2300AD

AEROSPACE ENGINEERS' HANDBOOK

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HUMANITY DISCOVERS THE STARS

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INTRODUCTION

Aerospace Engineering is the art and science of designing spacecraft and starships. This practice encompasses a range of craft from sleek surface-to-orbit craft to lumbering bulk carriers, and the aerospace engineer is key to their design.

This book is based on *High Guard* but uses different technological assumptions, focusing on a narrower range of vessels, from approximately TL10–TL12 and up to a maximum of 10,000 tons. Most starships in *2300AD* are comparatively small, with the majority under 1,000 tons. Few exceed 5,000 tons.

2300AD

The nations of the human sphere are still badly divided, even with the threat of the alien Kaefers looming at the far end of the French Arm. At least 25 nations maintain fleets of starships, from merchant hauliers and warships to fighters and interface craft. Only a few countries can afford the vast investment needed to field fleets of advanced warships. At the forefront of human spacecraft design is France, with the largest military and merchant fleets. France has more starships, either military or commercial, than any three other nations combined. Trailing France is Manchuria, rebuilding after the losses of the Central Asian War, then a reunited Germany and Britain. Rounding off the top five is the United States, coming off a significant re-armament programme with a force of fast and effective drone-armed craft. This fleet's expense precludes deployment in large numbers but could herald a new space combat paradigm.

Facing the human fleets are the forces of the Kaefers, an alien race that seemingly lives for war. Their tactics in the battles for Aurore indicate long experience with space warfare and their ships consistently out-performed the human fleets arrayed against them. The true extent of Kaefer forces that could attack from beyond Arcturus is unknown but human military planners take the alien threat seriously.

TECHNOLOGY

The critical difference between *2300AD* and the Charted Space universe is the Jerome-effect stutterwarp, a macro-scale implementation of quantum-scale electron tunnelling. In effect, a stutterwarp ship makes hundreds of short, very-nearly instantaneous jumps every second. Jumps vary in length from a few metres to kilometres, depending on local space-time conditions. A ship in stutterwarp is effectively travelling faster than light while still in the 'real' universe. Stutterwarp drives can be used anywhere from high orbit above a planet to the gulfs between stars.

No Gravity-Control

The lack of gravity-control technology has two key effects in the *2300AD* universe.

Space stations and spacecraft must rotate large sections of their hulls to provide sufficient gravity for crew and passengers. This artificial gravity is subtly-different from real gravity and can have adverse effects, especially in small-diameter habitats.

Spacecraft require reaction drives to reach orbit and manoeuvre in planetary gravity wells. The reactionless thrusters and anti-gravity lifters of other universes do not exist in *2300AD*. Due to this, the most challenging portion of star travel is making it to orbit. Once in orbit, a Traveller is half-way to *anywhere*.

Reaction Drives

Rockets and thrusters are the principle methods of attaining orbit, although other technologies bear mentioning. Reaction drives are required to lift spacecraft from planetary gravity and manoeuvre within the stutterwarp Wall, a region where the stutterwarp drive's efficiency effectively drops to zero. Rockets and thrusters both require large quantities of fuel to achieve orbit, a fundamental design limitation for interface craft.

On some worlds, a heavily laden vessel requires boosters to lift it to orbit (see Advanced Options, page 59). Conversely, the efficiency of stutterwarp means that in-system reaction drives are not required and travelling to other planets in the system is a relatively simple matter.

Heat

The vacuum of space is a near-perfect insulator and heat build-up is a fundamental concern for spacecraft, especially military vessels. Starships and spacecraft are thus required to carry radiators to disperse this heat.

STARSHIP CONSTRUCTION

Starship construction in the 24th Century is an incredibly complex and sophisticated industry. Construction takes place in a wide variety of locations; some vessels are built in large orbital yards, with components either constructed nearby or shipped up from a planet's surface. Others, particularly smaller ones, are built in planet-based facilities little different from those that assemble aircraft.

The limiting factor in the construction of new vessels is the rarity of an isotope of tantalum. This isotope, Ta-180m, is one of the rarest in the universe. Fortunately, a starship drive only requires a few grams.

When constructing a ship, builders follow two procedures: design and evaluation. Often a ship will need to be redesigned based on its assessment and how it fulfils its design goal. These two procedures are often on-going and continuous but will be treated separately for the design system.

UNITS: Size is measured in displacement tons, with one displacement ton being equal to 14 cubic metres. It is referred to as a ton in the text and is the basis of the design system. It is not the same as a ton of mass, which is equal to 1,000 kilograms.

In general terms, Power 1 is equal to 0.1 megawatts (MW). The design system uses Power throughout but equivalent megawatts are in each ship's description for flavour.

Mass is not directly considered in the design system but is roughly equal to displacement tonnage multiplied by 10, with the result in metric tons.

Tech Levels

Most technology in *2300AD* corresponds roughly to TL10–12, although electronics are more advanced, equal to TL13–15.

Construction Times

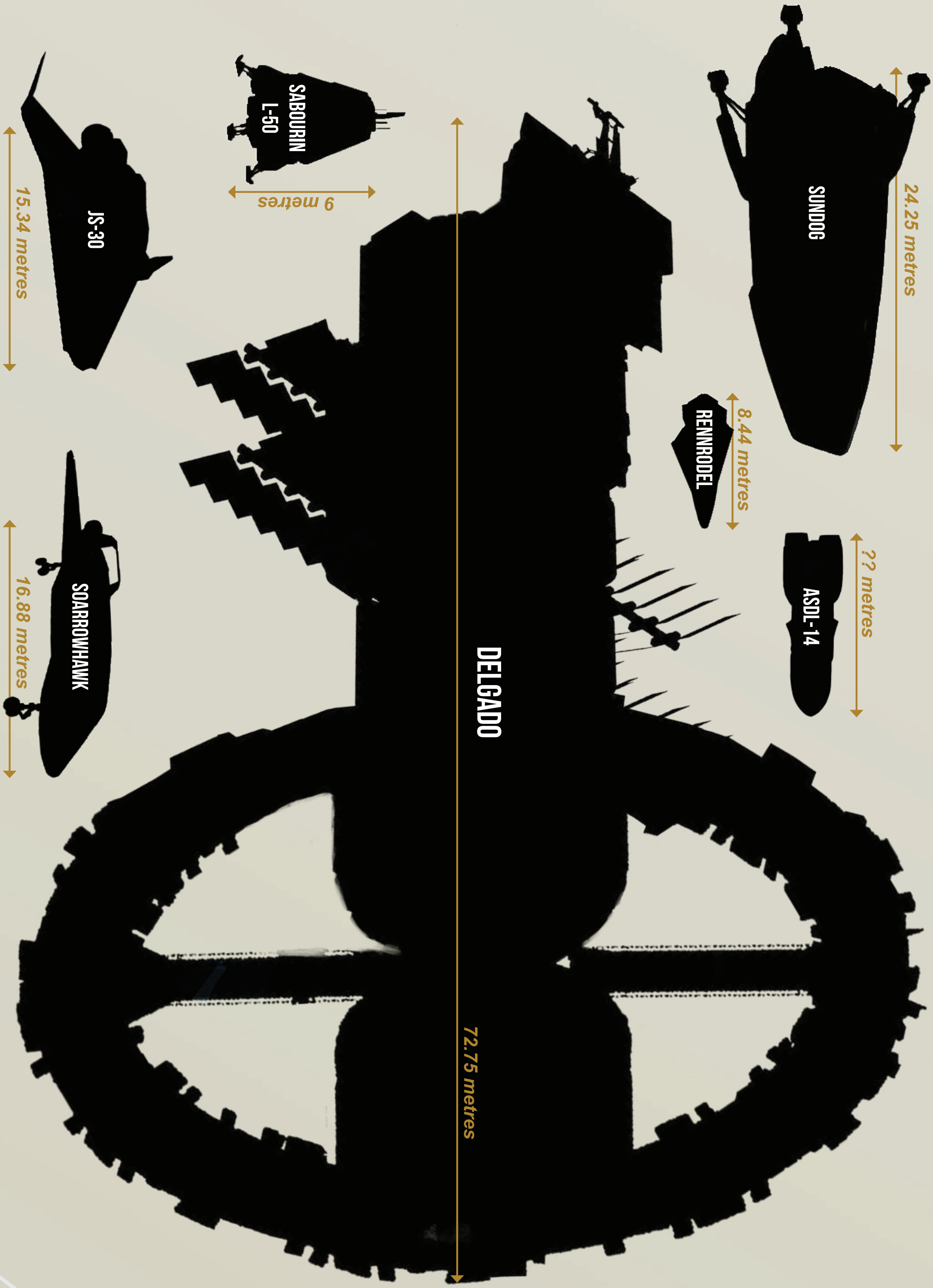
Construction times vary wildly, depending on the spacecraft's size and complexity and the shipyard's capabilities. On average, assume that it takes four days per million Livre to build a spacecraft at a small commercial shipyard, like Beowulf, Tirane, Beta Canum, Chengdu and Ellis. At the larger shipyards in the Core and Nibelungen, the construction rate is only two days per million Livre.

Standard Designs vs New Designs

A few commercial and light military ship designs have been used for decades and become standard across much of human space. Plans for such spacecraft are freely available and components can be purchased in bulk by shipyards, reducing the cost of the ship's construction by 10%. This reduced cost does not include ammunition for weapons or fuel, which must be bought – at full price – separately for the ship.

If a buyer needs a new type of ship, they must employ a specialised aerospace engineer to design it. The engineer's fees are an additional 1% of the final cost of the ship.

Tech Level	Frontier Availability	Core Availability
10	Commonly available on the Frontier	Tier 4 and 5 nations
11	Only available on High Tech worlds	Tier 3 Nations
12	Only available to Military, Government and TransNats	Tier 1 and 2 nations


SUNDOG
24.25 metres
RENNRODEL
8.44 metres
ASDL-14
?? metres
DELGADO
72.75 metres
SABOURIN L-50
9 metres
JS-30
15.34 metres
SOARROWHAWK
16.88 metres

Space Craft Size Comparisons

Starships are described by both purpose and class. The *Aconit* light patrol craft, for example, is also popularly classified as a frigate as it is a multi-purpose interface capable vessel. While it can undertake extended patrols, it needs a base nearby for refuelling. The *Tunghu* light patrol craft, although it has a similar purpose, reflects a very different design philosophy from the *Aconit*, being more of a specialised raider than proper multi-purpose ship.

Tons	Civilian Designation	Naval Term	Purpose
1	Drop Pod	—	Cargo Drops
5	—	—	—
10	Lifeboat	Gig	—
30	Boat	Light Fighter	Aerospace Fighter
40	—	—	—
50	Lighter	Longboat	—
70	—	Heavy Fighter	Gunboat
90	Longboat	—	—
95	Shuttle	—	—
100	Courier	Corvette	—
300	Light Freighter	Frigate	Light Patrol Vessel
600	Medium Freighter	Destroyer	Multirole Vessel
900	—	Cruiser	Heavy Patrol Vessel
2,000	Heavy Freighter	Battleship	—
3,000	—	—	Planetary Dominance Vessel
5,000	Bulk Carrier	Dreadnought	System Dominance Vessel
10,000	Colony Ark	—	—

Civilian vessels are designed to carry cargo and often passengers. Most are not capable of landing, instead relying on local interface transport to carry freight and passengers to and from a planet's surface. Some small vessels have surface-to-orbit capability but tend to be couriers or luxury vessels, thus justifying the high cost of interface operations. Some multirole military vessels in the 100–300-ton range are designed to land and may have a small contingent of ship's troop to provide groundside security and limited assault capability. However, the fuel and internal space costs of this reduce these vessels' overall combat effectiveness.

Military vessels are designed to fulfil a variety of roles, from combat to support. Small navies will have multi-purpose warships, capable of handling almost any task, while the larger navies will have more specialised vessels.

DESIGN EXAMPLES

Through the course of this book, design examples will be presented; the Jian-class fighter and the Kennedy-class Missile Carrier. The Jian is an interface-capable light fighter while the Kennedy is a large warship, classified as either a heavy patrol vessel or light cruiser, depending on the military tradition.

Ship Classification

All ships fall into two broad classifications determined at time of conceptualisation. If the ship is used for short-duration missions, typically 12 hours or less, it is considered a small ship. Fighters and landing craft usually fall under this heading. If a vessel is intended for long-duration missions, then it is regarded as a large ship. Most starships fall into this category, whether military or civilian. Note that the inclusion of a stutterwarp drive does not affect these classifications.

There is a third class of craft, the drone. The design of various types of drones, including combat drones, is dealt with in Appendix I.

The ship classification will indicate procedures to be used in the design sequence, primarily in the type of bridge and in accommodations and life support.

DESIGN CHECKLIST

1. **CREATE A HULL (PAGE 7)**
   a. Choose Hull Configuration (page 7)
   b. Choose Hull Material (Page 7)
   c. Install Armour (page 11)
   d. Install Hull Options (page 12)
2. **INSTALL REACTION DRIVES (PAGE 14)**
   a. Reaction Drive options
   b. Reaction Mass
3. **INSTALL STUTTERWARP (PAGE 17)**
   a. Stutterwarp options
4. **INSTALL POWER PLANT (PAGE 19)**, ensuring enough power for Stutterwarp, Reaction Drive (if applicable) and any Screens, Sensors and Weapons
5. **INSTALL RADIATORS**
6. **INSTALL FUEL TANKS (PAGE 23)**
7. **INSTALL BRIDGE (PAGE 25)**
8. **INSTALL COMPUTER AND ANY SOFTWARE (PAGE 26)**
9. **INSTALL SENSORS AND ELECTRONICS (PAGE 30)**
10. **INSTALL WEAPONS AND SCREENS (PAGE 34)**
11. **INSTALL DRONE BERTHS AND BAYS, AS APPROPRIATE (PAGE 35)**
12. **ADD SMALL CRAFT AND VEHICLES**, including lifeboats, support drones and satellites (page 37)
13. **DETERMINE CREW (PAGE 39)**
14. **INSTALL ACCOMMODATIONS (PAGE 43)** and other accommodation options
15. **INSTALL INTERNAL FITTINGS AND CREW AMENITIES (PAGE 45)**
16. **INSTALL ENGINEERING FITTINGS (PAGE 48)**
17. **INSTALL TROOP FITTINGS (PAGE 49)**
18. **ARTIFICIAL GRAVITY SYSTEMS (PAGE 50)**
19. **INSTALL EXTERNAL FITTINGS (PAGE 51)**
20. **INSTALL ADDITIONAL AIRLOCKS (PAGE 52)**
21. **ALLOCATE CARGO SPACE AND INSTALL SPECIAL CARGO HANDLING (PAGE 53)**
22. **FINALISE DESIGN (PAGE 54)**

STEP 1

CREATE A HULL

The first step in designing a ship is to build its hull – this is the ship's body or fuselage.

Decide on the total tonnage of the ship. A small scout might be 100–200 tons, while a fully armed cruiser might be in the region of 800–1,200 tons. Ship size will determine the ship's performance and, ultimately, limit what it can carry and achieve.

All large ships are equipped with a LaFarge radiation screen, which protects against charged particles at no additional cost. This screen protects the crew against up to 500 rads of radiation exposure but has no other effect. Extra shielding can be added.

Cost:	A basic hull costs Lv20000 per ton (MLv0.02 per ton).
Hull:	The ship will have one Hull point for every full 10 tons of hull or fraction thereof.

Hull Material

Hull materials are synthetic ceramic composites, incorporating ceramics, metals, plastics and quasi-ceramic materials in an elaborate sandwich. The resulting materials are exceptionally light and robust, and easy to produce in moulded shapes. They are not easy to fix after the fact, however, and patched hulls have nowhere near the originals' strength. In military service, damaged hull sections are typically replaced and recycled. Even a crystal steel hull is of very advanced construction, using magnetic fields in micro-gravity factories to create sheets of lightweight metal with their crystal structure aligned and intertwined for maximum strength and flexibility.

Hull material and armour material must be the same.

Hull Configuration

The configuration of a hull dictates its shape, which affects the capabilities and Signature of the ship. Some ships may be capable of entering atmospheres, for example, while others risk destruction if they try.

Hulls are broken down into unstreamlined and streamlined hulls. Unstreamlined hulls cannot enter an atmosphere under any circumstances. Streamlined hulls have varying degrees of atmospheric manoeuvrability.

The hull configuration chosen for a ship will often affect its cost as more complex engineering factors must be resolved before construction, as shown on the Hull Configuration tables. Once selected, hull configuration cannot be changed – it is not possible to retrofit a new hull configuration.

All human-made hulls are self-sealing. A self-sealing hull automatically repairs minor breaches such as micrometeoroid impacts and prevents hull hits causing explosive decompression. This is included in the cost of the hull.

Unstreamlined Hull Configuration

Configuration	Hull Points	Cost
Spaceframe	—	—
Dispersed	20%	-25%

Unstreamlined hulls are designed to operate in vacuum conditions only. If equipped with thrusters or rockets, they can land on airless worlds but cannot enter any Atmosphere with a code of 1+, including any gas giant.

SPACEFRAME

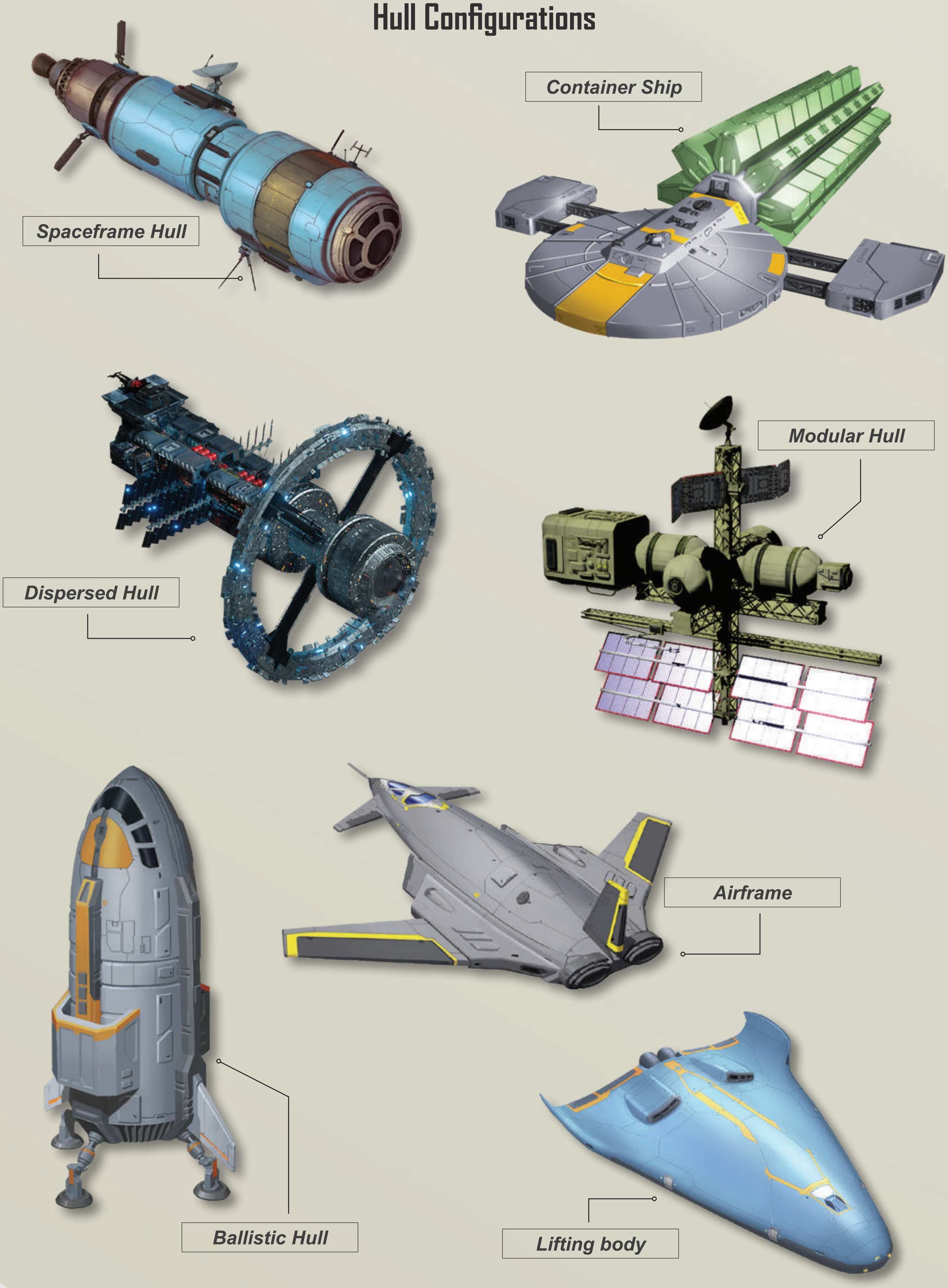
The most common hull form for unstreamlined hull ships is the spaceframe, the classic cylinder or slab-like hull. These hulls consist of joined box-like shapes or cylinders designed to produce a minimal front cross-section-and tend to be long and narrow. These hulls can use any spin configuration to provide artificial gravity. Spaceframes are oriented with their decks perpendicular to the axis of travel, like an office building.

Hull Material

Material	TL	Cost Multiplier	Max. Armour	Traits
Aligned Crystal Steel	10	1	TL-3	—
Synthetic	11	1.2	TL-1	Efficient, -2 to Reflected signature
Composite	12	1.5	TL+1	Tough

Cost Multiplier applies to the cost of the base hull only. Max. Armour is the maximum amount of armour for a hull of that material type.

Hull Configurations



DISTRIBUTED HULL

Distributed hulls are structurally-weaker than other hulls, they cannot land on anything larger than a Size S world and cannot be armoured. These Hulls have 20% fewer Hull points than normal. Distributed hulls cannot use the 'spun hull' or 'two-body' configurations for artificial gravity but may use other types. This type of hull is 25% cheaper than a standard hull. Distributed hulls are very common in commercial craft and are often used with the container ship option, on page 9.

MODULAR HULL

Starships and spacecraft can be designed with modular hulls, allowing installation of various mission modules including cargo holds, weapon pods, hangars and labs. Up to 75% of a ship's internal tonnage may be designated as modular space but may not include the bridge, power plant, drives or structural and armour options. The additional cost of a modular hull is equal to the modular tonnage, multiped by the hull material cost. This extra cost includes structural reinforcements, data links, power and life support connections and the modules' attachments rails. If the vessel has a distributed hull form, this cost is halved. Modules must be in place for the craft to operate properly, as they are part of the vessel's structural integrity. Running without modules in position reduces the Hull value by 50%, regardless of the number of modules missing. Interface craft can use modular hulls but cannot operate in an atmosphere or undergo re-entry without the module in place. Modules on interface craft must include heat shields.

TL	Cost
11	Hull material cost, per ton

Modules are designed as spacecraft, although they typically do not need a power supply.

