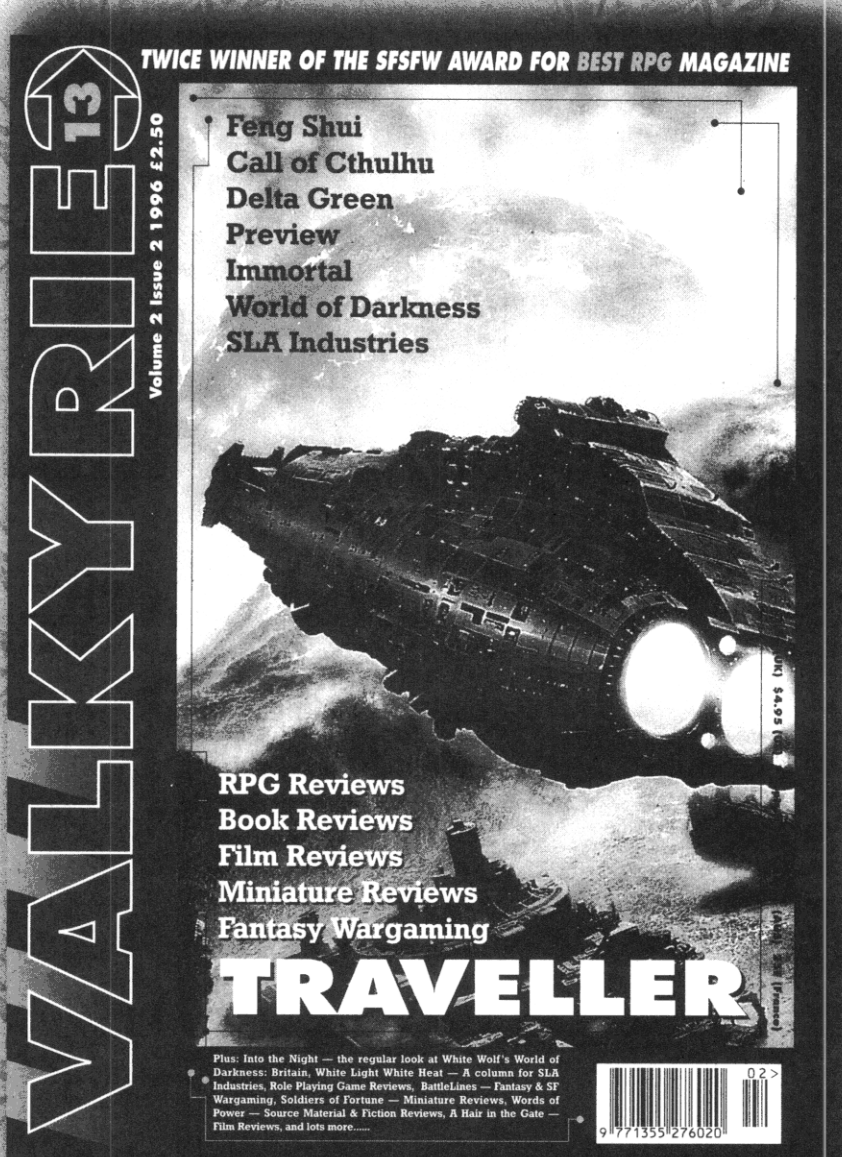

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