TL	Tons	Cost
11	Any up to the amount designated on the parent	Design costs

For example, a 100-ton hull typically costs MLv2. If 30% of the ship's hull is modular, then the hull's cost increases to MLv2.6, or 130% of the original price. This means that 30 tons of the ship's components could easily be swapped out from mission-to-mission. When hauling passengers, the ship could install a module with six staterooms and six tons of cargo space (totalling 30 tons). The ship could also install a module with a standard laser mount and fighter hangar totalling 30 tons when going into combat.

Container Ships

Cargo ships of the first century of commercial starflight carried cargo internally, primarily to protect it from vacuum and radiation exposure. In particular, the earlier Generation I drives produced a great deal of hard radiation external to the hull due to how these early drives operated. The newer Generation II drives, in addition to being much faster, do not produce this radiation while they travel.

Generation II ships followed the same standards as earlier vessels for several decades until Maersk Solar Transport commissioned the first container ship, the *Terra Maersk*. This early design was relatively small, only capable of carrying 20 containers. Later models like the French Metal-class and vessels of the British BC-type would implement a more efficient container and handling system. Eventually, even Maersk adopted the French standard. Container ships are designed as distributed hulls; they are not modular.

Container ships consist of two primary sections. The first is the main body, which houses the engineering areas, crew, secondary cargo and most other functions. The other section is the cargo spine, which contains the clamps and connections for cargo pods. These connections provide power and life support as required but typically there is no access between spine and cargo. Some ships have a few clamps that contain accessways for pods that need it, however.

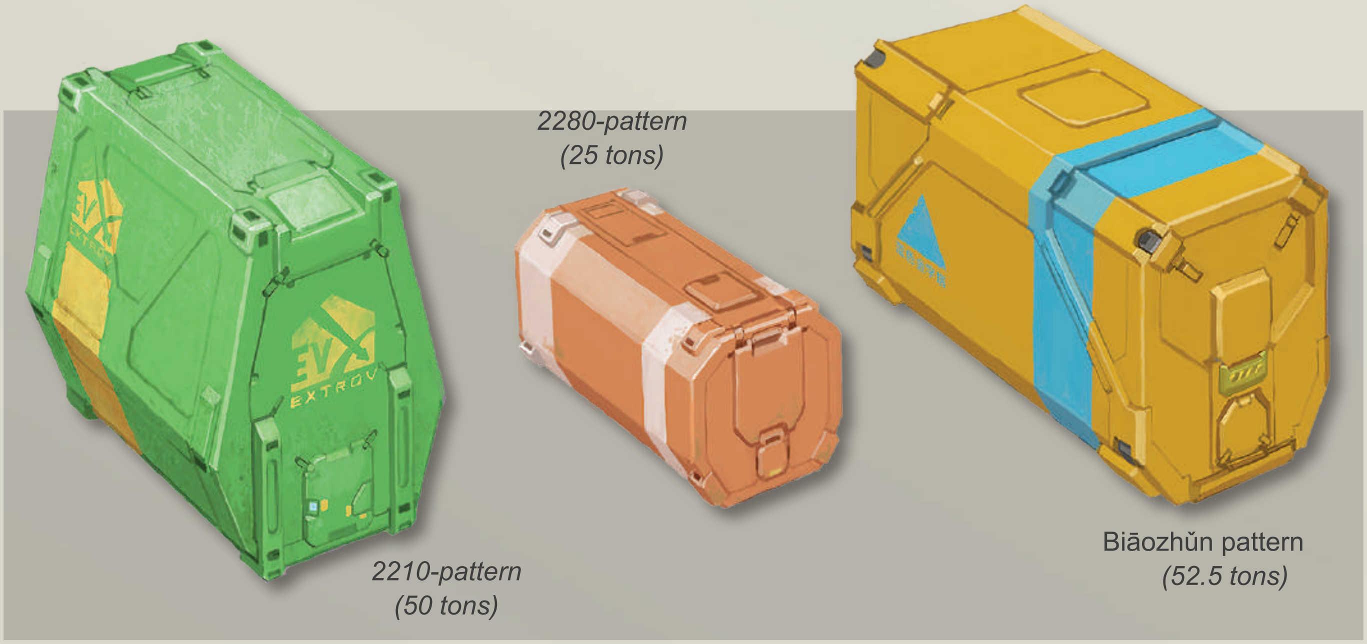
The structure of the spine is an accessway that connects to every pod and requires tonnage equal to 5% of the total storage of all pods. For example, 3,600 tons of pod capacity would require a spine that takes up 180 tons. This amount is added to the ship's main body and used to compute the ship's unloaded tonnage. This spine costs MLv0.05 per pod, which includes the necessary clamps and umbilicals.

CONTAINER TYPES

Container ships are built to handle the 50-ton French standard (2210-pattern) pod, the newer 25-ton ISO standard (2280 pattern), or the 52.5-ton Manchurian standard (Biāozhǔn pattern, or Type-B). Pods are not interchangeable; the Manchurian Type-B was specifically-designed to be incompatible with the French standard.

All three types are available in various configurations, including refrigerator (reefer), liquid storage, dry storage, live cargo and even as passenger carriers.

Pods cost Lv5000 per ton for a basic sealed container.



2280-pattern
(25 tons)

2210-pattern
(50 tons)

Biāozhǔn pattern
(52.5 tons)

Cargo Pod	Hull	Size	Cost
2210-Pattern	1	50	MLv0.25
2280-Pattern	0	25	MLv0.125
Type-B	1	52.5	MLv0.27

Cargo pods have a cargo capacity identical to their size. Cargo pods designed to carry liquids or gases are the same size but double the price.

Every 200 tons of carried pods, or fraction thereof, adds +1 to a ship's Signature.

Standard clamps provide power and life support to connected pods, if required, but do not allow access. A ship can be designed with docking clamps that enable access to pods but these are an additional MLv0.05 per clamp so equipped.

The type and size of the pods must be determined at the time of construction and cannot be changed later without a major overhaul.

When determining reaction drive and stutterwarp performance for a container ship, calculate the values for when the ship is full. These would be the baseline numbers. Then recalculate for when the ship is empty and note both values in the ship's description. Reaction drive size, cost and Burn requirements should be based on the loaded size of the ship.

Streamlined Hulls

Streamlined hulls are built to enter atmosphere, operate there and land. All streamlined hulls have appropriate landing gear installed.

Streamlined Hull Configuration

Configuration	Hull	Cost
Ballistic	—	—
Airframe	-10%	+10%
Lifting Body	—	+20%

Ballistic hulls can enter (or leave) atmosphere but cannot effectively manoeuvre within it. They are strictly 'up and down', with minimal lateral capability.

Airframe hulls generate lift and can manoeuvre in atmosphere. This aircraft-like configuration generates lift from its wings rather than the shape of the hull and many drop-gliders and spaceplanes use this configuration. An airframe hull requires 25% more hangar space but does not require extra tonnage in a berth or external sling. The wings can be made retractable for an additional 25% of the base hull price. Doing so reduces Hull value by 10% (minimum 0) as the retractable wing configuration is less durable than a solid hull.

Lifting body hulls generate lift through the shape of their hull and either lack wings entirely or have short wing-like control surfaces. Although challenging to control, lifting body craft are more compact and less vulnerable to damage, so see greater use as military landers. Large vessels often use lifting body hulls, avoiding the immense wingspans and structural loads that an airframe hull would entail. Lifting body designs cannot make use of folding wings to reduce carriage space, unlike Airframes.

Streamlined hulls can only have retractable spin habitats, detailed in Accommodation and Life Support on page 39.

Take-off and Landing

All interface-capable spacecraft are equipped with appropriate landing gear as part of the hull. Most airframe and lifting body vessels require a runway for taking off and landing. The length necessary in metres for take-off is equal to the hull size in tons, multiplied by the Size code for the planet. The landing requires 75% less distance. Lifting body craft require 75% less runway than conventional airframes. For vessels that glide to a landing, the landing distance required is as the powered landing requirement x 3.

Most ballistic craft merely need a cleared area that can withstand the take-off blast and little else.

VTOL AND STOL

Any airframe hull can also be designed as either VTOL (Vertical Take-Off and Landing) or STOL (Short Take-Off and Landing).

While VTOL operations consume extra fuel over runway take-offs and landings, this is not significant in the long run. Extensive VTOL operations consume 1 Burn per 10 minutes of VTOL flight.

The STOL feature halves take-off and landing distance requirements but does not require extra fuel. Due to the wing's shape, STOL craft have a lower maximum speed than would otherwise be the case. While this does not affect orbital insertion, it does reduce atmospheric cruise speed by one Speed Band and limits maximum speed to Transonic.

Hull Type	Tons	Cost
VTOL	4%	MLv2.0
STOL	2%	MLv0.25

Tons is a percentage of the vessel's hull and Cost is per ton of the system.

For example, a 100-ton ship with a VTOL lifter on a Size 8 world would require 4 tons of space for the lift system, which would cost MLv8.

For example, a lifting body hull is coming into a landing on a Size 7 planet. If the landing is powered, the distance required is 260 metres (1 x 50 x 0.75). If it is gliding to a landing, as most will, the length required is 1,040 metres. Take-off would require 260 metres.

Install Armour

All hulls provide some protection from anti-ship weapons fire but it is possible to add heavier armour for better defence.

All hulls start with Armour 0.

As noted previously, ships with distributed structure hulls cannot have their Armour increased.

The Hull Armour table shows how much of the hull's tonnage is consumed per point of Armour, along with its cost. A minimum Tech Level is required for each material type, along with a maximum Armour value.

Any ship that is armoured above half its maximum gains the Heavy trait (see page 12).

An airframe hull can only be armoured to TL-5, due to the large and relatively fragile wings. Modular hulls can be armoured but the modules must be armoured as well.

Hull Armour

Armour	TL	Tons	Cost	Max. Armour
Aligned Crystal Steel	10	1.25%	5%	TL-3
Synthetic	11	0.80%	8%	TL-2
Composite	12	0.50%	15%	TL+0

TONS: How much of the hull is required for each point of Armour.
COST: The percentage of the base hull cost per point of Armour.
MAX ARMOUR: This is the maximum amount of Armour that can be installed.

Hull Traits

Trait	Cost	Reaction Drive Effect	Stutterwarp Drive Effect	Other Effects
Advanced	+100%	-1	x1.05	—
Crude	-25%	+1	x0.9	—
Disposable	-25%	-1	x1.05	—
Efficient	Material	-1	x1.05	—
Heat Shield	0.01/ton	—	—	—
Heavy	Material	-1	x0.9	—
Lightweight	+50%	-1	x1.05 speed	-1 Hull per 100 tons
Radiation Shield	0.005/ton	—	—	—
Tough	+50%	—	—	+1 Hull per 50 tons
Stealth	0.1/ton	—	—	Reflected Signature -4

Hull Traits

Traits can be added to a hull to modify performance or provide additional capabilities. Some options give a ship traits that affect performance. Each trait may affect both reaction and stutterwarp drives.

For reaction drive effects, the listed number, positive or negative, is the change in effective world Size for determining Burns. Note that in this case, a negative is effectively a bonus, as it reduces the Burn requirements. Most traits can be combined, although Crude cannot be combined with Advanced, nor can Crude hulls have Stealth.

Advanced (TL12): An Advanced hull is made from strong, lightweight variations of the standard materials.

Crude: Crude hulls are quickly made and both heavier and less efficiently streamlined than other hulls. Crude hulls increase base Reflected Signature by +25%.

Disposable: A Disposable hull is designed for only a single-use and usually discarded. Attempts can be made to reuse the hull but all repair and operations checks suffer DM-4. It does see some performance increases due to the less robust and lightweight construction.

Heat Shielding (TL6): Heat shielding protects a ship against the heat of re-entry. A ship attempting re-entry without heat shielding will burn up and be destroyed on worlds with Atmosphere 1+. Heat shielding does not protect against starship combat weapons. It is only available for streamlined hulls and cost is per ton of hull.

Heavy: Any ship that is armoured at or above half of its maximum or one that is otherwise overloaded, has the Heavy trait.

Lightweight (TL11): Some materials or manufacturing processes can create a lightweight hull. For interface operations, treat the craft as if the world was one Size smaller to determine Burn requirements. Time to orbit and orbital transfer times remain based on the normal world Size. Such hulls are more fragile than standard.

Radiation Shielding (TL10): Radiation shielding improves the crew's protection against radiation from both natural sources (such as solar flares) and artificial (including nuclear bombs and particle beam weapons). A ship with added radiation shielding decreases the number of rads absorbed by all crew by 1,000 and treats the bridge as Hardened. This is in addition to the LaFarge charged particle screen included in every ship.

Stealth (TL11): This EM absorbing coating degrades active sensors, including radar and lidar beams. It does not help against heat emissions (see Radiators on page 22). Stealth modifies Reflected Signature by -4 but is only effectively used in interface craft, which can employ stealth in atmospheric operations. Starships will almost always be detectable by the heat they radiate.

Tough: The Tough trait grants a ship +1 Hull per 50 tons and increases its base cost by 50%.

Example

The TL11 Jian has a 32-ton lifting body hull made of composite material. It is Armoured as well, with Armour: 4. A 32-ton hull has Hull 3 and a composite hull has the Tough trait. The Jian is too small for this to have an effect, however, as the Tough trait only adds 1 additional point of Hull per 50 tons.

The base hull cost is 32 x MLv0.02 for MLv0.64. The material modifier of 50% adds MLv0.32. As a lifting body, an additional 20% of the base hull cost is added (MLv0.64 x 0.2) or MLv0.128, for a total of MLv1.088.

Armour for a composite hull at TL11 can be increased to 11 but the Jian will stop at 5. Composite armour takes up 0.5% of the hull per point of armour, so the Jian's Armour: 5 will use 2.5% of the hull or 0.8 tons, for 75% of the base hull cost (15% of base hull cost per point of armour), totalling MLv0.48.

The hull made with cutting-edge technology, giving it the Advanced trait. This costs 100% of the base hull cost of MLv0.64 for another MLv0.64.The Jian is equipped with a heat shield for making planetary approaches. The heat shield costs MLv0.32 (32 x 0.01).

Total hull cost is therefore MLv2.528.

As an interface craft, the Jian is equipped to take-off and land on a planetary surface. As with most aerospace craft, it usually makes an unpowered descent and glides to a landing. The take-off roll is hull tonnage multiplied by world Size, expressed in metres. On a Size 8 world, this would be 256 metres (32 x 8). The landing roll is typically 75% of the take-off roll or 192 metres. However, with the lifting body hull, the Jian would only require 144 metres for a powered landing. If it glides to a landing, the landing roll would be multiped by 3, for 432 metres.

Example

The Kennedy is a TL12 900-ton spaceframe constructed of synthetic material. A 900-ton hull has Hull 90 and the synthetic hull has the Efficient trait. This will affect Stutterwarp capability later.

The base hull costs 900 x 0.02 for MLv18. Using Synthetic materials adds another MLv3.6 to the cost, for a total of MLv21.6. A spaceframe hull has no cost modifier.

Built with the latest in material technology and design advances, the Kennedy has the Advanced trait. This adds 100% of the hull base cost of MLv18, for another MLv18. This will affect the design phase for both reaction drive and stutterwarp.

The Kennedy has additional radiation screens fitted. This requires no hull tonnage but costs MLv4.5 (900 tons x 0.005). As a spaceframe hull, the Kennedy does not conduct interface operations, so there is no need for landing and take-off runs.

Total hull cost is MLv44.1.

STEP 2 INSTALL REACTION DRIVES

A wide variety of technologies are used to leave the surface of planets and travel in local space. The most common are reaction drives like thrusters and rockets. Stutterwarp drives cannot effectively function above a 0.001 G gradient, otherwise known as the stutterwarp Wall. Any spacecraft that ventures below a planetary or stellar Wall requires a reaction drive for propulsion.

Burns

Burns are a shorthand method of determining fuel usage for interface and orbital operations. The amount of fuel in Burns required to reach the Wall is equal to the world Size in minutes. Any orbital manoeuvre also requires the expenditure of a Burn.

When allocating Burns to a ship, you should ensure that enough Burns are added for orbital operations, usually one or two.

Time to Orbit

Ballistic craft can attain orbit faster than airframes or lifting body hulls, although the amount of fuel consumed is the same. While most interface ships will burn for the Wall, some will only go to Low Orbit to reduce fuel requirements.

Hull Type	The Wall	Low Orbit
Ballistic	World Size x 5 in minutes	World Size in minutes
Airframe or Lifting Body	World Size x 10 in minutes	World Size x 3 minutes

Reaction Drives

Reaction drives are usually only used for interface and orbital operations. Interplanetary and interstellar travel uses stutterwarp drives but a stutterwarp cannot lift a ship against a gravity well. In fact, below the stutterwarp Wall, the drive is entirely ineffective.

Interface-capable vessels use a rocket or MHD thruster to attain orbit. In some cases, add-on fuel tanks and solid rocket boosters will be required to lift a vessel, either due to load or because the local gravity is higher than the craft's design limits. It is rare to find any interface craft bigger than 200 tons, although there are exceptions.

Special Case

Aurore orbits Tithonous, a super-Jovian gas giant, almost a brown dwarf in mass. The colony world sits deep below the gas giant's Wall and requires ships with extended Burn capability, tugs or a method of refuelling. Aurore orbital space is a dangerous region due to Tithonous' extensive radiation belts. Despite this, a small refuelling station sits outside the planet's Wall to top off reaction mass for incoming and outgoing ships. The original station was destroyed in the Kaefer invasion of 2297 and the replacement built by France is a makeshift affair now operated by the Kovachi Libertine clan. They are in the process of cleaning the station up and expanding it to offer better service. However, they are keenly aware that it is vulnerable to attack from any returning invaders and have a ship on standby to evacuate if need be.

THRUSTER: A thruster is a recombustion chamber attached to a MHD turbine as a sort of afterburner, requiring an input of power and fuel.

Thrusters require an MHD power plant. Thrusters can use the Advanced, Air-breathing and Crude traits but cannot use the Disposable trait. The Thruster is part of the MHD turbine and cannot be discarded.

Power:	Hull tonnage / 10
Tons:	0.5% of hull tonnage per world Size
Burns:	2.5% of hull tonnage per Burn
Cost:	MLv0.5 per ton of thruster

NUCLEAR THRUSTER: Thrusters can be powered by a nuclear reactor, either fission or fusion. Fission reactors can be used in interface craft but fusion plants are too massive. Both reactor types are in common use on starships however, where they can power a thruster for use below the Wall.

Nuclear thrusters require a nuclear power plant. They can use the Advanced, Air-Breathing and Crude traits but cannot use the Disposable trait. Like a conventional thruster, the nuclear thrusters are an integral part of the reactor system.

Power:	Hull tonnage / 10
Tons:	0.75% of hull tonnage per world Size
Burns:	1.5% of hull tonnage per Burn
Cost:	MLv1 per ton of thruster

ROCKET: Rockets are self-contained, but are otherwise designed much the same as thrusters. A rocket does not require a power plant.

Like thrusters, rockets are rated according to the Size code of the world for which they are designed. Rockets tend to be more finely-tuned than thrusters, however, and are typically designed for specific worlds. Rockets can use all traits used by reaction drives.

Power:	N/A
Tons:	1% of hull tonnage per world Size
Burns:	4% of hull tonnage per Burn
Cost:	MLv0.5 per ton of rocket

OMS DRIVE: Thrusters and rockets for orbital operations allow the craft to perform orbital manoeuvres. They do not allow the craft to perform interface operations from a world of Size 1 or greater. Most starships have OMS (Orbital Manoeuvring System) thrusters for orbital operations and non-stutterwarp operations.

OMS drives are designed to only operate in a vacuum. They are more efficient than multi-environment interface drives that must run from a planetary surface to deep space. Even if a ship is not interface-capable, it still requires an OMS drive for orbital operations unless not intended to operate below the Wall. OMS systems do not have to account for world size. Most are designed with two to four Burns to enable orbital operations and transit to and from the Wall to Low Orbit.

OMS ROCKET: Like interface rockets, OMS rockets are a self-contained system that does not require an input of power. They can use the Advanced, Crude and Disposable traits but cannot use the Air-Breathing trait.

Power:	N/A
Tons:	2% of the hull tonnage
Burns:	3.5% of hull tonnage per Burn
Cost:	MLv0.03 per ton of rocket

OMS THRUSTER: OMS thrusters require an input of power from an MHD turbine. They can use the Advanced and Crude traits, although not together. They cannot use the Air-Breathing or Disposable traits.

Power:	Hull tonnage / 10
Tons:	3% of the hull tonnage
Burns:	3% of hull tonnage per Burn
Cost:	MLv0.03 per ton of thruster

NUCLEAR OMS THRUSTER: Nuclear OMS Thrusters can use either fission or fusion power plants. Orbital nuclear thrusters can use the Advanced and Crude traits, although not together. They cannot use the Air-Breathing or Disposable traits.

Power:	Hull tonnage / 10
Tons:	2% of the hull tonnage
Burns:	0.00075% of hull tonnage per Burn
Cost:	MLv1 per ton of thruster

A descent to Low Orbit from the Wall requires a Burn, as would ascending back to the Wall. A vessel can then re-enter from Low Orbit. Most ships will not have more than two to four Burns, enough to descend to Low Orbit, perform basic orbital manoeuvres and then return to the Wall. Military ships will typically have more, however, and are generally capable of extensive orbital operations.

Reaction Drive Traits

Advanced (TL12): These drives are more compact and consume less fuel than normal but are considerably more expensive.
Air-Breathing: Air-breathing rockets and thrusters reduce the fuel requirement by effectively lowering the world Size code for purposes of determining Burns required. These effects can be stacked with the Advanced trait but cannot be added to an OMS drive of any sort.
Crude (TL10): Large and inefficient, the only advantage of Crude engines is that they are cheaper.
Disposable: Designed to be thrown away after a single use, Disposable drives are significantly cheaper, although no smaller, than conventional models. They are often used on disposable rockets or as single-use boosters. While it is possible to design a disposable

Reaction Drive Traits

Trait	TL	Tons	Cost	Interface Drive Effect	Orbital Operations Effect
Advanced	12	-10%	+100%	World Size -1	10% less fuel per Burn
Air-Breathing	9	+10%	+50%	World Size -1	—
Crude	—	+10%	-10%	World Size +1	10% more fuel per Burn
Disposable	—	—	-25%	—	—
Low Orbit	9	—	-10%	World Size -1	—

thruster, this is very uncommon. Disposable rockets and thrusters are 25% cheaper.
Low Orbit: Some interface craft are designed to operate to and from Low Orbit only. This reduces the fuel requirement, saving the one Burn required to reach the Wall from Low Orbit. Military landing craft often have this trait, as they tend to be heavily-loaded and need to save on fuel.

Atmospheric Cruise Operations

Airframe and lifting body vessels can operate as aircraft in an atmosphere. This performance can be improved through the Advanced and Air-breathing traits.

A spacecraft's range in atmospheric flight is 20 minutes of flight time per Burn spent. If the craft has an Advanced drive, that adds another 20 minutes to the range per Burn and an Air-Breathing drive adds another 40 minutes. A spacecraft with an Advanced, Air-Breathing drive can travel for an hour and 20 minutes per Burn expended.

Performance

Hull Type	Speed Band
Airframe	Hypersonic
Lifting Body	Supersonic

Modifications

Speed increases by one Speed Band in a Very Thin atmosphere and reduces by one Speed Band in Dense and higher atmospheres.

A STOL or Hydrodynamic Hull reduces speed by one Speed Band, although if the two are combined into one vessel, they do not lower the speed by two Speed Bands. Hydrodynamic and STOL hulls are limited to the Transonic Speed Band for atmospheric cruise operations. Orbital insertion and re-entry capabilities are not affected.

An Advanced engine will increase speed to the next Speed Band, while a Crude engine will lower it one Speed Band. These engines also alter fuel consumption, as noted in their trait description.

An Advanced hull will likewise increase the atmospheric speed by one Speed Band. An Advanced hull coupled with an Advanced engine will therefore boost the maximum Speed Band by two levels.

Additional Speed Bands

At Subsonic speeds and above *2300AD* uses the Speed Bands listed on the High Speed Bands table.

High Speed Bands

Speed Band	Speed Band Number	Kilometres per Hour
Subsonic	8	800–1,200
Transonic	9	1,200–1,800
Supersonic	10	1,800–6,000
Hypersonic	11	6,000–12,000
High Hypersonic	12	12,000+

De-orbit Burn and Landing

The de-orbit burn and landing takes 10 x world Size in minutes. The first quarter of this is the actual de-orbit burn and the rest of the time is spent coasting and then shedding velocity once the craft is in the atmosphere.

Airframe and lifting body hulls will normally glide the entire distance for a landing, although they can make a powered descent.

Example*: The 32-ton Jian was designed to use air-breathing thrusters and operate from a Size 8 world. The thruster is 1.28 tons (0.005 x 32 x 8), costs MLv0.64 and would require a minimum input from an MHD turbine of 3.2 Power. The Air-Breathing trait takes another 0.128 tons and costs MLv0.32, reducing the effective world Size by l, reducing the Burns required to 7. However, the Jian also uses an Advanced hull, which also reduces the effective world Size by one and now only 6 Burns are required to reach the Wall. Add one more for return operations and another for orbital operations and 8 Burns are needed in total. These 8 Burns require 20% of the hull (8 Burns x 32 tons x 2.5%) or 6.4 tons.*

Example*: The Kennedy is powered by a fusion reactor and uses an Advanced orbital nuclear thruster for orbital operations. The thruster itself requires power, at Hull Size x 0.1, which comes to 0.1 x 900 or 90 Power. This thruster uses 0.03 x hull tonnage (0.03 x 900 ton) or 27 tons and the Advanced trait reduces the size by 10% (-2.7 tons), for a total of 24.3 tons. At MLv1 per ton, the drive costs MLv2, and the Advanced trait adds another 100%, for a total of MLv54.*

Burns for the 900-ton Kennedy are equal to (0.01 x 900) nine tons per Burn, less 10% for the Advanced drive or 8.1 tons per Burn. The 8 Burns allocated require 64.8 tons and are sufficient to move the ship from the Wall to Low Orbit and back again three times, with a small allowance for further orbital operations.

STEP 3

INSTALL STUTTERWARP

The Jerome-effect stutterwarp is one of the most important discoveries of the past 300 years, alongside fusion power and human DNA modification. These drives are the primary means of transportation between worlds within a system and the only practical method of travel between star systems.

Stutterwarp drives have a maximum range of 7.7 light-years, after which they must discharge their drives in a gravity well. Failure to discharge the drives means risking an inversion event as the Tantalum-180 in the drive decomposes to Hafnium. This event destroys the drive and thoroughly irradiates the ship, with the equivalent radiation of a small nuclear bomb. As it is internal to the ship, radiation screens offer no protection.

The performance and cost of a Stutterwarp drive varies significantly by Tech Level. For this reason, commercial vessels almost never use the TL 12 drives, as the slight added performance is not worth the additional cost.

Stutterwarp Performance

Stutterwarp speed is based on a somewhat complex formula. Stutterwarp performance varies on a power/size curve, rather than a straight line.

Warp Efficiency is equal to the Tech Level Modifier (*TLM* – TL10 = 10, TL11 = 12, TL12 = 14, TL13 = 16), multiplied by the square root of Power (*P*) dedicated to Stutterwarp operation, divided by hull tonnage (*T*) multiplied by five. Warp Efficiency (*We*) is in light-years per day.

$$We = TLM \times \sqrt{(P/5T)}$$

Drive Size and Cost

Stutterwarp drives consume space based on the power rating of the drive and its Tech Level. The Tech Level of the drive does not have to match the Tech Level of either the hull or the power plant. The size in tons is equal to two, multiplied by the square root of the Power (*P*) dedicated to the drive, divided by the Tech Level Size Modifier (*SM*), which is equal to the TLM+4.

$$2 \times \left(\sqrt{\frac{P}{SM}}\right) = \text{Drive size}$$

The costs of Stutterwarp drives vary by Tech Level. At TL10, this is MLv equal to 1.25 x the drive's tonnage. At TL11, it is equal to 2 x the tonnage and at TL12 it is equal to 5 x the tonnage.

The result is the Stutterwarp Efficiency or the speed of the ship in light-years per day.

System Speeds

Once within a system, a starship's speed drops dramatically. Once a ship has crossed the 0.0001 G system Threshold, multiply the Warp Efficiency by 0.645 to get the speed in AUs per day.

Once below the Wall, the stutterwarp drive is unable to function effectively and reaction drives must be used. Once at the Wall, however, a ship can discharge its drive into the world's gravity well, a necessary step if it is to continue travelling. Many ships transfer cargo and passengers at the Wall to interface transports or transfer stations and do not approach closer.

Tactical Speed

To get the tactical (combat) speed of a starship, round Stutterwarp Efficiency to the nearest whole number.

Arcturus

Arcturus is a red giant star at the end of the French Arm and it presents a special problem. It is an old Population II star and as such has no planets. Normally, in a star system without planets, ships could discharge their drives in the gravity well of the star, below its Wall. However, Arcturus is so enormous (25x the diameter of Sol) that the Wall is within the star. This closed Arcturus to exploration for decades, until 2287, when a detailed system survey found a small, distant dwarf planet with just enough gravity to allow a drive to be discharged. The Arcturus Discharge Point, as it is officially called, sits at a mean distance of 98 AU from the star. It has a highly-elliptical orbit sharply inclined to the plane of the system and appears to be a captured object. It is uninhabited and simply has a beacon that allows it to be easily found. The world itself is small and uninhabitable, with an ice-covered surface and a relatively shallow liquid water layer about 50 kilometres under the surface ice.

Discharge Vanes

The latest military designs incorporate discharge vanes which, when extended, reduce the amount of time required to discharge a stutterwarp drive. The vanes are long, thin panels that extend from the engineering section of a ship and require a physical connection to the stutterwarp drive itself. An installed set of discharge vanes reduces the time required for a full discharge from about 40 hours down to around 20 hours.

TL:	12
Power:	25% of stutterwarp drive Power
Tons:	0.1 per Power devoted to discharge vanes
Cost:	MLv2 per ton of discharge vane

***Example**: The Jian has a TL12, Power 6 stutterwarp drive installed. Warp Efficiency would be calculated as:*

$$We = 14\sqrt{(6/(5 \times 30))} = 2.85 \text{ ly/day}$$

Power input is 6 and the Size Modifier (SM) is 16. The drive takes up 2√6/16 = 1.15 tons.

The cost is the size in tons, multiplied by the cost modifier for that Tech Level, in this case 2. This totals (2.74 x 2), or MLv 5.77.

System Speed is 2.85 x 0.645 = 1.84 AU per day.

Tactical Speed is equal to Warp Efficiency (2.85), rounded to 3.

***Example**: The 900-ton Kennedy has a TL12, Power 400 stutterwarp drive installed. Tech Level Modifier (TLM) is 14, so Warp Efficiency would be calculated as:*

$$We = 14\sqrt{(400/(5 \times 900))} = 4.17$$

However, as an unarmoured ship with an Advanced Synthetic hull, the Kennedy has its Warp Efficiency further increased by 5% for the Synthetic hull and another 5% for Advanced construction. This requires the We to be multiplied by 1.1025, for a total of 4.6.

Power input to the drive is 400 and the Size Modifier is 18. The drive requires:

$$2\left(\sqrt{\frac{400}{18}}\right) = 9.89 \text{ tons}$$

The cost is the size in tons, multiplied by the cost modifier for that Tech Level, in this case 5, totalling (9.89 x 5) MLv49.44.

System speed is 4.3827 x 0.645 or 2.97 AU per day.

Tactical Speed is equal to Warp Efficiency rounded to the nearest whole number, or 5.

The Kennedy also makes use of Discharge Vanes to shorten the discharge time from 40 to 20 hours. These vanes require Power equal to 25% of the Power used for the stutterwarp drive, (25% of 400 = 100) for 100 Power. They consume 0.1 tons per Power (10 tons) and cost MLv2 per ton, for MLv20.

STEP 4 INSTALL POWER PLANT

The power plant is the beating heart of a starship, providing power for thrusters, stutterwarp drive, life support, sensors and weapons. Choose a power plant based on the capabilities desired for a vessel. Any trans-atmospheric vessel will usually mount an MHD turbine for a power system, as a thruster can be added to it.

Rocket-powered small craft with endurance of less than six hours do not require a power plant, instead usually relying on batteries and generators powered from the drive system to run avionics and life support. Craft with endurance requirements of more than six hours need a power plant to support electronics and life support.

Power Requirements

All ships require Power equal to 1% of their hull tonnage for basic life support and operations. This is also what an emergency power supply should generate, at minimum. This also covers basic equipment like computers, minimal sensors and communications.

If the ship does not carry crew, this requirement is halved (0.05% of the hull).

For example, a 200-ton ship requires Power 2 for life support and operations.

Power Plant Types

There are various technologies used to provide power to spacecraft and starships. Power plants fall into two broad categories: chemical and nuclear. Fuel cells and MHD turbines use hydrogen-oxygen reactions to create power, although in different ways. Fission and fusion plants comprise the nuclear options, using the power of either splitting atoms or joining them.

Batteries and solar panels are also available but are generally not suitable for interstellar craft.

The main drawback of chemical power plants is the amount and cost of the fuel required. Nuclear plants are much bigger and costlier but do not need to be refuelled under normal circumstances.

FISSION REACTORS

Fission reactors are built with sealed fuel modules, designed to last about 5 years and then be replaced at specialised facilities. Most civilian reactors use thorium as a fuel, while military vessels use uranium or plutonium. The creation of weapons-grade material from starship reactors is an important function for most militaries. Fission plants are relatively inexpensive for their power output but are large and require bigger crews than other power plants.

Fission Reactors

Type	TL	Power per Ton	Cost per Ton	Minimum Size
Basic	10	6	MLv0.2	40 tons
Advanced	11	8	MLv0.4	20 tons

FUEL CELLS

Fuel cells are used for low-power applications and backup systems. They operate on a chemical reaction that combines hydrogen and oxygen to provide electricity, with water as a by-product. Although they are low-power, they are compact, low-maintenance and easy on fuel. They are expensive, however.

Fuel cells have a maximum output based on Tech Level. Many ships will install fuel cells in banks to supply power for different requirements.

Fuel Cell

Type	TL	Power per Ton	Cost per Ton	Maximum Output
Fuel Cell	10	10	MLv1	30
Commercial Fuel Cell	11	12	MLv2	48
Advanced Fuel Cell	12	14	MLv3	90

FUSION REACTORS

Utilising a high-beta fusion reaction, modern fusion reactors are compact and safe, although the engineering overhead on them does limit the lower end of their size. The fuel module for these reactors is sealed and the supply of deuterium-tritium fuel is designed to last 25 years. At the end of life of the reactor, the containment vessel is thoroughly contaminated by radiation and neutron particles from the fusion reaction and the structure starts to break down. TL12 fusion reactors are typically only found in military and TransNat use, while most commercial and state operations use the TL11 model. There is theoretically no maximum power output for a fusion reactor but rather than building a single huge reactor, common practice is limit them to 1,500 tons or under and build multiple installations.

Fusion Reactor

Type	TL	Power per Ton	Cost per Ton	Minimum Size
Basic Fusion	11	12	MLv1	100 tons
Advanced Fusion	12	15	MLv1.2	60 tons

MAGNETOHYDRODYNAMIC TURBINES

The MHD turbine is a method of direct electrical conversion, using the exhaust to generate a current by seeding it with charged particles. It is not literally a turbine; the movement of the exhaust through a set of coils creates a current, with no moving parts in the combustion chamber itself. A single MHD turbine has an upper limit on the power it can produce, which varies by Tech Level. MHD turbines are commonly used to power thrusters, accelerating the large amounts of fuel being burned to greatly increase the efficiency of the drive system. They are the most common power plant used in smaller military and commercial vessels.

MHD Turbine

Type	TL	Power per Ton	Cost per Ton	Maximum Output
MHD Turbine	10	8	MLv0.25	500
Commercial Turbine	11	10	MLv0.4	750
Advanced Turbine	12	12	MLv0.55	1,000

RADIOTHERMAL GENERATOR

A RTG is a compact, low-power, long-duration power source using heat from decaying radioactive material to generate electricity via thermocouples. It is a marginal technology, found only in long-range probes and small belter communities. The fuel supply is self-contained and will supply power for 10 years. If run unshielded, a conventional RTG produces 10 rads/hour. Size and cost below assumes a shielded unit. Unshielded units are typically not available, although an existing one could be stripped or otherwise damaged.

Solar Panel Size

The apparent size discrepancy between solar panels here and the *2300AD Core Rulebook* is due to the differences between a ship-based retractable array and a ground-based array. The lower-power production of the *2300AD Core Rulebook* system is also due to being on a planet and within atmosphere, rather than in space.

Radiothermal Generator

Type	TL	Power per Ton	Cost per Ton	Maximum Output
RTG	10	0.5	MLv2	10

SOLAR PANEL

Extendable solar panels provide backup power for a vessel's power plants. They are sometimes installed in scout or mining ships, giving them greater range and endurance or in conjunction with closed-cycle fuel cells to recycle waste-water into fuel. In such cases they must provide power both to regenerate the fuel and to power basic operations of the ship. Another common use is to power a separate fuel processor to crack hydrogen and oxygen from water ice to provide fuel.

Solar panels are installed in banks with an area of 200m^2. Sizes listed on the Solar Panel table are for fixed panels that are part of the vessel's hull. A ship with retractable solar panels must set aside an additional one ton of space per panel, although there is no cost for this. Spacecraft cannot use more than one cell per 10 tons of hull, due to the area of the extended arrays.

Solar Panel

Solar Panel	Power per Panel	Cost per Panel
Basic	4	MLv0.1
Improved	5	MLv0.2
Advanced	6	MLv0.3

BATTERIES

Batteries use a variety of technologies, from advanced graphene batteries at TL10 to super-conducting storage rings at TL12. The duration of a battery is determined by its size and Tech Level, and can easily be reconfigured by an engineer.

As batteries store power, rather than generate it, a slightly different process is used. Batteries are rated in Power-Hours. A 10 Power-Hour battery can either produce Power 1 for 10 hours, or Power 10 for one hour, or anything between. When installed, batteries have a default Power/duration setting that can be altered by an engineer as required.

Batteries use total Power multiplied by the total duration (in hours) multiplied by tonnage of the battery itself.

For example, a TL11 survey drone requires Power 10 for all its systems and it has an expected operation endurance of 24 hours. At TL11, the tonnage per Power-Hour is 0.005 tons. Power 10 for 24 hours is 240 Power-Hours, multiplied by 0.005, so requiring 1.2 tons. This battery could be stretched out to deliver Power 1 for 240 hours or Power 240 for one hour, or some combination equalling 240 Power-Hours. Batteries cost MLv1 per ton, so a 1.2 ton battery would be MLv1.2.

The maximum output of a battery is Power multiplied by duration in hours. This is also the amount of power that needs to be replenished to recharge the battery.

Battery

Battery	Tons	Cost per ton	Recharge
TL10	0.05	MLv1	2/hour
TL11	0.01	MLv5	4/hour
TL12	0.005	MLv10	6/hour

Batteries can be recharged by a ship's power plant or solar panels. Each Power point-dedicated to recharging the battery can recharge the amount listed under the Recharge column, per hour.

Batteries can be used to provide emergency power. For most ships, this is normally equal to the base life support cost, with a duration of 24–48 hours. Some ships may set aside more power for other systems, like sensors.

***Example**: The 30-ton Jian requires Power 0.32 for life support and other basic systems. It is designed to use a Power 35 MHD turbine that does not quite provide enough power for all ship systems to be run concurrently. In normal operation, the thruster and the stutterwarp do not operate at the same time.*

The TL12 Power 35 MHD turbine consumes 2.9 tons and costs MLv1.6.

As a small ship, it does not have an emergency power system.

***Example**: The 900-ton Kennedy requires Power 9 for life support and other basic systems. It is equipped with the latest technology fusion reactor, generating Power 1,200. The reactor consumes 80 tons, and costs MLv96. The Power 1,200 reactor supplies all necessary systems, with a small surplus for future upgrades and expansion.*

In addition to the fusion reactor, the Kennedy has emergency power available of Power 9 with a duration of 24 hours. The size of the battery is 9 x 24 x 0.005, or 1.08 tons. At MLv10/ton, the cost is MLv10.08.

STEP 5 INSTALL RADIATORS

Radiators are a critical part of a spacecraft's design, as the ship must be able to get rid of the heat it generates. This requirement is based on power plant output, which is the major portion of a spacecraft's waste heat production.

Radiators and Waste Heat

Every component of a ship generates heat, from the power plant to the electronics, weapons and even the crew. This heat must be disposed of. The vacuum of space is neither hot nor cold but is a near-perfect insulator. The heat generated by a spacecraft's systems can only escape the ship by the use of radiators. Typically, radiators are large, wing-like panels on a ship's engineering section and habitation areas. Heat from the ship's systems is transferred to the radiators, where it slowly bleeds out into space. While these systems are suitable for civilian vessels, military craft need a more effective and faster method of dumping waste heat. Advanced Heat Dissipation Radiators (AHDRs) are more efficient and robust than normal large-panel radiators, but substantially more expensive.

CONVENTIONAL RADIATOR

Conventional radiators are large, wing-like panels. Coolant is pumped through channels in the wings and heat radiated out from both sides. Due to their size, radiators can make a ship easier to detect. For every 50 tons of radiator, add +1 to the craft's Signature.

TL	10
Tons	10% of the ship's Power output
Cost	MLv0.05 per ton

AHDR

Advanced Heat Dissipation Radiators use a different technology than the conventional radiator, which sheds much more heat but at a substantially higher cost. It makes use of a high-density liquid coolant, which can also be used to rapidly dump heat, although possibly exhausting the ship's supply of coolant. This coolant can only be replenished at Class A and B starports. ADHR systems are available for TL11 and higher level ships, and standard on most military vessels.

Because they are more efficient than conventional radiators, AHDRs have a smaller overall effect on Signature. For every 100 tons of an ADHR system, add +1 to Signature.

TL	10
Tons	5% of the ship's Power output
Cost	MLv0.5 per ton

OVERSIZED RADIATOR

Most ships are built with radiators designed to handle their output. However, they can be constructed with larger radiators that better dissipate the heat, resulting in a lower Radiated Signature. For every 50% increment bigger the radiators are, the Radiated Signature is reduced by -1. Radiated Signature cannot be reduced lower than 1, however.

HEAT SINK

Heat sinks are a method of temporarily storing waste heat, although for only a limited time. This is the only effective way to achieve stealth in space, as otherwise the ship's waste heat would be detected. As waste heat is a function of energy generated by a ship, heat sinks, like radiators, are rated by the Power they are designed to handle.

Heat sinks are phase-change materials that can be used to absorb a large amount of heat. They behave normally until they start to melt, whereupon they can absorb a large amount of heat energy without changing temperature. They will continue to function until the material is thoroughly melted and the material is saturated. At this point, the heat sink can be bled off to a radiator or else the entire heat sink can be jettisoned.

A typical heat sink is designed to absorb the full amount of heat the ship can generate, for up to five rounds (30 minutes). Multiple heat sinks can be linked but this just makes the problem of bleeding off heat even more difficult later. Once the absorption limit is reached, a ship must begin bleeding off the heat through radiators. Note that the radiators also have to cope with the regular heat requirements of the ship; for this reason, heat sinks are often simply jettisoned at the end of their absorption limit.

Heat Sink

TL	Tons per Power	Cost per Ton
10	0.5	MLv0.2
12	0.1	MLv1

While heat sinks are in use, a ship's Radiated Signature is 0, equal to the cosmic background energy.

For example, a 200-ton stealth Kaefer infiltrator, with Power output of 200, has heat sinks to absorb the ship's heat for five rounds (30 minutes). At TL12 this requires 20 tons (200 x 0.1) and costs MLv20.

***Example**: The Jian has a Power 35 MHD turbine and must have radiators to dispose of the waste heat generated. The fighter utilises a conventional radiator, which is 0.1 ton per Power or 3.5 tons. The cost of the system is MLv0.05 per ton, which works out to MLv0.175.*

***Example**: The Kennedy is fitted with an extremely powerful Power 1,200 fusion plant. As a military vessel, it uses the more efficient and robust ADHR system to dispose of this heat. The ADHR is designed well over-capacity, able to dispose of Power 2,400 worth of waste heat. As an ADHR is 0.05 tons per Power, this requires 120 tons. The cost of the more robust ADHR is MLv0.5 per ton and this system on the Kennedy costs MLv60.*

STEP 6 INSTALL FUEL TANKS

Both MHD turbines and fuel cells consume fuel, which consists of liquid hydrogen and oxygen in separate tanks. The listed fuel consumption is for the combination of both components. Reaction drives typically consume the same fuels but their requirements are dealt with on page 14.

Fuel Requirements

The Chemical Fuel Consumption table lists consumption for fuel cells and MHD turbines. Fuel tankage does not have a price if installed at the time of construction. If added later, fuel tanks cost the same as a hull; MLv0.02 per ton. Short Term is tons per hour per Power, while Long Term is tons per week per Power.

Chemical Fuel Consumption

Chemical Power Plant Type	Short Term	Long Term
MHD Turbine	0.0015	0.25
Fuel Cell	0.0009	0.15

Fuel Production

Spacecraft can be fitted with fuel cracking equipment to create hydrogen-oxygen fuel from water, either with a fuel cell run in reverse, or a dedicated fuel processor.

FUEL CRACKING

An operating fuel cell combines hydrogen and oxygen to produce power, with water as a by-product. This water can be captured and reused as fuel by cracking it. A fuel cell can be run in reverse to crack fuel from its water exhaust, or any other available water source. This requires an external power source and tankage to capture the water exhaust from the fuel cell. It is not as efficient as a dedicated fuel cracker but the system is compact and self-contained. The external power requirement is usually met with solar panels, enough of which must be installed to run the fuel cracking and the ship's basic operations. Alternatively, a separate fuel cracker can be installed, allowing a fuel cell or other power plant to run concurrently with the cracker.

A fuel cell running in reverse can crack fuel at the same rate it consumes it, 0.001 tons per hour per Power. A Power 20 fuel cell run in reverse can crack 0.4 tons of fuel a day.

TL:	10
Tons:	50% of the size of the base fuel cell
Cost:	5% of fuel cell price

FUEL PROCESSOR

Ship's with MHD turbines, or nuclear-powered ships that need fuel for reaction drives or subordinate craft, can install separate fuel processors. These are reverse fuel cells, optimised for cracking water and not intended to be used as power plants (a skilled engineer could modify them, however). They require an external source of power for normal operation. These systems utilise the empty fuel tanks on the ship but additional tankage can be added for MLv0.1 per ton.

A standalone fuel cracker is significantly more efficient than a power fuel cell run in reverse. It can crack 0.01 tons per hour per Power dedicated (10 times the effectiveness of the fuel cell). In most cases this power comes from solar panels, although on nuclear-powered ships the reactor can also supply the power. It consumes 0.1 tons per Power and costs MLv2 per ton. A 20 Power fuel cracker can process up to 4.8 tons of fuel a day.

TL:	10
Tons:	0.1 per Power
Cost:	MLv2.0 per ton

FUEL PURIFIER

Fusion and fission-powered ships still require reaction mass for their thrusters but can use ammonia or even pure water. These two sources of reaction mass must still be filtered and purified, but it is far less power-hungry than cracking water into oxygen and hydrogen.

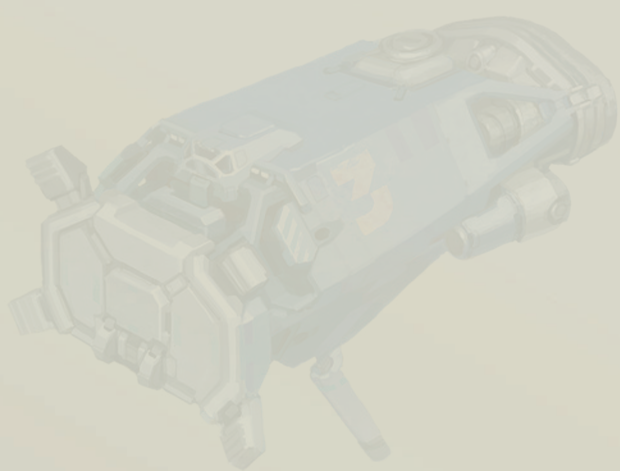
The fuel purifier removes impurities from water and ammonia for use as reaction mass for nuclear thrusters. The purifier can filter one ton of fuel per hour. Power cost is negligible, as it just needs pumps and filters. Additional purifiers can be added to speed up processing time.

TL:	9
Power:	None
Tons:	0.5
Cost:	MLv1

***Example**: The Jian requires fuel for both the MHD turbine and thruster. On an hourly basis, MDH turbines require 0.0015 tons of fuel per hour per Power. The Jian is designed as a patrol craft and carries 12 hours of fuel. This requires 0.0015 x 35 x 12 = 0.63 tons.*

The Jian is designed to lift off and reach the Wall from a Size 8 world, requiring 8 Burns. It is also designed to have additional orbital operations capability, for a total of 10 Burns. The thruster is an air-breathing model and the hull is advanced, reducing the effective world Size by -2, for 6 Burns required to reach the Wall. Two more Burns are added to give the Jian some operational flexibility. Each Burn consumes 0.8 tons, for 6.4 tons of thruster fuel.

***Example**: The Kennedy does not require fuel for the fusion reactor, as it is self-contained. The nuclear OMS thruster does require fuel, with 8 Burns available for orbital operations. Each Burn requires 8.1 tons of fuel, for a total of 64.8 tons.*



STEP 7 INSTALL BRIDGE

All ships must have a bridge or an autopilot system, which contains basic controls, communications equipment, avionics, sensors and other equipment for proper operation of the ship. The size of the bridge varies depending on the size of the ship and can range from a massive deck with multiple crew positions on a capital ship to a snug single-seat cockpit in a fighter.

The size of bridge required is shown on the Bridge Size table.

Bridge Size

Size of Ship	Size of Bridge
50 tons or less	3 tons
51–99 tons	6 tons
100-200 tons	10 tons
201-1,000 tons	20 tons
1,001-2,000 tons	40 tons
2,000 tons or more	60 tons

The cost of any bridge is MLv0.5 per 100 tons (or part of) of the ship.

AUTOPILOT

Spacecraft without a bridge or cockpit will have some form of automatic control, based on the size of the craft. The autopilot consumes 0.01 tons and costs MLv0.01 per ton of ship. A computer and Robotic Control software are also required. Unmanned interface craft can use the Minimal version but all manned and all stutterwarp ships require a higher level of programming.

TL:	10
Tons:	0.01
Cost:	MLv0.01 per ton of ship

Smaller/Larger Bridges

It is possible to install a smaller bridge than a ship should normally have or a larger one. This is sometimes done to save space and money or to increase the vessel's capabilities.

A ship can have a bridge one size larger or smaller than the Bridge Size table indicates, doubling or halving the cost of the bridge respectively. For example, a 100-ton scout, which normally requires a 10-ton bridge, could be built with a 20-ton bridge or a six-ton one.

A ship with a smaller bridge suffers DM-2 for all checks related to spacecraft operations made from within the bridge (these would include Astrogation and Pilot checks, for example). Non-commercial ships do not suffer this penalty. A ship with a larger bridge gains DM+2 to the same checks.

PROTECTED BRIDGE

It is possible to build a starship's bridge deep inside the ship, protected by layers of armour and redundant systems. A protected bridge ignores the first critical hit against it in each combat.

TL:	11
Tons:	+50% of bridge size
Cost:	100% of bridge cost

COCKPIT

Instead of a bridge, ships of 100 tons or less may install a cockpit. This is a self-contained, sealed area that contains a single seat and all controls necessary for the operation of the ship. Cockpits are typically entered via an external hatch or canopy. A cockpit is not designed for long term use and only has life support for 24 hours. However, pilots will want to leave the cockpit long before then. After 12 hours in a cockpit, crew will suffer DM-2 to all actions.

TL:	10
Tons:	1.5
Cost:	MLv0.1

DUAL COCKPIT

A dual cockpit provides space for an additional crew member, such as a sensor operator or dedicated gunner. The seats are either in tandem or side–by–side.

TL:	10
Tons:	2.5
Cost:	MLv0.15

SURVIVAL COCKPIT

Some small craft encase the cockpit in an ejection module, equivalent in capability to a five-ton escape pod.

TL:	10
Tons:	5
Cost:	MLv1.5

FLIGHT DECK

Non-combat small craft often have a flight deck rather than a dual cockpit. It is slightly larger than a dual cockpit and provides access to the rest of the craft. A flight deck can have up to three crew.

TL:	10
Tons:	3
Cost:	MLv0.25

NEURAL LINK

Neural Links allow a direct mind-machine interface between a ship's crew and the ship, improving reaction times, giving heightened situational awareness and increasing sensor acuity. They require crew members to have neural jacks to take proper advantage of the technology. Neural links grant DM+1 to all checks made by the linked crew. Ships with neural links must have computers or computer cores of Processing 10+ running Neural Interface software.

TL:	12
Cost:	50% of bridge cost

Example: *The Jian has a simple dual cockpit, which consumes 2.5 tons and costs MLv0.015.*

Example: *At 900 tons, the Kennedy requires a 20-ton bridge, although some command variants have a larger 40-ton bridge. This costs MLv4.5 (the command bridge would be MLv9).*

The Kennedy is equipped with neural interfaces for the bridge crew. This takes no space but costs MLv9.

STEP 8 INSTALL COMPUTER

Every ship needs a central computer, usually installed near the bridge. The computer is the heart of the ship, controlling all functions from life support to the complex calculations needed to safely operate a stutterwarp drive. Computers are identified by their Processing score and the Computers table indicates price and Tech Level. In general, more powerful computers are advantageous in combat. The computers installed in a ship work just like personal computers (see the *Traveller Core Rulebook* page 110) but are considerably more powerful because the software needed for ship operations requires a great deal of processing power (see Ship Software on page 27).

Computers

Processing	TL	Cost
Computer/5	10	Lv15000
Computer/10	10	Lv80000
Computer/15	10	MLv1
Computer/20	11	MLv2.5
Computer/25	11	MLv5
Computer/30	12	ML10
Computer/35	12	MLv20

Computers do not consume any tonnage on a ship – while they do have a physical presence, it is distributed throughout the ship and considered part of other components such as the bridge, staterooms, and engineering. A ship may have multiple computers, although secondary computers are typically less powerful than the primary. It is normal for both commercial and non-commercial ships to have a backup computer, while military and long-range exploratory craft often have two or more backups.

Computer Options

HARDENED SYSTEMS (/FIB)

A computer and its connections can be hardened against attack by electromagnetic pulse weapons and other radiation events. A hardened computer is immune to EMP and radiation damage but costs +50% more.

TARGETING COMPUTER (/TAR)

A targeting computer adds +5 to its Processing score for running Fire Control, Advanced Fire Control and Point Defence software. This increases the cost of the computer by +50%.

Computer Cores

If more computational power is required than standard systems can deliver, a computer core can be used. As a massively parallel system, a core has processing power to spare. These expensive systems are rare and are most often used on the largest warships and space stations.

Computer Core Table

Processing	TL	Cost
Core/40	10	MLv32.5
Core/50	10	MLv35
Core/60	11	MLv40
Core/70	11	MLv45
Core/80	11	MLv50
Core/90	12	MLv60
Core/100	12	MLv70

Computer Core Options

HARDENED SYSTEMS (/FIB)

A computer core and its connections can be hardened against attack by electromagnetic pulse weapons and other radiation events. A hardened computer core is immune to EMP and radiation damage but costs +50% more.

NETWORKED CORES

Multiple cores can be installed to manage the operations of large stations. The networked infrastructure takes no space but does cost 1% of the total cost of the installed cores.

Software

Several software packages are in common use on starships across human space. Presumably, Kaefers have something similar, even if their programming appears to be more rudimentary. The software available to all vessels is on the Basic Software table.

Basic Software

ARCHIVE

Utilising the almost-unlimited storage potential of computers, Archive software is a searchable meta-base that mirrors publicly available information from the Link network. Every time a ship checks in at a new world, it updates itself from the local network, while the local network retrieves updates from the ship. This keeps the Link synchronised and error-checked across the breadth of human space.

AUTO-REPAIR

Auto-repair allows the computer to make a number of repair attempts per round equal to the software's level. Alternatively, it can give a positive DM to a repair attempt equal to the score or any combination of the two. Requires the ship to carry at least one repair drone.

FIRE CONTROL

Fire Control allows the computer to assist targeting. It adds DM+1 for each level of Fire Control

INTELLECT

Allows the ship's computer to understand and obey properly phrased verbal commands. A ship running Intellect software and with access to Archive can keep up multiple conversations on a wide variety of topics.

MANOEUVRE

The Manoeuvre software is the fundamental control system of a spacecraft and all ships must have it. It monitors all ship systems and assists with reaction

Basic Software

Software	TL	Bandwidth	Cost
Archive	10	0	Included
Auto-Repair/1	10	5	MLv5
Auto-Repair/2	11	10	MLv10
Fire Control/1	10	5	MLv2
Fire Control/2	11	10	MLv4
Fire Control/3	12	15	MLv6
Intellect	10	5	MLv1
Manoeuvre	9	0	Included
Operations	9	Station size/1000	Included in cost of station
Stutterwarp Control	10	2 x Warp Efficiency	Bandwidth divided by 5

drive control and orbital operations. This software also includes the control software that manages a ship's systems, such as life support and power distribution.

OPERATIONS

In the same vein as Manoeuvre, Operations is the monitoring and control software used for space stations and static installations. The Bandwidth required for Operations software is equal to station size divided by 1,000, with a minimum of 1. The largest stations will require multiple networked computer cores to run all required software.

STUTTERWARP CONTROL

Stutterwarp Control software monitors and adjusts the output of a stutterwarp drive, determining pseudo-velocity and pulse rate. This software is required for all operations of a stutterwarp drive. The Bandwidth and cost of this software is based on the Warp Efficiency (in light-years/day) of the ship.

Advanced Software Packages

There are advanced software packages not as commonly available. Many require the enhanced processing power of the computers on military vessels.

BATTLE SYSTEM

The Battle System software package is a complex suite of programs that interact with each other and other shipboard systems to create a tactical view of fleet actions. It then runs high-level simulations and makes predictions to advise officers as to the correct course of action. Any Traveller using Battle System gains a DM to Tactics (naval) checks equal to the Battle System level (so, Battle System/2 grants DM+2 to the check).

Software	Bandwidth	TL	Cost
Battle System/1	5	9	MLv18
Battle System/2	10	12	MLv24

BROAD SPECTRUM EW

While a software suite cannot match a skilled sentient electronics warfare officer, computers can act much faster, disrupting entire salvoes in the time it takes an operator to simply notice a launch. The Broad Spectrum EW package continuously scans for hostile missile launches and automatically sends disruptive signals known to interfere with the guidance systems of all common drones. A single electronic warfare action (with no skill DM applied) is automatically performed against any and all enemy salvoes launched within Long range.

Software	Bandwidth	TL	Cost
Broad Spectrum EW	10	13	MLv14

ELECTRONIC WARFARE

With access to the ship's sensor suites, this software package provides aid to the vessel's electronic warfare experts by quickly finding the correct frequencies to disrupt a target and then applying massive processing power to break through firewall security.

All electronic warfare actions performed from the ship gain a DM to their Electronics (sensors) checks equal to the Electronic Warfare package's level (so, Electronic Warfare/2 grants DM+2 to the checks).

Software	Bandwidth	TL	Cost
Electronic Warfare/1	5	10	MLv15
Electronic Warfare/2	10	12	MLv18

NEURAL INTERFACE

This software allows a ship's computer to interpret the signals from trained neural interface operators, enhancing reaction time and task precision.

Software	Bandwidth	TL	Cost
Neural Interface	5	11	MLv1

Robotic Control	TL	Bandwidth	Cost	Capability	Notes
Basic	10	5	Lv1000 per ton of ship	All bridge positions skill 0	Voice/Speech Recognition, INT 3 EDU 4
Improved	11	10	Lv2500 per ton of ship	All bridge positions skill 1	Voice/Speech Recognition, Interactive, INT 5 EDU 6
Advanced	12	15	Lv5000 per ton of ship	All bridge positions skill 2	Voice/Speech Recognition, Interactive, Personality, INT 7 EDU 8
Minimal	10	5	Lv500 per ton of ship	All bridge positions skill 0	None

ROBOTIC CONTROL

Many ships, especially system ships, are operated by computer control, with minimal crew or no crew at all. Since all systems are effectively linked anyway, computer control is largely a matter of the correct software. This software requires Manoeuvre and Stutterwarp Control, if necessary. For stations, Operations would be required. Robotic Control can be installed on any vessel and is required for ships with an autopilot rather than a bridge

SECURITY

This package constantly monitors airlocks, access to critical areas and attempts to break into computer systems. In the event it discovers an anomaly, the software automatically shuts down access to the affected area, making unauthorised attempts to enter key areas and functions difficult. This is intended to act as a ward against hijacking but also serves as a strong security system. Any check made to gain unauthorised entry to the ship's computer or any restricted area suffers a negative DM equal to double the Security software level.

Software	Bandwidth	TL	Cost
Security/1	2	10	MLv6
Security/2	4	11	MLv8
Security/3	6	12	MLv10

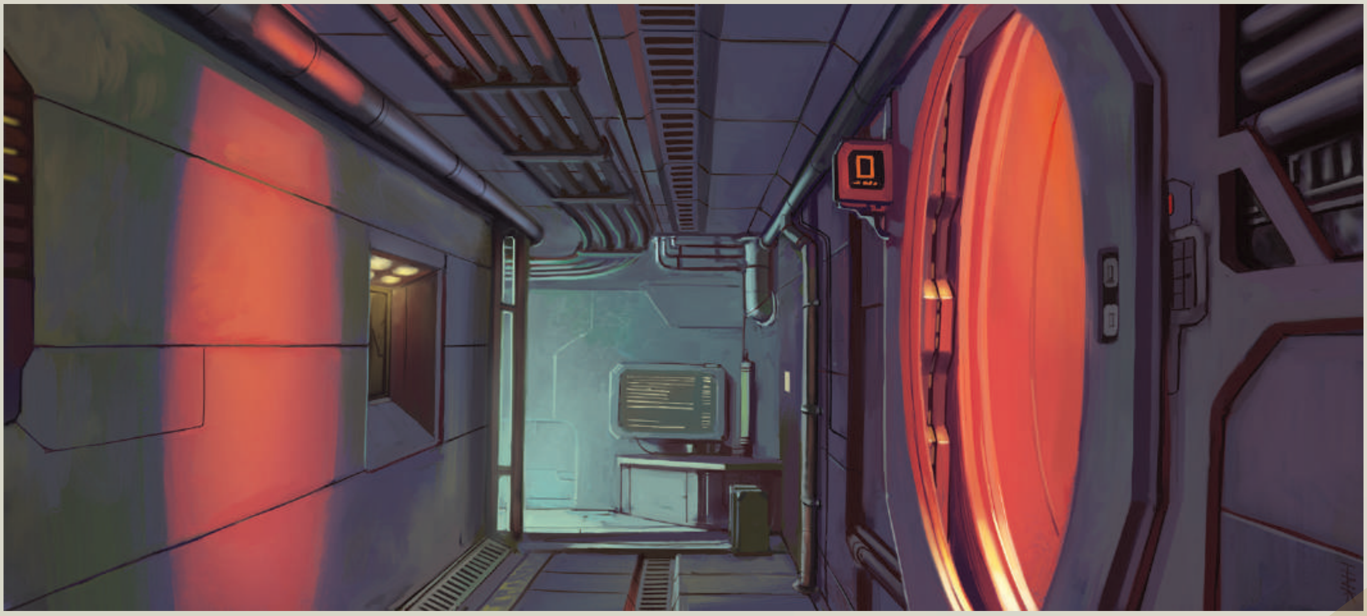
***Example**: The Jian is equipped with a hardened Computer/10fib and a backup Computer/5fib, neither of which require space and cost MLv1.62. It is running Manoeuvre, Fire Control/1 and Stutterwarp Control. Manoeuvre requires no Bandwidth, Fire Control/1 is Bandwidth 5 and with its 2.85 ly/day drive, Stutterwarp Control requires a Bandwidth of 5.7 (2 x Warp Efficiency). Manoeuvre has no cost, Fire Control/1 is MLv2, while Stutterwarp Control is MLv1.14. The software comes to a total of 12.7 Bandwidth, and MLv3.14*

***Example**: The Kennedy is equipped with a powerful Computer/30. The computer is hardened, and so the Computer/30fib costs MLv15 (MLv10, + 50% – or MLv5 – for the fib option). The primary Computer/30 is more powerful than the Kennedy currently requires, but it does leave expansion potential.*

The Kennedy also has a backup Computer/25fib. Base cost is MLv5, +50% for the hardening (MLv2.5) for MLv7.5.

The Kennedy is further equipped with a Computer/10tar. This specialised targeting computer costs MLv0.08 + 50% for the targeting option, for a total of MLv0.12. It acts as a Computer/15 for the purposes of running targeting programs, freeing the ship's main computer for other systems.

For software, the Kennedy is equipped with Archive and Manoeuvre (Bandwidth 0), along with Intellect (Bandwidth 5), Auto Repair/1 (Bandwidth 5), Neural Interface (Bandwidth 5) and Stutterwarp Control (Bandwidth 9.66), for a total Bandwidth of 24.66. Fire Control/3 (Bandwidth 15) runs separately on the targeting computer. Total software cost is MLv13.



STEP 9 INSTALL SENSORS AND ELECTRONICS

All ships come equipped with basic communications, sensor and emission-control suites, usually as part of their bridge. However, specialised or military ships often benefit from more advanced systems that are far more sensitive and resistant to jamming.

Sensors are the eyes and ears of a spacecraft, used in navigation, surveying and combat. There are two basic types of sensors: active and passive. Active sensors are emitters, sending out pulses of radio or laser energy, which reflect off the target and return. Passive sensors look for emissions from elsewhere; heat, radio or visible light.

Civilian Sensors

Civilian sensors are used in commercial and personal spacecraft. These systems tend to be limited in range and effectiveness.

MINIMAL ELECTRONICS SUITE

As part of the bridge or cockpit, all vessels are built with a minimum standard of electronics equipment, including communications and sensors. The included sensors are a short-range radar/lidar array with an effective range of less than one light second. The included comms suite has an effective range of 1 AU but if sensitive enough antennae are pointing directly at the ship, the range could be system-wide. This system is suitable for orbital and interface craft.

BASIC NAVIGATIONAL ARRAY

The basic navigation array is required for any starship not travelling on a well-charted route and combines a short range (one light second) active radar system with a 0.8 metre optical telescope with limited thermal capability. This is adequate for navigation between systems, in a system with a published ephemeris for all significant astronomical bodies or any system with adequate beacon coverage. However, in a system without an ephemeris or beacons, the Astrogation check to compute a course will be considerably more difficult. If an ephemeris exists, then computing a course requires a Routine (6+) Astrogation check (1D minutes, EDU) but if there is no ephemeris, and the basic navigational array is all that is available, then it becomes a Difficult (10+) Astrogation Check (1D days, EDU).

Military Electronics

There are three grades of military electronics packages, each incorporating active and passive radar and lidar, along with visual, thermal and EM detectors. These systems also include encrypted communication and electronics warfare.

The visual telescope incorporated into a military sensor array is identical to the telescope in the civilian basic navigational array but includes better image processing for superior sensitivity and resolution. The included communications systems incorporate both radio and laser comms, with ranges between one and 3 AU.

Military sensor suites contain a full array of active and passive sensors. While in use, active sensors add to the ship's Signature (Radiated Signature if using the optional rules on page 85). Otherwise, if in use, Active Sensors add +2 to the Signature value of the ship using them.

Civilian Sensors	TL	DM	Comms Range	Includes	Power	Min. Hull Size	Tons	Cost
Minimal Electronics Suite	10	-4	1 AU	Radar, Lidar, Visual	1	—	—	—
Basic Navigational Array	9	-2	1 AU	Radar/Lidar, Passive EM, Visual	5	—	1	MLv0.1

Military Sensor Systems

System	TL	DM	Comms Range	Includes	Power	Min. Hull Size	Tons	Cost
Basic Military	11	+0	1 AU	Radar/Lidar, Passive EM, Visual, Jammers	10	—	2	MLv1
Advanced Military	12	+1	2 AU	Radar/Lidar, Passive EM, Visual, Jammers	20	100 tons	3	MLv2
Very Advanced Military	12	+2	3 AU	Radar/Lidar, Passive EM, Visual, Jammers	30	300 tons	5	MLv4

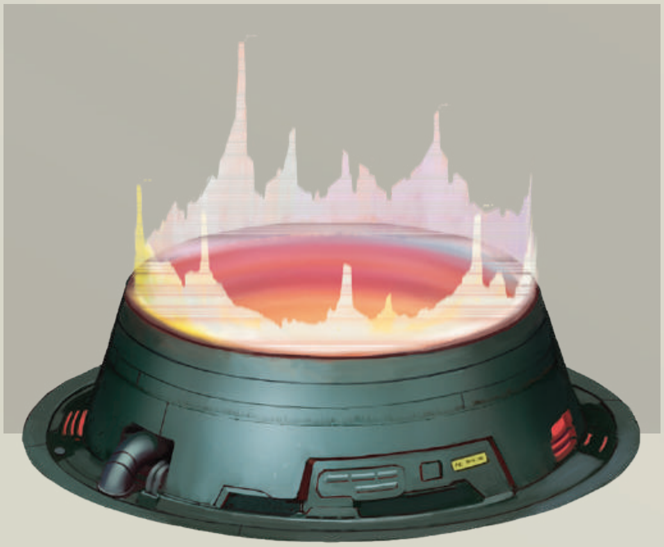
Some sensors have a minimum hull size, to reflect the size of their arrays. A folding array (see page 33) reduces this requirement, so an advanced military sensor suite can be installed on any size vessel, while the very advanced suite still requires a hull size of at least 100 tons.

GRAVITATIONAL ANOMALY DETECTION SYSTEM

The so-called 'grav sensor', or Gravitational Anomaly Detection System (GADS), works in concert with an operating stutterwarp drive to detect the presence of gravitational anomalies within 150 AU of the sensor. Grav sensors are a suite of ultra-fine sensors attached to the stutterwarp drive to detect minute fluctuations in its operation. These fluctuations indicate the presence of a space-time anomaly, usually a massive object of some sort. The system can also detect a stutterwarp drive in operation, although current designs can only determine range, not bearing. While most often used as a survey sensor, able to detect the presence of objects as small as a minor planetoid within operational range, GADS has some utility in starship combat as well. These sensors are super-cooled and require a minimal amount of power to maintain the cooling and operate the sensor.

Grav sensors only detect that there is an object within 150 AU and do not provide information on direction, range or vector. Detection is limited to the speed of light, like all sensors.

As a side-effect, the grav sensor can also detect an operating stutterwarp within range. The fluctuations induced by stutterwarp are qualitatively different from those of a massive object and much more difficult to detect. Consequently, detection of stutterwarp drives requires more operator interpretation. This is a Very Difficult (12+) Electronics (sensors) check (1D hours, INT).



Given the distances and speeds involved, data on stutterwarp vessels will be more historical, rather than tactical. At the extreme range of most sensors, the best information that can be determined is that a stutterwarp vessel was within range 10 hours ago and then was not.

At tactical ranges, information is marginally more useful. Within 10 light seconds, it is possible to determine if the stutterwarp is of human or Kaefer design, as they resonate differently. Pentapod ships, however, cannot be differentiated from human ships on the basis of their stutterwarp drives. This requires a Difficult (10+) Electronics (sensors) check (1D rounds, INT). It is still impossible to determine direction or vector, even at the closest ranges and range is a broad estimate.

TL:	11
Power:	5
Tons:	0.1 x stutterwarp drive tonnage
Cost:	MLv0.1, plus 10% stutterwarp drive cost

DEEP SYSTEM SCANNER

The Deep System Scanner (DSS) is a small folding optical telescope array, used to search a system and catalogue planets, moons, large planetoids and comets within 50 AU of the star. The folding array is the equivalent of a 1.5 metre optical telescope, although optimised for a wide field of view. The DSS usually needs several hours to give a system a cursory scan, after which it can concentrate on individual objects. From the edge of the stutterwarp shelf of a system, a ship with a DSS array can map the surface features of a planet in the habitable zone with two kilometres resolution, after as little as three planetary rotations. Worlds with heavy cloud cover may require more time or may be unable to be mapped by the DSS. The optical telescope on page 31 works better for high-resolution imaging. Part of the DSS package is a dedicated workstation running control and search software. At TL10 scanning a system requires a Very Difficult (10+) Astrogation check (2D days, EDU). Every TL of the DSS above 10 grants DM+2.

A streamlined ship cannot enter an atmosphere with the DSS extended. Doing so will destroy the DSS and perhaps even the ship. Avoiding damage to the ship requires a Very Difficult (12+) Pilot check (1D minutes, DEX). Failure results in damage to the ship equalling the Effect x 10. In either case, the external telescope will be destroyed.

TL:	10
Tons:	2
Cost:	MLv1.5

SURVEY SENSOR

Survey sensors are designed to operate from an orbital position and use a combination of visible, IR and UV light to map the surface and vegetation, along with radar and lidar sweeps to determine topography and ground-penetrating radar to map hidden features. In addition to mapping and resource hunting, survey sensors are also used to look for signs of life. This includes spectrographic analysis of the air, ground and upper layer of surface water, looking for herds of animals and using high-resolution thermal sensors to find warm-blooded animals at night.

Survey sensors are not magic. They cannot be used to determine if there are 'life signs' on a starship, for example, nor can they be used to provide highly detailed information. At best, they provide information for follow-up surveys by robot probes and, eventually, humans.

Military sensor suites contain a full array of active and passive sensors. While in use, active sensors add to the ship's Signature (Radiated Signature if using the optional rules on page 85). Some skill checks associated with Survey Sensors include:

Mapping a Planet: Routine (6+) Electronics (sensors) or Science (planetography) check (2D days, EDU).

Analyse a Planet for Specific Resources: Very Difficult (12+) Science (planetography) check (2D days, EDU)

Analyse a Planet for Animal Life: Formidable (14+) Science (biology or xenology) check (3D days, EDU)

TELESCOPE

A telescope is in addition to any telescopes that may be included as part of a civilian, military, survey sensor or deep system scanner packages. While it can be used to observe a terrestrial world in high detail, it is intended to be used as an astronomical platform, observing the local system. The typical starship telescope is a compact two-metre reflector, which is relatively small but quite sufficient for system survey. Telescopes are large and fragile. They are folded for transit, and then extended from the hull and unfolded for use. At least a day must be spent calibrating the scope once it has been unfolded.

Telescopes

The typical two-metre telescope is marginally-smaller than the 21st Century Hubble Space Telescope. It operates from deep infrared into the near-ultraviolet and is equipped with a sensitive wide-field camera, spectrometer and faint object detector. Other telescopes, sensitive to different parts of the electromagnetic spectrum, can be installed for the same size and double the cost. These include a radio telescope (ten-metre unfolded diameter), an x-ray telescope and a gamma ray telescope.

Tons:	2
Cost:	MLv5

Sensor Options

Upgraded sensor suites are common on military vessels and some survey craft.

COUNTERMEASURES SUITE

A countermeasures suite is specifically designed for jamming enemy transmissions, including active sensors. Use of a countermeasures suite is easily detectable by passive sensors, however, and adds +2 to a ship's Radiated Signature when in use. The range of a countermeasures suite is Short is DM-4, applied to the OpFor's Electronics (sensors) check (see page 59 of *2300AD Core Book 3: Vehicles and Spacecraft*).

TL:	11
Power:	5
Tons:	3
Cost:	MLv5

Survey Sensor

Sensor	TL	Power	DM	Tons	Cost	Min. Size
Basic	10	1	-1	2	MLv5	50 tons
Standard	11	3	+0	4	MLv10	100 tons
Advanced	12	10	+1	10	MLv20	150 tons

ENHANCED SIGNAL PROCESSING

Similar to improved signal processing except that susceptibility to jamming has been overcome.

TL:	12
Tons:	2
Cost:	MLv8

EXTENDED ARRAYS

This option is used with sensor suites to extend their range and increase resolution. Sensors function normally if the arrays are stowed but if extended, they improve resolution by reducing the effective range band by one (Long to Medium, Medium to Short and so forth). Extended arrays of this sort do not affect the minimum ship size requirements of some sensor types.

TL:	11
Tons:	50% of sensor tonnage
Cost:	50% of sensor cost

FOLDING ARRAYS

This option allows sensor suites with large hull requirements to be mounted on smaller ships by making the sensor array fold into the hull when not in use. The folding array adds +1 to a vessel's Signature when deployed and a ship cannot attempt re-entry or perform atmospheric operations with the array extended.

TL:	10
Tons:	50% of sensor tonnage
Cost:	50% of sensor cost

IMPROVED SIGNAL PROCESSING

Signal processing consists of specialised computers and software to improve the quality and likelihood of detection. Improved signal processing provides DM+2 to sensor-related checks and improves the range of 'full' and 'limited' by two range bands for radar, lidar, thermal and visual sensors. However, this comes at a cost of increased vulnerability to jamming, with all jamming checks gaining DM+2.

TL:	11
Tons:	1
Cost:	MLv4

MILITARY COUNTERMEASURES SUITE

The military countermeasures suite is the cutting edge of countermeasures technology in human space, incorporating both powerful transmitters and advanced electronics warfare programs to shut down enemy communications.

DM-6 is applied to the OpFor's Electronics (sensors) check. The range of a military countermeasures suite is Medium.

TL:	10
Power	10
Tons:	10
Cost:	MLv15

Communication Options

ENCRYPTED

A civilian vessel can add encrypted communications. Military electronics have encryption already included.

TL:	12
Tons:	—
Cost:	MLv0.05

LONG RANGE LASER COMMS

Even a low-power radio broadcast can be detected from across a system, although pinpointing it amidst background noise can be difficult. Laser comms, however, transmit securely across a system using a tight-beam signal. They consume a great deal of power and so normal practice is to disengage the stutterwarp while in use.

At Adjacent range (less than 50 km) laser comms are powerful enough to cause 1D damage.

TL:	12
Power	10
Tons:	2
Cost:	MLv5

Redundant Systems

Additional sensors and electronics can be added for redundancy purposes. These secondary systems cost 75% of the cost of primary systems. They use the same amount of Power and consume the same amount of space.

Example: *The Jian is equipped with basic military sensors, relying on a network of more capable ships and drones to feed it information. These sensors require Power 5, and consume two tons of space. The cost is MLv1.*

Example: *The Kennedy is an advanced warship, designed to operate on its own or at the core of a small formation. It has a very advanced military sensor, costing MLv4, consuming 5 tons and requiring Power 15.*

In addition to this package, however, the Kennedy also possesses the following: deep system scanner (two tons and MLv1.5), GADS (Power 5, 0.943 tons, MLv4.814), military counter measure suite (Power 20, 20 tons, MLv15), enhanced signal processing for the military sensors (two tons and MLv8) and a long range laser comm (Power 10, two tons, MLv5). It is also equipped with a survey sensor (Power 2, five tons, MLv1) and a telescope (two tons, MLv5).

The Kennedy is also equipped with a redundant advanced military array (Power 10, three tons and MLv2).

STEP 10 INSTALL WEAPONS AND SCREENS

Military ships rely on a broad range of weaponry to project power across space. Civilian vessels rarely mount weaponry, although with increased tension on the frontier of the French Arm and the frequency of pirate and raider attacks on the Manchurian Arm, some basic weapons like point defence clusters are starting to appear.

Weapons are installed in the same way as other components, taking note of the tonnage they consume within the hull, Power requirements and cost.

Defensive screens are also available to provide additional protection to a vessel. While these do not directly affect performance, unlike armour, the Power requirements of a screen can adversely affect a vessel.

Specific details of weapons and defensive screens and how they are installed in a ship can be found on page 65.

Example: *The Jian fighter is equipped with a single laser array in a retractable fixed-forward mount, which uses Power 20, consumes three tons and costs MLv1.4, along with a missile bay for a Fan Tan missile. There are no weapons for atmospheric operations. It also mounts a submunition dispenser very similar in operation to the German LHH637 design (Power 1, 2.7 tons and MLv2.7).*

Targeting for the laser array and the submunition dispenser is provided by a light target tracking array (Power 5, two tons and MLv0.25).

Example: *American terminology designates the Kennedy as a missile carrier, with primary armament of combat drones. In addition to its drones, the Kennedy sports a number of laser arrays for close combat. Primary laser armament consists of eight EA-1000 lasers in retractable mounts. Each mount requires one ton for the mount itself, one ton for the weapon, another ton for the retractable option and one ton for the UTES system; four tons per weapon. Total Power requirement per mount is 25, for a total of 200 for all eight. The eight mounts consume a total of 32 tons and cost MLv38.*

Along with the eight laser arrays, the Kennedy is also equipped with a dedicated point defence system. It carries a Type-29 PDC in a standard surface mount, with the retractable option. This consumes one ton and MLv1. PDCs have built-in targeting, so the UTES is not required. The PDC-29 requires Power 20, consumes two tons and costs MLv2. Combined, the weapon and mount consume four tons and cost MLv4.

As it is over 500-tons, the Kennedy has a Tactical Action Centre (TAC) for the 22 crew in tactical stations: a command officer, nine gunners, 10 remote operators and two sensor operators. The TAC consumes 22 tons and costs MLv2.2.

STEP 11

DRONES

Drones are small, remote-operated craft used for a variety of purposes, including reconnaissance, system surveys, sentinels and combat (sometimes referred to as missiles, although this is not common). They are a class of remote object capable of movement under their own power while remote-operated from a starship by a human operator, effectively miniature spacecraft, complete with stutterwarp drives. Even the smallest drone is many times the size of a missile or torpedo from *High Guard*.

Drone Controllers

Each drone 'in flight' requires a dedicated drone controller and human operator.

DRONE CONTROLLER

This is a dedicated workstation and tight-beam communicator, used to control remote objects like drones and probes. Each can control only one object at a time.

TL:	10
Power	2
Tons:	1
Cost:	MLv0.5

Combat Drones

Combat drones are weaponised drones, equipped with either a directed energy weapon that has a limited number of shots or a detonation laser warhead. They represent the most common class of drone, with the most variations and largest number of total vehicles. Drones fitted with a weapon are often termed 'drone fighters', while some term the detonation-laser models 'missiles'. A third type has just started to appear, where the warhead is deployed to fire while the drone, the 'bus', moves to a safe range. This saves the drone body and its expensive stutterwarp drive for future use.

Another type of combat drone is the point defence drone, a variant of the drone fighter that mounts an optimised point defence cluster in place of the laser or particle beam array.

Combat drones are equipped with rudimentary sensors and use their link back to the controller for all targeting and guidance. Combat drones are further detailed on page 35.

Decoy Drones

With the onset of widespread hostilities towards the end of the Central Asian War, merchants and other non-combatants suddenly found themselves potential targets for Manchurian, and later French, commerce raiders. While the actual amount of shipping destroyed was relatively small, it nonetheless served to greatly diminish interstellar traffic. While convoys were used on the French Arm, a good commerce raider could still damage or destroy a ship before escaping. The Manchuria Tung-hu was specifically designed to foil this tactic.

The decoy drone consists of two parts. The first, the main bus, contains the electronics, radiators and power supply necessary to have a Radiated Signature equal to the mimicked ship. The second part is a rapidly inflating reflective mylar balloon that mimics the Reflected Signature of the mimicked ship. A careful analysis of the stutterwarp signature using GADS might be able to tell the difference but GADS scans are difficult. While first designed for use by civilian vessels, the military soon saw their usefulness and they are fielded by France, Britain, Germany and Argentina. Other space forces are pushing into development their own decoy platforms.

A decoy drone is detailed on page 167.

Sensor Drones

Most sensor drones carry optimised packages to extend the eyes and ears of military starships. Some, however, are fitted with scientific instruments to assist scout ships and survey teams. These will typically carry out surveys of other worlds in a system while the parent ship investigates the main target. These are further detailed on page 166.

Probes, Satellites and Other Remote Objects

Aside from the stutterwarp driven drones, there are other remote objects in use by starships, including remote science landers, inspection remotes, repair remotes and a panoply of various satellites and deep space buoys. These short-range devices do not require a dedicated drone controller. Several examples of all of these can be found on page 161.

Drone Support Options

As miniature spaceships, drones need to be housed either within a ship or externally in slings or missile packs. These remote craft also require specialised support fittings.

DRONE BAYS

Drone bays are designed as small craft bays and require 1.1 tons of space per ton of missile. Missile bays do not consume hardpoints, although ships are limited to one every 100 tons. A bay can deploy two drones per round.

TL:	10
Tons:	110% of the total missiles tonnage
Cost:	MLv0.01 per ton

NUCLEAR WARHEAD MAINTENANCE BAY

A maintenance bay includes facilities for the safe handling, maintenance and containment of nuclear warheads. All other repairs require a standard workshop.

TL:	11
Tons:	4
Cost:	MLv1.2

DRONE PACKS

Combat drones are sometimes carried in external packs, developed for spacecraft lacking drone capability. These packs contain two to six drones of the same type and at least one drone controller, sometimes more. Drone packs are usually carried in external slings; the actual missiles are purchased separately. An external drone pack adds +1 to a ship's Signature. The Stealth trait can be added to missile packs, at a cost of MLv5.

TL:	11
Tons:	1.2 per missile, plus 1 per controller
Cost:	MLv0.15 per ton, plus MLv0.5 per controller

Spacecraft can carry drones in external slings. Vessels under 50 tons can carry one, while vessels from 50–99 can carry two. Larger vessels can carry two for every 100 tons. These drones require external slings on the spacecraft and each drone in flight requires a drone controller on the ship.

Example: *The Jian carries a single Fan Tan combat drone in an internal bay, along with a dedicated controller for the weapon. The Fan Tan drone itself consumes 1.6 tons (subsumed in the tonnage of the drone bay) and costs MLv2.45.*

The drone bay is built to accommodate the 1.6-ton drone, with the +10% overhead, so is 1.76 tons and costs MLv0.18. The single drone controller requires Power 2, 0.25 tons and costs MLv0.5.

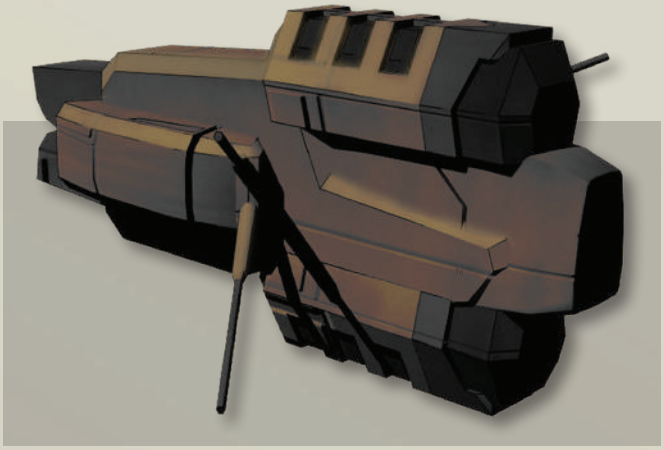
Example: *American terminology designates the Kennedy as a missile carrier, with primary armament as its combat drones. Two bays hold 10 SIM-14 drones apiece.*

The Kennedy has 10 drone controllers. In normal operations, one is used to control a sensor drone, the other nine to control combat drones.

The 10 controllers require Power 20, consume 2.5 tons and cost MLv5. The 20 combat drones are carried in two bays, which consume a total of 41.8 tons and cost MLv0.418.

These bays are attached to a warhead maintenance workshop. The workshop consumes four tons and costs MLv1.2.

Along with its combat drones, the Kennedy also carries several other remote objects and drones, including 10 communication satellites, 4 inspection drones, 10 repair drones, a Goalkeeper point defence drone and an HD-5 sensor drone. All of these remote objects are contained in berth and consume 12.1 tons. Total cost for drones and berths is MLv13.5.



STEP 12 SMALL CRAFT AND VEHICLES

The various sub-craft carried by a ship require storage and maintenance space. All sub-craft, including lifeboats, drones, missiles and satellites, use the options here for storage and housing.

STRUCTURAL BERTHS

Structural berths house single-use craft, typically lifeboats, in a rapid-release mount. While a door seals behind the lifeboat, launching one can compromise the structural integrity of the parent vessel. Since the structural berth is designed to permit rapid launch, it lacks the fail-safes normally found in bays and berths. Structural berths do not consume any space by themselves; there is simply a cost for them, as they are closely conformal to the specific lifeboat fitted. Refitting a lifeboat to a structural berth requires the services of at least a Class C starport. Structural berths can only take ballistic lifeboats; airframe types must be housed in a berth or externally on the hull.

Cost:	MLv0.01 per ton of carried craft

BERTH

Berths are custom-built bays designed to hold a specific small craft. A berth consumes 110% of the tonnage of the vessel or vehicle being stowed. In the case of vehicles, use their Shipping Space as tonnage.

Tons:	110% of craft tonnage
Cost:	MLv0.01 per ton

CLOSE HANGAR

Normally, when a small craft is included in the design of a larger vessel, it is installed into a berth. The crawler on a landing craft, for example, is carried in a small compartment in the forward section, with barely enough room for passengers to scramble on board. Most repairs and maintenance require the crawler to disembark first.

Adding a close hangar allows for repairs and maintenance of the small craft when docked. The hangar includes limited spare parts, a small industrial fabricator, and specialised testing and repair equipment. As a close hangar is still a cramped place to work, DM-1 is applied on all repair-related checks.

For example, carrying a 50-ton landing craft in a berth normally consumes 55 tons of space. If it is given a close hangar, requires 65 tons instead. A close hangar provides five points for repairs of carried craft, as per the workshop on page 48.

Tons:	130% of craft tonnage
Cost:	MLv0.2 per ton

FULL HANGAR

Full hangars are found only on the largest vessels and allow unfettered access and repair of carried vessels. A full hangar allows for easy repair and maintenance, and includes a limited supply of spare parts, a medium industrial fabricator and specialised testing and repair equipment. A full hangar grants 10 points for repairs of carried craft, as per the workshop on page 48.

Tons:	200% of craft tonnage
Cost:	MLv0.3 per ton

SLING

A sling is a clamp system designed to hold a small craft or cargo against the hull. The tonnage includes a small, one-person airlock for physical access between the carrier and any daughter-craft.

TL:	11
Tons:	5% of craft tonnage
Cost:	MLv0.01 per ton of craft

Vehicles and Small Craft

There are a large number of vehicles and small craft that a ship can carry. The Vehicle and Small Craft table gives the size, cost, fuel, crew and maintenance crew required.

***Example**: The Jian has no carried craft .*

***Example**: The Kennedy has no carried craft but does have an external sling capable of carrying 55 tons. This sling consumes 0.55 tons and costs MLv0.55.*

Vehicle and Small Craft

Vehicle or Spacecraft	Tons	Cost	Fuel	Crew	Maintenance
AB.100 Spaceplane	95	MLv16.78	16	4	1
AS-400 Drop Pod	400	MLv19.84	24	0	2
Assegai Space Fighter	20	MLv11.92	4	1	2
Auroch IFV	10.875	MLv1.34	0	3	1
Battleaxe IFV	6.5	MLv0.3	0	3	1
Beachhead Lander	400	MLv144	50	57	4
Bessieres Hover IFV	9	MLv0.9	0	3	1
Bison Spaceplane	60	MLv9.25	17	2	1
CITIIIA Combat Lander	30	MLv14.51	9.18	2	1
DC-30 Ballistic Lander	30	MLv4.1	16.65	2	1
DRV-4 Drop Pod	160	MLv8.61	5.6	0	0
EDA-150 Combat Lander	150	MLv46.65	28	5	2
Endeavour HLV	200	MLv20.63	40	4	2
Explorer-X Tracked ATV	20	MLv0.52	0	2	1
FS-17A Space Fighter	20	MLv17.62	4	2	2
Gustav Space Fighter	30	MLv34.1	5	2	2
HL-150 Cargo Spaceplane	150	MLv14.68	26.5	2	2
Jian Space Fighter	32	MLv25.32	8	2	2
JM-40 Lander	40	MLv5.74	7.5	2	1
Kangaroo IV Hover IFV	9.5	MLv0.338	0	2	1
L-50 Drop Pod	50	MLv2.83	1.75	0	0
LC-10 Combat Lander	40	MLv12.16	8.5	2	2
Lynx Wheeled Armoured Scout	7.5	MLv0.416	0	3	1
Martel Gunboat	60	MLv56.28	16.17	2	2
Mistral Aerospace Fighter	30	MLv27.15	6.5	2	2
Piper Personal-ATV	2	MLv0.009	0	1	0
R40 Pinnace	40	MLv5.01	7.5	3	1
RangeStar Range Truck	5	MLv0.015	0	1	0
Sabourin L-50 Drop Pod	50	MLv2.83	1.75	0	0
SLV-55 Multi-Mission Pod	15	MLv1.03	0	0	1
SLV-55 Scout Lander	55	MLv12.22	22.75	2	1
Songbird Hover Jeep	3.5	MLv0.023	0	1	0
Starlight Spaceplane	50	MLv13.53	9.5	2	1
Turmfalke Spaceplane	20	MLv4.12	7	2	1
Typhoon Aerospace Fighter	20	MLv17.84	4.5	2	2
Walker	1.5	MLv0.6	0	1	0
Workerbee	1.5	MLv0.15	1	1	0

STEP 13 DETERMINE CREW

All ships, regardless of technology and automation, require a certain number of crew on board to run each system and perform necessary duties. The smallest of ships can get away with just one or two multi-skilled individuals but the capital ships may need several hundred.

Life Support

Any ship with an expected duration of more than 12 hours must allocate a certain amount of space for life support consumables; food, water and waste requirements. While water is recycled on short-haul ships with mission durations of less than six months, waste is usually dehydrated and stored. In all cases, space is required for food, medicine and other consumables.

Short duration ships require 0.002 tons per person per week for consumables and water/waste storage. Long duration ships and space stations have different challenges and requirements, addressed on page 60.

These consumables do not have a cost, as they are part of monthly life support costs, which include food along with such things as filter replacements and water/air top-offs.

Luxury consumables double this size requirement and add +1 to the ship's Comfort Rating.

Small Ship Crews

All small craft require at least a pilot and many commercial craft also carry a co-pilot. In military craft, the second crew position is often a co-pilot/weapons officer. Any additional crew in small craft must have acceleration couches.

Large Ship Crews

Ships have three bridge watches of eight hours each and at least some crew are always expected to be available.

Non-commercial vessels are usually small and used for roles like transportation of corporate officers or government officials. Scout craft and couriers can fall into this category as well, although most governmental or foundation-owned survey craft will use the requirements for commercial crews.

Commercial vessels carry cargo and occasionally passengers. They are required to have a full watch and two half-watches to staff the alternate watch periods.

Military vessels are required to maintain full bridge staff for each watch period. Some civilian vessels, like long-range explorers and colony arks, have the same staffing requirements. Tactical personnel, like gunners and remote operators, maintain two full watches, often divided into three understrength watches, on the assumption that a watch crew can be brought to full strength quickly.

The Crew Requirements tables show how many crew are needed for a ship and include any required watch redundancy. Salary can vary but the values on the tables show a monthly average for skill level one crew, with the presumption that +50% will be added for every skill level above this.

Bridge Watches

On non-commercial and non-military vessels, crew can fill multiple roles and three bridge watches are not required, although there should always be at least one person on the bridge. Commercial vessels generally require at least three personnel on the bridge, although often make do with two. Military vessels, on the other hand, unless they have lost crew from combat or accident, are always required to have all bridge positions fully staffed (see table below).

Bridge Crew

Position	Skills	Salary	Non-Commercial	Commercial	Military
Captain	Leadership or Tactics	Lv10000	1	2	3 (Captain, plus bridge officers)
Pilot	Pilot	Lv6000	1	2	3
Navigator	Astrogation	Lv5000	1	2	3
Engineer	Engineer	Lv4000	1	2	3
Sensors	Electronics (sensors)	Lv3000	1	2	3

Tactical Crew

Position	Skills	Salary	Non-Commercial	Commercial	Military
Flight Controller	Tactics	Lv3000	0	0	1 per 10 small craft
Gunner	Gunner	Lv2000	0	1 per TTA, UTES or PDC	2 per TTA, UTES or PDC
Remote Operators	Electronics (remote ops)	Lv4000	1 per drone controller	1 per drone controller	2 per drone controller
Sensor Operators	Electronics (sensors)	Lv4000	0	2	3
Drone Technicians	Engineer	Lv3000	0	0	1 per ten missiles

Tactical Crew

Armed starships require crew to operate weapons, one per fire control system. A fire control system is a single TTA controlling any number of weapons in a battery, a light TTA controlling up to four weapons in a battery or a UTES controller.

Ships also require crew to operate remote objects and drones, at one per drone controller, and may require other specialised crew. In ships over 500 tons, the duty watch of this crew is located in a Tactical Action Centre (TAC), a hardened 'battle bridge' located in a sheltered part of the ship. TAC crew are drawn from the standard crew complement. The TAC is never located in a vulnerable spin section and is usually in the centre of the ship.

Non-commercial starships often do not allocate crew for combat positions.

Large military ships typically have crew in the TAC which may, or may not, be adjacent to or even part of the bridge. In most military vessels, the TAC is buried deep in the hull, as well-protected as possible.

Tactical Action Centre

Position	Military
Command	1
Flight Controller	1 per 10 small craft
Gunner	1 per TTA or UTES
Remote Operators	1 per drone controller
Sensors Operators	2

Support Crew

Commercial and military vessels are required by regulation to have the listed crew but some variance in commercial ships is generally allowed. Non-commercial ships do not have to abide by these restrictions and one crew member can fill multiple roles.

Support Crew

Position	Skills	Salary	Non-Commercial	Commercial	Military
Administrator	Admin	Lv1500	0	1 per 500 tons of ship	—
Cargo Handlers	—	Lv750	1 per 200 tons of cargo	1 per 200 tons cargo (1 per 500 for containers)	—
Medic	Medic	Lv4000	0	1 per 120 passengers	1 per 25 crew
Security	Vacc Suit, Athletics, Gun Combat	Lv3000	0	1 per 20 passengers	1 per 20 crew
Ship's Troops	Vacc Suit, Athletics, Gun Combat	Lv2500	0	0	Varies
Small Craft/ Fighter Pilots	Pilot	Lv5000	0	1 per small craft	2 per small craft
Steward	Steward	Lv2000	0	1 per 10 High or 100 Middle passengers	1 per 10 High or 100 Middle passengers, 1 per 10 officers

Engineering Crew

Engineering Component	Skill	Salary	Non-Commercial	Commercial	Military
Fission Plant	Engineer (power)	Lv4000	1 + Power/50	x2	x3
Fuel Cells	Engineer (power)	Lv4000	1	2	3
Fusion Plant	Engineer (power)	Lv4000	1 + Power/300	x2	x3
MHD Turbine	Engineer (power)	Lv4000	1 + Power/500	x2	x3
Radio-Thermal Generator	Engineer (power)	Lv4000	1	2	3
Solar Panel/PSM	Engineer (power)	Lv4000	1	2	3

Engineering Crew

Engineering crew requirements typically depend largely on either the output of the power plant or power requirement of the drive system. Some systems, like life support, depend on vessel size, while small craft and missile maintenance roles depend on the number carried. Damage control teams are often filled by ships troops, one of the few 'double duties' permitted on military craft.

The various types of power plants have different requirements for optimal operation. Commercial and military craft have redundancies in various positions for safety and security.

Drive System Crew

There are only a few types of drive systems in common use, such as the interface drive and stutterwarp. System drives are only in use with independent belt miners and similar drifters, although even those ships are liable to have stutterwarp.

Other Systems

The other technical systems on a spacecraft often require a skill other than Engineer to handle maintenance and repair.

Small Craft Crew

Ships of less than 100 tons only need a single pilot but commercial craft usually require a co-pilot too. Journeys undertaken by such ships are generally short and it is assumed regular maintenance will remove any need for mid-voyage engineering.

Specialised small craft, such as those engaged in scientific work or with separate weapon stations, may function more efficiently with more crew positions but they are not strictly necessary to the operation of the ship.

Small craft do require maintenance and, when stationed on another ship, require maintenance personnel onboard. Ships under 100 tons require one maintenance crew and one more if they are armed. Ships over 100 tons require one person per 100 tons.

Drive System Crew

Engineering Component	Skill	Salary	Non-Commercial	Commercial	Military
Interface Drive	Engineer (m-drive)	Lv4000	1	2	3
Stutterwarp	Engineer (stutterwarp)	Lv4000	1	2	3
System Drive	Engineer (m-drive)	Lv5000	1+ Power/20	x2	x3
Small Craft/Fighter Technician	Engineer	Lv3000	1 if any carried	1 per 2 craft	1 per craft

Other Systems

Engineering Component	Skill	Salary	Non-Commercial	Commercial	Military
Life Support Technician	Mechanics	Lv2000	1	2	3
Sensors and Avionics	Electronics	Lv3000	0	2	3

Small Crew Complements

Spacecraft in the hands of small-time traders or adventurers, like Libertines and belters, usually run with the minimum of crew, with personnel often fulfilling more than one role. For example, it is very common on a smaller ship for the pilot to also act as astrogator, or a steward to have basic medical skills. This keeps the monthly salary bill low and increases what may otherwise be very slim profit margins.

Ships of less than 400 tons can, in theory, be run by just one or two multi-skilled people but the ship will be at a serious disadvantage in high-stress situations such as combat. The crewman acting as pilot will likely be kept busy on the bridge, actually flying the ship, while the other will find their attention split between engineering, damage control and the weapon systems – a quick look at the Crew Duties section of the *Traveller Core Rulebook* (page 154) demonstrates how inefficient this can be.

Lifeboats

The carriage of lifeboats is often a legal and insurance matter. In deep space, far from a planet, the typical lifeboat is just a way of prolonging death; no lifeboat ejected into deep space has ever been recovered with its occupants still alive.

Military ships almost never carry lifeboats. The closest they come is with orbital drop pods, an incredibly dangerous tactic that few nations perform any more.

Civilian ships, especially liners, are required by the laws of their flag nation to carry lifeboats. By default, most follow France's lead in this requirement, with enough lifeboat capacity to offload all passengers and crew. Germany only requires lifeboats for orbital stations, while the United States and Manchuria do not require lifeboats at all. The Incan Republic, on the other hand, only requires lifeboat capacity for the crew.

Most lifeboats are sturdy, squat cones with a blunt, rounded base for the heat shield. There are three standard sizes of lifeboat, at 1, 5, and 10 tons, with Manchuria having its own spin, as their larger lifeboat is a lifting body glider.

***Example**: The Jian has a crew of two: pilot/ commander and weapons officer.*

***Example**: As a military vessel, the Kennedy has large crew requirements. Most crew positions require three full watches, including bridge and engineering. Gunnery and drone control have two full watches. The bridge has five positions (command, pilot, astrogator, engineer and sensor operator), multiplied by three for a total of 15.*

The tactical crew contains two full watches, rather than three. For the Kennedy, these are the nine gunners required for the eight weapons/ UTES mounts and single PDC, and 10 remote pilots for the missiles and drone. Multiplied by two, that is 18 gunners and 20 remote pilots.

Two drone technicians (1 per 10 drones) are also required and considered to be part of the tactical crew. These specialist positions do not have three-watch redundancy.

The engineering crew requires three full watches, breaking down to three life support technicians, 15 engineers for the fusion power plant, three for the stutterwarp drive, three for the reaction drive, and three electronics technicians.

Additional support crew includes 3 security personnel (marines), three medics and a single steward to support the command officers and any high-ranking guests.

Total crew is therefore 90.

STEP 14 ACCOMMODATIONS

All vessels, no matter duration or size, require some means of accommodating passengers and crew. The requirements vary greatly between long and short duration craft. When designing accommodations and other crew fittings, track any tonnage that will be in a spin habitat.

Short Duration Accommodations

All that is required for very short ranged flights are standard acceleration couches. Other amenities can be added, including freshers and entertainment facilities.

STANDARD ACCELERATION COUCH

For short-duration flights, many ships use standard acceleration couches, similar to the seats in a commercial airliner. These are most commonly found in interface vessels, where flight times are typically an hour or less.

TL:	8
Tons:	0.25
Cost:	MLv0.03

LONG-ENDURANCE COUCH

Long-Endurance couches are available for longer flights, of up to two days. They are significantly more comfortable than a standard acceleration couch but, even then, begin to get uncomfortable over long time periods.

TL:	9
Tons:	0.5
Cost:	MLv0.05

Standard Accommodations

There are a number of options used by starships to accommodate crew and passengers for long-term travel. Some are not suitable for paying passengers but all tend to be on the spartan side at best. While choosing accommodations and other interior fittings, it is important to note what will be under spin, if spin is available for the craft.

STATEROOMS

Staterooms represent the standard living space for both crew and passengers. A single stateroom contains living and sleeping facilities, including a bed, fresher and a small amount of storage. Most staterooms also contain a terminal that allows access of the ship's network for archive and entertainment purposes. Authorised users can also access many of the ship's higher functions. Most ships will allocate one person to each stateroom.

TL:	9
Tons:	4
Cost:	MLv0.5

Double Occupancy

Some ships have bunks in their staterooms rather than single beds, allowing two people to share the same stateroom. This is called double occupancy and often done on exploratory ships, privately-owned vessels and, especially, military ships. On some ships, however, even two to a room is a luxury.

Military ships will often put two or even four in a room, while colony ships will typically allocate a cabin to a four-person family or three adults. Life support costs are based on the number of passengers, not number of rooms.

CRYO BERTHS

A cryo berth provides suspended animation facilities for emergencies and low-paying passengers. They are not always safe to use (see the *Traveller Core Rulebook*, page 182) but take up relatively little space or power. They provide DM+4 on Medic checks to revive passengers but take 10 times longer to freeze or thaw their contents. A cryo berth can hold a single passenger.

TL:	10
Tons:	0.5
Cost:	MLv0.5

BUNKS

Bunks are installed in banks of three beds each. Bunks do not have space for freshers or other facilities and only minimal storage for occupants. Only trained military crews, typically marines and passengers in steerage can be supplied bunks. Each ton of bunk holds three people.

TL:	9
Tons:	1
Cost:	MLv0.0.25

RACK CAPSULES

Rack capsules, often just called 'racks', are installed in blocks of two and afford more privacy than bunks. They are small enclosed rooms, about 1 m x 1 m x 2 m. Storage is provided within the enclosed space and outside, as drawers and lockers. There is enough room in a capsule to sit up, work on a terminal and give a feeling of personal space. Capsules are usually carefully sound-proofed to enhance privacy and are common on long-range exploration vessels. Like bunks, capsules cannot be used for passenger accommodations except under unusual circumstances. For long duration crews in cramped quarters, capsules offer something that shared accommodations do not: privacy. A block of capsules houses two people.

TL:	10
Tons:	1
Cost:	MLv0.25

EMERGENCY OPTIONS

Rack capsules can be outfitted as emergency shelters of a sort, supplying short-term life support, including a limited supply of air, food, water and waste handling. They are often found on exploratory vessels to keep mission specialists and scientists safe and out of the way of crew during emergencies.

TL:	10
Tons:	0.02 per day
Cost:	MLv0.01 per day

SMALL STATEROOMS

Small staterooms are intended only for single occupancy. This small space includes storage, a fold-up bed, fold-out desk and chair, and a very small fresher complete with fold-out sink and toilet. In a spin gravity environment, small staterooms seem very confining but in zero-Gravity conditions they seem spacious. Small staterooms are common on vessels without spin gravity. They offer more privacy in the same amount of space as a double-occupancy stateroom. For craft that lack spin habitats, a small stateroom is treated as a normal stateroom for purposes of calculating Comfort Rating.

TL:	9
Tons:	2
Cost:	MLv0.1

LUXURY SUITES

These are high-class suites, complete with full bath facilities, separate sleeping quarters and living room. The tonnage required is not just for the suite but includes connecting corridors and other common spaces. Suites like this are seldom seen outside of the largest liners and space stations.

TL:	10
Tons:	8
Cost:	MLv1.0

ACCOMMODATIONS

Type	Power	Tons	Cost
Acceleration Couch	0	0.25	MLv0.03
Bunks	0	1	MLv0.025
Cryo Berth	0	0.5	MLv0.5
Long Duration Couch	0	0.5	MLv0.05
Luxury Suite	0	8	MLv1.0
Rack Capsules	0	1	MLv0.25
Small Stateroom	0	2	MLv0.1
Stateroom	0	4	MLv0.5

COMMON AREAS

It is common practice to assign an additional amount of tonnage, typically equal to half that used for staterooms, as common areas or general living space. These will typically be open spaces used as a mess, canteen or lounge. The cost does not include dedicated exercise equipment or other recreational equipment; it is simply open space. This is not strictly necessary and ships can and will vary in this allocation, either increasing it to give crews and passengers a more luxurious (or at least more comfortable) journey or cutting back to give more space to useful components at a cost of crew comfort. Allocating a volume equal to at least half that used for staterooms and other accommodations results in a +1 bonus to the ship's Comfort Rating.

Common areas cost MLv0.05 per ton.

__Example__: The Jian has no accommodations fitted.

__Example__: The Kennedy requires accommodation for 90 crew and possible guests. Four of the crew are command staff and have their own staterooms. There are another 90 small staterooms for crew and guests.

The captain takes one of the staterooms, as do the senior NCO onboard and the other two command staff. 90 small staterooms consume 180 tons and cost MLv9. The four staterooms take up 16 tons and cost MLv2. All of these accommodations will be under spin.

It should be noted that the Kennedy is widely regarded as a luxurious posting.

STEP 15 INTERNAL FITTINGS

Internal fittings are contained within the hull of the ship and include equipment and spaces for use of the crew for functions other than sleeping space. When adding fittings to a ship, note which are under spin and which are not. The size of all accommodations and fitting under spin is used to determine the size and cost of the spin system.

Facilities

These are directly for the enjoyment and support of the crew and passengers.

EXERCISE EQUIPMENT

This is designed to help maintain muscle tone in low and zero gravity. Any large craft that does not have a spin habitat requires these facilities to ensure crew health, regardless of mission duration. Exercise facilities require one ton per person using it and should accommodate a third of a ship's watch at a time. For passengers, it should be able to accommodate 10% of the passengers at a time, in addition to the crew.

TL:	8
Tons:	1 per person
Cost:	MLv0.25

FRESHER

A fresher is a combination toilet/shower/washroom. Staterooms have one built-in but bunkrooms do not. Medbays will also often have a fresher nearby.

TL:	9
Tons:	0.25
Cost:	MLv0.010

GALLEY

A galley is a small space devoted to food preparation, rather than simply reheating prepack meals. On some ships it is dubbed a 'cafeteria'. Galleys include food storage, preparation and heating appliances. The space also includes a compact bar to accommodate people eating. A galley requires space equal to the number of people served at a time, in tons. Cost is likewise calculated on the number served. Galleys are usually designed to serve a third of a watch at a time.

TL:	9
Tons:	1 per person
Cost:	MLv0.05

GALLEY, FULL

A full galley is like a dedicated workshop for the preparation of food. It has multiple work surfaces, food storage and cooking surfaces. Up to three people can work in a full galley. The full galley grants DM+1 to Steward checks in food preparation. A full galley does not include space for people to sit and eat.

TL:	8
Tons:	4
Cost:	MLv0.25

LIBRARY

A library room contains computer files as well as lecterns, display screens, holotanks and even hard copies of books. A good library is useful for both research and passing time on long journeys. Having a library on board a ship grants DM+1 to EDU checks made while training new skills.

TL:	8
Tons:	4
Cost:	MLv0.05

LUXURY DINING

While minimal dining facilities are included in the space requirements and cost of all accommodations, luxury dining represents a true full-service restaurant. Luxury dining requires a full galley for food preparation and an additional steward per 12 people.

TL:	8
Tons:	1 per person
Cost:	MLv0.05

SIMPLE FRESHER

A simple fresher lacks the shower facility of a standard fresher and is most often found in public areas of a ship or station. Simple freshers typically have three toilets and accompanying sinks.

TL:	9
Tons:	0.5
Cost:	MLv0.005

TACTICAL ACTION CENTRE

Most military vessels 400 tons and higher have a Tactical Action Centre (TAC), usually well-protected deep within the ship. The tactical crew consists of one per weapon and missile controller, one or two for sensor operators and one (or more) for any flight controllers. It is hardened and ignores the first critical hit against it.

TL:	10
Tons:	1 per crew member
Cost:	MLv2 per ton

THEATRE

Theatres are used for large briefings, live performances, movies or immersives. Costs and space requirements include necessary equipment for all types of performances.

TL:	8
Tons:	0.75 per occupant
Cost:	MLv0.04

SAFETY LOCKER

While not all ships have safety lockers, they are mandated for commercial vessels in the registries of most nations. France, for example, requires one safety locker per 20 passengers, while the German Republic insists on one safety locker per 15 people on the ship. Notably, Indonesia does not require safety lockers for ships bearing its flag, although most Indonesian corporate ships follow the French example.

They typically hold a variety of safety equipment like rescue balls, emergency patches, fire extinguishers and similar items of equipment. A locker consumes effectively no space on the ship, tucked away into odd corners and waste space.

TL:	10
Cost:	MLv0.05

SHIP'S LOCKER

Every ship larger than 90 tons has a ship's locker. Typical equipment carried will include protective clothing, vacc suits, weapons such as shotguns or pistols, ammunition, compasses and survival aids, and portable shelters. The locker is usually protected by a biometric lock keyed to the ship's officers. The size of locker varies based on the size of the ship.

TL:	10
Tons:	0.5 for ships up to 500 tons, 1 for ships up to 2,000 tons, or 2 tons for ships larger than 2,000 tons
Cost:	MLv0.1 per ton

UNREP SYSTEM

The Underway Replenishment (UNREP) system is designed to allow for resupply of spacecraft while in motion and is vital to the function of squadrons in unexplored or hostile systems. Spacecraft cannot use stutterwarp drives or expend Burns while undertaking UNREP operations, however. The system includes fuel hoses, cargo transfer tubes and other gear designed to move ordnance and freight between two ships. Only one ship is required to have an UNREP system, although the other must have a cargo airlock.

TL:	10
Power:	1 per ton
Tons	0.05 per ton of cargo to be transferred per hour
Cost:	MLv0.05 per ton

Medical Facilities

Starships operating far from inhabited worlds need to have provision for the health and safety of their crew. Many governments have regulations on medical facilities required for long-haul commercial vessels. It should be noted that some medical operations are more difficult in zero-G, in particular control of bleeding. DM-2 is applied to Medic check for injuries or illnesses that result in bleeding or other fluid loss while in zero-G.

AUTOMED

An automated medical bed, capable of sustaining a critically injured person, assisting in operations (DM+1) or even performing medical procedures on its own (at Medic 2).

TL:	11
Tons:	0.25
Cost:	MLv0.25

MEDBAY

A medbay is a fully-stocked infirmary that can support up to four patients at a time. It has the equivalent of a portable diagnostic imager as part of its standard equipment, along with two gauntlet-style autodocs, in addition to medication equal to 20 standard medkits. It is strictly an acute care facility, built to handle minor sickness and trauma. For example, it is fully-capable of handling a gunshot wound or burns of up to 10% of a patient's body. Anything more would require a full operating theatre and recovery ward for post-operative treatment. The medbay grants DM+2 to Medic checks.

TL:	11
Tons:	6
Cost:	MLv4

Commercial Vessels

Nations vary in their requirements for medical support. Medical personnel are required in most nations at a ratio of 1 per 20 passengers or crew. Most nations also require one automed per 50 passengers or crew, although France and the United States require one per 20.

OPERATING THEATRE

This is a full operating room equipped to the level of a core world hospital. It includes all the advanced technology one would expect and grants DM+3 to all Medic checks. The operating theatre must be placed in an area of the ship under gravity of at least 0.1 G. If not, all Medic checks gain only DM+1.

TL:	11
Tons:	4 per patient
Cost:	MLv3 per patient

RECOVERY WARD

Recovery wards are often placed in low-gravity habitats, although wards for victims of burns and radiation damage will often be housed in zero-G wards with medication to handle nausea. Recovery for injuries causing internal damage or heavy bleeding need to be in an artificial gravity environment.

TL:	11
Tons:	1 per patient
Cost:	MLv2 per patient

Workspaces

Workspaces are dedicated spaces to undertake professional, scientific or artistic tasks.

OFFICE

Although the same size as a stateroom, dedicated office space lacks many of the life support functions and other built-in amenities like a fresher or storage space. It is an empty room with space for two desks, hardcopy file storage and perhaps a small meeting table. One wall is a smart wall for displays and interactive tele-presence meetings. An office allows up to two people to practice Admin, Advocate, Broker or Diplomat skills effectively.

TL:	9
Tons:	4
Cost:	MLv0.025

STUDIO

Space allocated to studios can be dedicated for specific specialities of the Profession skill. The studio combines laboratory, workshop and office for a specific skill. Each studio can accommodate one person at a time.

TL:	9
Tons:	4
Cost:	MLv0.04

GENERAL LABORATORY SPACE

Each four tons of laboratory space allows one scientist to perform research. A general-purpose laboratory is capable of relatively-sophisticated analysis of samples, including chemical composition and physical characteristics. This adds DM+1 to most scientific analytic endeavours for TL10 laboratories, DM+2 for TL11 laboratories and DM+3 for TL12 laboratories. TL11 labs cost MLv1 more than the TL10 version, while TL12 cost MLv2 more.

TL:	10+
Tons:	4
Cost:	MLv1

***Example**: As a short-duration fighter, the Jian has no interior fittings for its crew.*

***Example**: The Kennedy is designed with a large crew and undertakes long patrols. As such, it has many interior fittings to support its crew and mission. These include a galley capable of serving 10 crew at a time (10 tons, MLv0.5), exercise facilities for 20 personnel at a time (20 tons, MLv5), two full medbays (12 tons, MLv8), five automeds (0.5 tons, MLv0.5), a pair of safety lockers and ship's locker (two tons, MLv0.6) and 10 simple freshers (1 ton, MLv0.04), all under spin. In the zero-G portions of the ship are six simple freshers (1.5 tons, MLv0.03) and a safety locker (MLv0.05).*

STEP 16 ENGINEERING FITTINGS

Engineering fittings are additional facilities to ease the work of repairing and maintaining a starship.

AUTOFACTORY

A standard multipurpose autofactory consumes 30 tons and requires Power 20 for operation. An autofactory can produce 10 tons of product per day, from 15 tons of specific raw materials, producing five tons of waste for recycling or disposal. Alternatively, an autofactory can refine ore or other materials into the specific raw materials required.

TL:	11
Power:	20
Tons	30
Cost:	MLv12

WORKSHOP

A workshop is designed to handle most shipboard repair work. It includes an industrial fabricator to manufacture new parts and other equipment as needed. If fully-stocked, the workshop has 10 'repair points' worth of material. This would allow repairs of up to 10 points of Hull damage or five points can provide a single temporary repair to a ship system damaged by a critical on a successful Very Difficult (12+) Mechanics check (1D minutes, EDU). 10 repair points cost MLv0.1 and consume one ton of space. Use of a workshop grants DM+1 to all shipboard repair work.

TL:	11
Tons	8
Cost:	MLv4

***Example**: The Jian does not have any crew facilities.*
***Example**: The Kennedy has two workshops (16 tons, MLv8) under spin. In the zero-G sections of the ship, it has another two workshops (16 tons, MLv8).*

STEP 17

TROOP FITTINGS

Some ships embark troops who require specialised facilities.

Armoury

Ships carrying a large number of marines or soldiers can benefit from an armoury, a specialised weapons store. An armoury can only be accessed by those with the correct codes (usually the ship's senior officers and security team) and contains a wide variety of weapons. An armoury has enough pistols or submachineguns for the crew, enough rifles for any marines and a selection of other military equipment like grenades, combat drug packs, vacuum combat dress and communications equipment. On a military vessel, one armoury is installed for every 50 crew or every 10 marines.

TL:	10
Tons	2
Cost:	MLv2

Briefing Room

A specialised briefing room is useful on military vessels, where teams can discuss plans. A briefing room grants DM+1 to Tactics checks when planning missions. Ships with command bridges and fighter squadrons require these additional briefing rooms and facilities. Military ships must have one briefing room for every 20 fighter or missile control crew.

TL:	10
Tons	2 per person
Cost:	MLv0.25 per person

Training Facilities

Separate from exercise equipment for the crew and passengers, training facilities for military personnel like marines require space for strength and endurance training, combat simulation and weapons practice. On the largest of troop carriers, these facilities are in separate spin habitats to simulate higher gravity.

TL:	11
Power	0.1 Power per ton
Tons	2 per person
Cost:	MLv0.2 per ton

Example*: As a short-duration fighter craft, the Jian has no interior fittings for its crew.*

Example*: The Kennedy does not have troops, aside from a small security detachment. It is a military vessel and has requirements for its crew. Facilities include an armoury (two tons, MLv0.5) and a briefing room able to hold 24 crew, the 20 drone crew and four officers (24 tons, MLv3), both under spin.*

STEP 18 ARTIFICIAL GRAVITY

For long-duration spaceflight, artificial gravity is necessary to maintain the health and wellbeing of the crew. The low gravity generated by typical ship-mounted spin habitats helps with this task but stringent exercise and metabolic treatments are still required. The psychological benefit of at least some gravity cannot be ignored; gravity allows the crew to eat, sleep and perform other daily functions in relative comfort and ease. Gravity is also required for certain medical procedures.

To design a spin habitat, total the tonnage of all ship components under spin. This includes staterooms, common areas and special features such as medical bays or briefing rooms. This is used to determine the size and cost of the spin habitat machinery. None of the spin habitats require power to operate; they require power to spin up but this is a one-time use and after that just power a trickle of power to replace frictional losses from bearings and other mechanical connections is needed.

The tonnage and costs listed are for a small 15 metres radius design. Increase the size and cost by 10% for each additional 15 metres increment.

SPUN HULL

This is the simplest, but usually largest, spin habitat available. The hull is simply a large cylinder that spins around its axis, providing gravity along the edge of the cylinder. Due to Coriolis effects, the central part of the cylinder (within a radius of 15 metres) is unusable for crew or passengers and is usually used for cargo, fuel and low maintenance machinery. Only spaceframes can be spun hull designs.

TL:	8
Tons	N/A
Cost:	N/A

DOUBLE HULL

The outer hull spins but surrounds an enclosed inner hull that does not. This is most useful for large designs, as the enclosed central hull is at least 15 metres in radius. More often the hull is built as a torus or drum and the central core is occupied by a non-spinning core containing engineering and other components.

Habitation can be split between the core and ring but, in general, fittings and accommodations are in the spin section. Spaceframe and distributed hulls can use a double hull.

TL:	8
Tons	0.05 per ton under spin
Cost:	MLv0.01 per ton under spin

SPIN CAPSULES

This system is a set of capsules at the end of a long rotating arm. Most ships have between one and four of these capsules, although two is most common. When possible, they should be installed in counter-rotating pairs to eliminate torque effects on the ship.

TL:	8
Tons	0.1 per ton under spin
Cost:	MLv0.05 per ton under spin

RETRACTABLE SPIN CAPSULES

The retractable spin capsule can retract against a vessel's hull, minimising target profile and reducing the vulnerability of the ship's life support sections. This can also be used on a streamlined or airframe vessel to fold habitat areas away during atmospheric operations.

TL:	10
Tons	+50%
Cost:	+50%

TWO-BODY

Two ships of the same size can join via a retractable tower or pylon and spin around the common centre of mass. The volume given is for the connecting tower that each vessel must have.

TL:	9
Tons	0.05 per ton of ship
Cost:	MLv0.1 per ton

Spin Gravity Effects

The amount of artificial gravity generated depends on the size and rotational speed of the habitat. In general, the larger the radius and the faster the rate of spin, the higher the gravity.

Spin habitats on most starships are neither very large, nor do they spin fast. Any rate of spin beyond one RPM can cause health effects, although they can usually be ameliorated with training or drugs.

Spin Gravity

Radius	4 RPM	3 RPM	2 RPM	1 RPM	<1 RPM
15m	0.26g	0.15g	0.07g	0.02g	0.01g
30m	0.53g	0.30g	0.13g	0.03g	0.02g
45m	0.81g	0.45g	0.20g	0.05g	0.03g
60m	1.07g	0.60g	0.27g	0.07g	0.04g
75m	1.34g	0.75g	0.34g	0.08g	0.05g
90m	1.61g	0.91g	0.40g	0.1g	0.06g

Spin habitats must have a radius of at least 15 metres in order to keep Coriolis effects to a minimum. Even at a 15 metre radius, however, experienced gravity is noticeably different from head to the feet (0.15 at feet, 0.13 at the head, at 3 rpm).

Example: *The Jian is far too small to have a spin habitat.*

Example: *The Kennedy has 294.83 tons of habitation space under spin. It is designed to use spin habs, which consume 29.48 tons and costs MLv14.74. Making the spin habs retractable to reduce the Kennedy's Signature consumes an additional 50% of their size and cost, for 14.74 tons and MLv7.37.*

The spin habs are designed with a 45 metre radius and spun at three rpm. This gives a felt gravity of 0.45 G when the habitats are fully extended. Each 15 metre increase in radius adds 10% to the size and cost of the spin machinery. This works out to an additional 5.895 tons and MLv2.95.

Total tonnage and cost of the spin habs is 35.38 tons and MLv17.69. The spin habs take 27 minutes to spin down and retract, or six combat rounds.

Spin Up and Spin Down

Spin gravity systems need time to spin up and spin down. The time to perform either is equal to one hour multiplied by the gravity (in Gs) of the spin system. A ship with a 0.45G system would take 0.45 hours (27 minutes) to spin up or down. Retractable spin habitats take 20% longer, due to the need to stow non-spinning sections. Doing so quicker requires a Very Difficult (12+) Engineer (power) check (EDU). Success reduces this time by the Effect x two minutes.

STEP 19 EXTERNAL FITTINGS

External components are normally mounted on the exterior of the hull of a spacecraft. They can be placed into retractable mounts if desired, for twice the tonnage and an additional 50% of the cost of the fitting.

BREACHING TUBE

All airlocks include flexible plastic docking tubes that allow passengers to cross from one ship to another. These tubes are typically no more than 10 metres long and can be easily breached by any moderately-sharp object. A breaching tube is a military version of the common docking tube. Instead of thin polymer, the breaching tube is made of a combination of ballistic cloth and ceramic mesh, with Protection +8. The breaching tube does not end in a docking collar but in a gekkocote seal that can attach to any hull. Along the inner rim of the seal is a ring of plasma torches that burn through the hull of an enemy vessel.

To use the breaching tube the craft must be within 10 metres of the target and then succeed in a docking action (see page 147 of the *Traveller Core Rulebook*). As the vessel does not have to line up with an airlock, this manoeuvre is easier than using a normal docking tube and receives DM+1.

If access is acquired via an airlock the plasma torches quickly burn through it and boarding can begin immediately. If trying to get through the hull, the plasma torches will take one full turn to cut through, increasing by one turn for every two points of Armour (rounding down).

TL:	11
Tons	2
Cost:	MLv2

CARGO ARM

A smaller version of the loading arm used on small craft and cargo handlers, this consists of an extendable arm and large gripping claw. The cargo arm can handle objects up to three metres wide and is rated to handle cargo modules up to 20 tons.

TL:	10
Tons	0.5
Cost:	MLv0.1

GRAPPLING ARM

A grappling arm is a remote-control device for manipulating objects in space. The arm has five-segments capable of a wide degree of motion. It is able to reach out up to 25 metres, with a nominal capacity of two tons. The arm ends in a set of cameras and grippers of varying sizes, from large claws to tiny micro-manipulators. It also carries a toolkit that can be customised for a particular task.

TL:	10
Tons	2
Cost:	MLv0.5

LOADING ARM

Unlike the multi-purpose grappling arm, the loading arm is designed to merely shift cargo back and forth. It consists of an extendable main limb and a very large gripper claw at the other end. The loading arm is capable of handling cargo up to five metres wide and is rated to handle cargo modules of up to 50 tons.

TL:	10
Tons	2
Cost:	MLv0.25

MANIPULATOR ARM

The manipulator arm is designed for fine motor control and used in maintenance and construction. The dextrous fingers are even capable of operating a keypad under the control of a trained operator. They are installed in pairs.

TL:	11
Tons	0.25 per pair
Cost:	MLv0.25

***Example**: The Jian has no exterior fittings.*

***Example**: The Kennedy has a pair of loading arms (four tons, MLv0.5).*

STEP 20 AIRLOCKS

Airlocks are sealed systems consisting of two heavy-duty hatches with atmospheric pumping equipment, allowing transit to and from a spacecraft in a vacuum or hostile atmosphere. A ship has one airlock for every 100 tons or part thereof, included as part of the hull, capable of cycling two humans in suits or four unsuited humans, per minute between the ship's interior and exterior, or vice versa.

Although powered, all commercial-use airlocks contain manual controls, allowing hatches to be cranked open and interior air either bled off or replaced from the ship's tanks. Manual operation cannot be shut down remotely, as a safety precaution, although access is often protected behind a mechanically-locked panel.

Craft of under 50 tons do not have an airlock automatically installed, while those over 50 tons do.

CARGO AIRLOCK, SMALL

The small cargo airlock is used for light cargo and luggage, usually with a docking arm. It holds up to three tons of cargo for transfer at a time, including a pressure-suited cargo handler.

TL:	9
Tons	4
Cost:	MLv0.04

CARGO AIRLOCK, LARGE

This cargo airlock is used to load large cargo, including the standard 10-ton ISO cargo container.

TL:	9
Tons	12
Cost:	MLv0.08

DOCKING COLLAR

Standard airlocks can have a docking collar attached, allowing them to dock with any ship or station with a compatible docking collar. Most ships only have one or two airlocks with docking collars.

TL:	9
Cost:	MLv0.01

SORTIE LOCK

Assault ships and other military vessels may have sortie airlocks, designed to hold large numbers of troops and support equipment at once. A sortie airlock can hold two people in space suits or one combat walker per ton of airlock and can be up to 10 tons in size. A sortie lock can mount support weapons (see page 127).

TL:	10
Tons	1 or more
Cost:	MLv0.02 per ton

STANDARD AIRLOCK

Additional airlocks can be installed into a hull.

TL:	10
Tons	2
Cost:	MLv0.02

***Design**: As the Jian is under 50 tons, it does not have an airlock included as part of the hull.*

***Example**: At 900 tons, the Kennedy is built with nine standard airlocks for accessing the ship and supporting extra-vehicular activities. Along with these standard airlocks, the Kennedy is also fitted with a small cargo airlock for loading supplies. This airlock consumes four tons and costs MLv0.04.*

International Compatibility

Manchuria specifically designs much of their equipment to be incompatible with French technology but most nations ensure their designs work with the French standard. A few with outposts and colonies on the Manchurian Arm will outfit ships and stations to ensure they can accommodate either standard.

STEP 21 CARGO

Any space left on the ship that has not been allocated to other components is considered to be free for cargo. There is no cost associated with areas so designated, but any cargo or other materials taken on board the ship cannot exceed this tonnage.

ENVIRONMENTAL OPTIONS

A basic cargo bay assumes either a vacuum or shirt-sleeve environment. Other options are possible, however, including liquid, refrigerated and pressurised gas storage. Any part or all of a cargo bay can be designated with an environmental option. Switching to a different type requires the services of at least a Class C starport.

TL:	9
Cost:	MLv0.001 per ton of cargo bay (MLv0.01 if retrofitted)

EXPANDABLE CARGO BAYS

A cargo bay can be designed to expand in order to accommodate additional or awkward cargo. This is common on mining boats. It can be used to increase the cargo space by up to 200% but affects the ship's performance. Extendable cargo bays can be fitted to interface craft, but cannot be deployed during orbital insertion, re-entry or any atmospheric operation. Use of the extended bay requires an additional Burn for orbital operations and reduces stutterwarp drive performance by 10%. An extended cargo bay adds +1 to a ship's Signature for every 30 tons of deployed bay. Extendable cargo bays can have environmental options installed.

TL:	9
Tons	5% of total volume of expandable cargo bay
Cost:	MLv0.1 per ton of cargo bay

VAULT

A vault is a special armoured chamber at the heart of a spacecraft, designed to survive attacks that would annihilate the rest of the ship. A vault has four Hull points that are only used when the ship is destroyed. A vault is often used for high value cargo, although in military ships it can be used to house the ship's TAC.

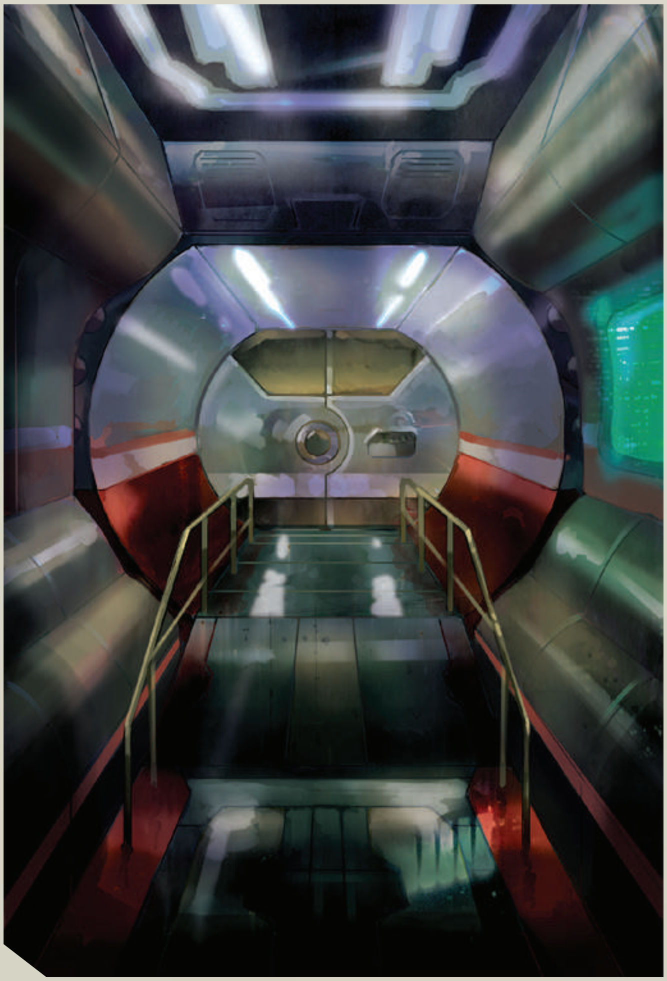
TL:	10
Tons	12
Cost:	MLv6

Cargo Hatches

Any area designated for cargo can be given a cargo hatch of any size but this is not an airlock. Generally speaking, cargo areas are capable of being sealed and so are effectively one large airlock unto themselves but this can cause problems when needing to unload cargo in a hostile environment. See the description of cargo airlocks on page 52.

Example: *The Jian has 0.12 tons of unallocated space, which is used to store pilot's gear and spare parts when the craft deploys to a ground station from a ship or vice versa. Otherwise, it is unused.*

Example: *The Kennedy has 36.45 tons of space allocated as cargo and potential system expansion space. This space is used to hold high value spares that would be difficult for the workshops to reproduce.*



– FINALISING THE DESIGN

The final steps in the design process are to add up Power, tonnage and costs to give final totals. If there are discrepancies, they should be resolved, which will likely require some elements to be redesigned.

POWER

The total Power required should be less than or equal to the total Power available. If not, then some systems can be redesigned or the ship can have power deficiencies. Perhaps it cannot use the reaction drive in the same round it is firing weapons or maybe the stutterwarp and reaction drive cannot be run at the same time. Trade-offs can help give a ship more character.

TONNAGE

Add up the tonnage of all equipment and fittings in the ship. This should be less than the total size of the hull. Any leftover amount can be used as cargo or fuel tank space and the amounts of each should be determined as part of this step.

Also make a note of the tonnage of the ship with no fuel, cargo or carried craft. This is the Unloaded Tonnage of the ship.

COST

Add up the costs of the ship. If it is a standardised design, then the price can be reduced by 10%.

COMFORT

The Comfort Rating of ship shows the liveability of the design and can impact crew function and the ability of a passenger ship to attract customers. Military and survey crews are typically trained to accept lower levels of comfort than would be acceptable in commercial service, while marines can make do with the most basic of accommodations. Total all the relevant values on the Amenities table. The result is the final Comfort Rating for the ship. Small craft with a duration of 12 hours or less do not calculate Comfort Ratings.

Amenities

Amenity	Comfort DM
Bunks	-2
Double-occupancy	-1
Galley/Full Galley	+1
Luxury Cabins	+2
Luxury Dining	+1
Rack Capsules, Crew	0
Rack Capsules, Passengers	-1
Recreation Facilities	+1
No Spin Gravity	-1
Spin Gravity over 0.6 G	+1

MAINTENANCE

The monthly maintenance amount for any spacecraft or station is 0.1% of its final cost, divided by 12.

SIGNATURE

Signature consists of two values, Reflected and Radiated. The higher of the two is used to determine the Base Signature. Signature modifiers are then applied to this to arrive at the final Signature, which is variable based on which modifiers currently apply.

Radiated Signature

A ship's Radiated Signature depends on the output of the power plant. This Signature is a combination of the electromagnetic output and waste heat from the power plant and all other systems.

Using the Radiated Signature table, find the nearest Radiated Signature at or above the total Power for the ship. If a ship has oversized radiators, the Radiated Signature is reduced by -1.

Radiated Signature

Power	Radiated Signature
≤1	0
≤10	1
≤100	2
≤1,000	3
≤10,000	4
10,001+	5

Reflected Signature

A ship's Reflected Signature is a rating of how visible it is to active sensors, including visible light, lidar and radar. Reflected Signature is a function of ship size, hull material and configuration. Synthetic hulls reduce this by -1.

Reflected Signature

Hull Size	Reflected Signature
1–10 tons	0
11–100 tons	1
101–1000 tons	2
1001–10,000 tons	3
10,001+ tons	4

Hull Form

Two Hull Form types modify the Reflected Signature. A distributed hull adds +2 to the Reflected Signature, while a lifting body hull subtracts -1.

External Fixtures

External fixtures can impact the Signature of a ship.

External Fixture Signature

Hull Fixture	Signature	Can be Stealthed?
AHDR Radiators	+1 per 100 tons	No
Conventional Radiators	+1 per 50 tons	No
Spin Hab: Double Hull, Spun Hull, or Two-Body	+2	Yes
Spin Hab: Spin Capsules or Extendable Spin Capsules	+1	Yes
Target Tracking Array	+1	No

AHDR RADIATORS

The dispersed nature of AHDR systems makes them less visible to active sensors than conventional radiators.

CONVENTIONAL RADIATORS

The large surfaces of conventional radiators form a large reflective surface for sensors.

SPIN HABS

There is a modifier based on the type of spin hab, with their large rings or rotating habitats.

TARGET TRACKING ARRAY

Target tracking arrays are large radar/lidar arrays that present a significant reflective surface for other active systems. UTES and light TTA systems do not affect Signature.

Added together, these form the Base Reflected Signature.

Stealth

Finally, if the vessel is equipped with Stealth, this modifies the Reflected Signature by -4. It is possible to have a reflected Signature less than zero.

For example, a 200-ton spaceframe hull made from aligned crystal steel has a Reflected Signature of 2. The 200-ton hull has a Signature of 2, while the spaceframe and hull material provide no modifier. However, a 200-ton lifting body hull made from synthetic material would have a base Reflected Signature of +0. The 200-ton hull has a Signature of 2, as before but the synthetic material hull provides -1 and the lifting body provides another -1.

Base Signature

Take the higher of the Radiated and Reflected Signatures and then add any relevant entries on the Variable Modifiers table to determine the ship's Base Signature.

Variable Modifiers

Hull Fixture	Signature	Can be Stealthed?
Containers	+1 per 500 tons	No
Discharge Vanes, deployed	+1	No
Expandable Cargo Bay	+1 per 100 tons	No
External Missile Pack	+1	Yes
Folding Sensor Array, deployed	+1	No
Inflatable Module	+1 per 200 tons	No
Reaction Drive in Operation	+10	No
Solar Panels, deployed	+2	No
Spin Hab, retracted	-1	Yes

CONTAINERS

The flat sides and hard profiles of shipping containers can contribute to the Reflected Signature of any ship and cannot be effectively concealed by Stealth technologies.

DISCHARGE VANES, DEPLOYED

While it would be rare for a starship to deploy fragile discharge vanes in the midst of combat, they would add +1 to the Signature. Despite the size of the deployed vanes, they are very dispersed and fairly transparent to active sensors.

EXPANDABLE CARGO BAY

An expandable cargo bay greatly changes the profile of a ship, resulting in an increase to Signature.

EXTERNAL MISSILE PACK

An external missile pack can be protected with a stealth covering. Otherwise, the missile pack adds +1 to Reflected Signature.

FOLDING SENSOR ARRAY, DEPLOYED

This modifier applies to any folding sensor array, including deep system scanners and telescopes. However, the modifier is only added once. Having three such systems deployed still only adds +1 to Reflected Signature.

INFLATABLE MODULE

Much like the expandable cargo bay, inflatable modules disrupt a ship's profile. However, the materials used make this less visible to active sensors.

REACTION DRIVE IN OPERATION

The exhaust plume of reaction drives is very noticeable and effectively guarantees detection. This modifier does not apply to ion or carriable plasma drives.

SOLAR PANELS, DEPLOYED

Solar panels have a large area and when deployed are very noticeable to active sensors.

SPIN HABS, RETRACTED

If a ship is equipped with retractable spin habs, they can be pulled down against the hull for combat manoeuvring. This reduces, but does not eliminate, their effect on Reflected Signature.

Example: *The Jian requires a total of Power 39.02 but the MHD turbine only generates 35. The Jian cannot use its thruster at the same time as the stutterwarp drive. This is considered an acceptable trade-off.*

All interior components of the Jian come to 31.51 tons, leaving 0.49 tons left over. All components, except the drone and submunitions, come to MLv22.62.

As a small craft with a duration of only 12 hours, the Jian does not calculate Comfort Rating.

The Jian is a 50-ton vessel with a lifting body configuration. It has a single laser array in a retractable mount. The Reflected Signature for a 50-ton hull is 1 and the lifting body hull reduces the Reflected Signature to +0. The radiators are too small to affect the Signature. The Radiated Signature for a Power 35 MFD turbine is +2, so Base Signature is 2.

Example: *The total output for the Kennedy is Power 921. The fusion reactor generates Power 1,200, leaving no shortfall.*

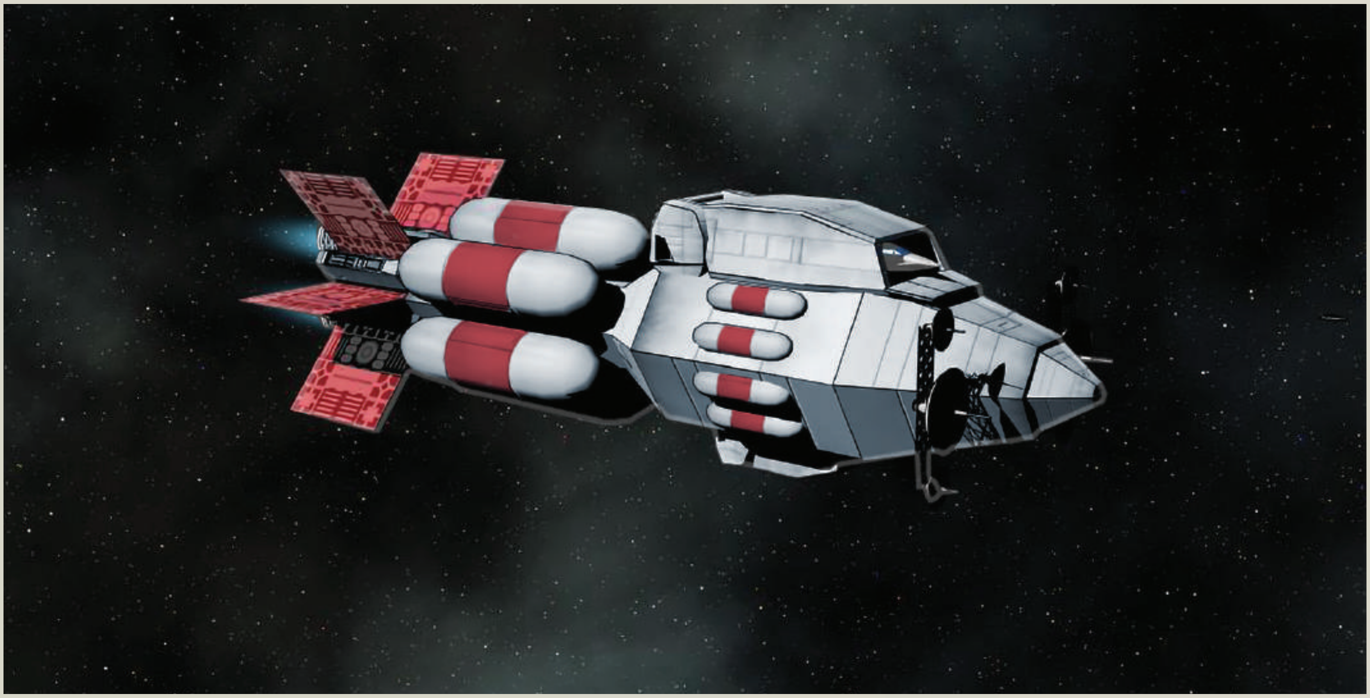
All systems in the Kennedy come to a total of 866.55 tons, leaving 36.45 tons for cargo or expansion. All systems, including drones, come to MLv536.52.

The spin gravity and private quarters give the Kennedy Comfort Rating +1.

The Kennedy is a 900-ton spaceframe, built of synthetic materials. The 900 tons give Reflected Signature 3, modified by the synthetic hull material to 2. The oversized radiators, at 85 tons, do not add to the Reflected Signature. However, the Kennedy has a spin hab, which adds +1 to the Reflected Signature for a total of 3.

With a Power 1,200 fusion reactor, the Kennedy has a Radiated Signature of 4. However, the oversized radiator, at 100% larger than required, subtracts -2 so the Radiated Signature is now 2.

The higher of the two values, the Reflected Signature, is the Base Signature for the entire ship at 3. If the discharge vanes are in operation, then the Signature is increased by +1. If the spin hab is retracted, however, the Signature is reduced by -1.



ADVANCED DESIGN OPTIONS

The design rules give all the options needed to build most spacecraft and starships. This chapter provides additional equipment and capabilities to spacecraft.

HULL OPTIONS

Hull options are add-ons or changes to hull design.

AEROSHELL

Aeroshells, sometimes called drop pods, are ballistic hulls designed to drop cargo from orbit and the most cost effective way to get cargo down to a planet's surface. Aeroshells are available in a range of sizes, from five tons to 400 tons. Most are blunt, round-bottomed cones, with an ablative heat shield on the underside.

Aeroshells are designed as ballistic hulls, with heat shields and a recovery package. The recovery package includes a single-use de-orbit motor, guidance system and parachutes. This consumes 5% of the hull volume and costs 0.2MLv per ton. Most aeroshells are designed for a single use and so have the Disposable trait.

Aeroshells of up to 100 tons can also be designed as reusable vehicles. They can be collapsible as an option, making it less expensive to return then to orbit, although that is not required. Some heavy-lift vehicles can lift a loaded 100-ton aeroshell into orbit but launchers of this size are not common.

A reusable aeroshell must have a new parachute/parasail loaded into it before it can re-enter but the heat shielding is good for 50 uses, after which the aeroshell is typically discarded. The replacement parachute will cost 50% of the price of the recovery system.

A collapsible aeroshell costs 50% more than a normal reusable model and loses another 5% of its interior volume for the structural features that allow it to be collapsible. It consumes 75% less space for shipping purposes to get it back into orbit, however.

Aeroshells can only be used on planets with Atmosphere 2 or higher. Final braking and landing employ parasails for smaller shells of up to 50 tons and multiple large parachutes for larger ones. The parachutes from aeroshells are often a significant fabric resource for a new colony as the resilient material is often remade into coats, tarps and durable clothing. The parachutes from a single 100-ton aeroshell can supply enough cloth to make clothing for 500 people.

DROP GLIDER

Related to aeroshells, drop gliders are used when more precise placement of a cargo is required or for more delicate cargo. Although they can be designed as disposable, this is uncommon, as the empty frame can be loaded with cargo and launched into orbit for multiple uses, by disposable rocket.

Drop gliders are designed as normal airframes or lifting bodies. Their descent profile is unpowered and identical to any other spaceplane. While designed with a cockpit, the only crew is usually a drone or robot controller; either will suffice. The less-expensive drone controller is more common but requires a qualified remote operator to pilot it.

Basic batteries (included) provide enough power for all control systems and navigation, while the hull also includes rocket motors for a de-orbit burn. They are not capable of orbital manoeuvring, save for docking.

FIBRE REINFORCED ICE ARMOUR (FRIA)

FRIA consists of a layer of water ice, with structural reinforcement provided by cellulose or synthetic fibre mixed into the water before it is sprayed on the ship's hull, adding +2 to a vessel's Signature. Of the spacefaring species, only the Sung use FRIA with any sort of frequency. FRIA cannot be used on spacecraft transiting to or from a planet's surface. Its Armour is added to any other present but is degraded by incoming weapons fire.

Every three hits from lasers or particle beam weapons degrade the Armour of the FRIA by -1. Other weapons reduces the Armour by -2 per hit, as rounds set off shockwaves that fracture the ice.

FRIA does not consume any space. However, it does affect the performance of the vessel. For every two points of FRIA Armour, enemies add DM+1 to attack rolls due to reduced performance.

FRIA

Armour	TL	Tons	Cost	Max. Armour
FRIA	10	N/A	5%	+8

FRONTIER HARDENING

Interface craft intended to operate from unprepared fields and in rough conditions are almost always hardened to protect them. This hardening includes enlarged wheels on landing gear, self-levelling shock absorbers and protective panels and screens over sensitive parts of the hull, including intakes for engines. These modifications allow a spacecraft to operate from any level, clear area.

TL:	10
Cost:	MLv0.05 x hull cost

HYDRODYNAMIC HULL

Streamlined hulls can be designed to land and take-off from water. Making a hull watertight and hydrodynamic has several effects; it increases the cost and the amount of waste space, and also affects atmospheric performance. Vessels with hydrodynamic hulls reduce their maximum atmospheric speed by one Speed Band. It has no effect on interface operations. A hydrodynamic hull includes a low-speed waterjet propulsion system, with a top speed of 30 kilometres per hour.

TL:	9
Tons:	5% of hull
Cost:	MLv0.1 x hull cost

INFLATABLE MODULE

Some ships and stations make use of inflatable hull modules. These take far less space to ship and are often found in early survey stations and new orbital terminals. On starships, they are typically used to provide additional living space while a ship is in orbit or otherwise stationary. Inflatable modules cannot be used on a starship while the stutterwarp is in operation as the field does not 'recognise' the structure of the lightweight module, so it will be torn apart in the first pulse of the drive.

Inflatable modules cannot be used as spin habitats. They can, however, be used as additional living space while on the ground and are often used by exploratory and survey teams, sometimes carried as cargo to make more permanent structures. Inflatable modules are usually available in 10-ton increments from 10 tons to 50 tons. When stowed, the inflatable module consumes 5% of its inflated size. A deployed inflatable module adds +1 to a ship's Signature for every 50 tons (or fraction of) in modules.

Most standard fittings are available to be installed in an inflatable module. Note that these fittings must be stored separately from the module while in transit. Fittings can be stored at half their normal size.

TL:	10
Cost:	MLv0.02 per ton

THERMAL SYNTHETIC ABLATIVE ARMOUR (TSAA)

TSAA is a spray-on material that flashes into vapour when struck by laser or particle beam fire, attenuating the effects of the strike. It provides no protection against other weapons. It is not common on military spacecraft but often used on civilian ships operating in hostile regions. TSAA cannot be used on spacecraft trying to attain orbit but can be used as a single-use heat shield. Its Armour is added to any other present but is degraded by incoming weapons fire.

Every two hits from lasers or particle beam weapons degrades the Armour of the TSAA by -1.

TSAA does not consume any space but does affect the performance of the vessel. For every three points of TSAA Armour, enemies add DM+1 to attack rolls due to reduced performance.

Armour	TL	Tons	Cost	Max. Armour
TSAA	11	—	1%	+6

BOOSTERS AND EXTERNAL FUEL TANKS

Under some conditions, interface craft need assistance in reaching orbit. Some may lack the Burns required for a world more massive than the one they were designed for or may be carrying a larger cargo. Some spacecraft such as drones and fighters may use boosters to attain orbit. Once orbital velocity is reached, boosters and external are discarded to save mass.

EXTERNAL FUEL TANK

When internally-carried Burns are not sufficient to lift a vessel into orbit, external tanks can be utilised. SRBs for external tanks are required if the external tank carries more than 4 Burns of additional fuel, with every extra 4 Burns in the external tank requiring a pair of boosters.

Determine the difference between Burns required and Burns available internally. The external tank will require double this amount of fuel; if 2 Burns are required, then the external tank must hold 4 Burns.

For thrusters, multiply the number of Burns contained in the external tank x 2% of the ship's hull tonnage. This is the size of the fuel tank. For rockets, it is the number of Burns x 5% of hull size. This gives the tonnage of the external tank.

External tanks are reusable and include guidance and recovery equipment. Disposable models are also available, at Lv4000 per ton and do not have guidance and recovery equipment.

TL:	9
Cost:	MLv0.005 per ton

SOLID-FUEL ROCKET BOOSTER (SRB)

An SRB uses a lightweight synthetic shell around a solid fuel core. The shell is just strong enough to support its weight when empty. Otherwise, structural integrity is provided by the fuel. SRBs attach to reinforced points on the hull of an interface-capable vessel and controlled alongside the other drives. Craft under 50 tons can only mount two boosters, while craft up to 100 tons can mount four. Any larger vessel can hold a maximum of six.

SRBs can be used to lift a vessel without using onboard rocket/thruster fuel or can supplement the onboard drive. SRBs are always installed in pairs and effectively increase Burns available by +2 per pair. Each pair is 10% of the hull size and costs MLv0.5 per ton, including fuel and recovery package. Refuelling a spent booster costs 50% of the cost of a new one.

Another use for boosters is to cut the time required to attain orbit. This substantially increases acceleration and can be dangerous for the crew. Boosters used this way will reduce the time to Low Orbit by 50% and to the Wall by 25%. When used in this fashion, the boosters do not add Burns.

When used to reduce time to orbit, any crew must make Difficult (10+) Athletics check (1D seconds, END). If failed, the crew member will pass out and remain so for the negative Effect x five minutes after the craft passes the boost phase.

TL:	10
Tons:	10% of the ship's hull size, per pair
Cost:	MLv0.5 per ton

LIFE SUPPORT

While the basic ship's systems Power requirement includes life support, there are other factors that can be considered.

Life Support Consumables

Most starships only travel for short periods, seldom more than two weeks at a time. For these starships, carrying life support consumables is easier than committing to the space and maintenance requirements of large-scale recycling systems. Water and air are constantly filtered and recycled in all starships but there are always losses; no system is 100% efficient. Food is consumed and, in most starships, the facilities cannot do anything more than reclaim water from waste. Without endurance life support systems, ships must carry 0.002 tons of consumables per person per day. This includes food, water and air, and space for dry waste. The cost of these items is included in life support costs, which includes cleaning and replacing filters, and recharging air systems.

Endurance Life Support

Long duration starships and space stations require larger and more robust life support systems. At the same time, these systems are much more complex, being closed ecological systems. On starships and space stations, endurance life support is a set of processes combined to extend supplies of clean air, food and water over the course of a multi-year mission. Maintenance of these systems requires a team of dedicated mechanics, professionals and scientists to ensure systems are kept in homeostasis.

Key skills for the operation and maintenance of a long term life support system are Mechanic for pumps and fluid supply lines, Profession (hydroponics) for the hydroponics tanks and protein synthesis arrays that form the heart of the system and Science (chemistry) to help keep the system healthy.

These processes include hydroponics, modified organisms and protein synthesis. Combined, these clean the air, scrub out carbon dioxide, dispose of organic waste and create food. Long-term life support systems are closed ecologies, where waste solids, liquids and gases go in one end and food, water and clean air come out the other. While there are always losses over time, these systems are good for years without needing a recharge.

Long term life support is available as early as TL9 but becomes markedly more effective by TL11. A Pentapod-designed system is expected to be commercially available at Beta Canum by early 2301.

Any endurance life support system decreases the requirement for consumables, from 0.002 tons per person per day to 0.0002 tons per person per day.

BASIC EXTENDED LIFE SUPPORT SYSTEM

Available for stations at TL9 and starships at TL10, the basic extended life support system is often found at outposts and distant stations. It is less common in starships, although the old ESA exploratory cruisers did use it.

TL:	9/10
Crew:	One mechanic, one hydroponics specialist and one scientist are required for every 50 tons, or part thereof, of life support system
Power:	0.1 per ton of system
Tons:	0.25 per crewmember or passenger on the ship or station
Cost:	MLv0.1 per ton

IMPROVED EXTENDED LIFE SUPPORT SYSTEM

The improved extended life support system offers a significant improvement over the basic model and is found in newer ships and stations. In the era of Consolidation, however, it is more common to find outposts and stations equipped with this capability. As countries begin to move out from the economic stagnation of the past few decades, there is likely to be an increased demand for these systems. The new Heinlein-class explorer from the United States uses an optimised version of this system.

TL:	11
Crew:	Mechanic, hydroponics specialist and scientist (x2 for commercial craft, x3 for military vessels) per 100 tons of system or fraction thereof
Power:	0.05 per ton of system
Tons:	0.1 per crewmember or passenger
Cost:	MLv0.2 per ton

ADVANCED EXTENDED LIFE SUPPORT SYSTEM

The advanced extended life support system was developed by the AR-I in partnership with Baverische Bioteknik for the Bayern mission. It is the most advanced design on the market, at least until the Pentapod 'Tree of Life' passes certification and becomes available. It can provide for a crew for up to 10 years before system losses and deterioration make it unsuitable, or even dangerous, to continue to use.

TL:	12
Crew:	Mechanic, hydroponics specialist and scientist (x2 for commercial craft, x3 for military vessels) per 100 tons of system or fraction thereof
Power:	0.025 per ton of system
Tons:	0.05 per crewmember or passenger
Cost:	0.3 per ton

PENTAPOD TREE OF LIFE

The Tree of Life is radically different from other extended life support systems. It is a self-contained organism that does not require a source of power but does need access to sunlight at least 50% of the time. The one human test ship that makes use of this system has a cluster of large, almost leafy structures that unfold from the hull when the ship moves within the life zone of a star.

ESA officials and NARL supporters have both expressed concern at this technology. The ESA worries about the effects of the technology on human crew, both physically and psychologically, but is willing to continue testing. NARL, however, has deep ethical concerns about the use of what appears to be, in their estimation, an enslaved intelligence to run and monitor the system.

Like many items of Pentapod technology, the Tree of Life is self-aware and requires no crew. It also requires no maintenance. The Tree of Life has INT 8 and EDU 10, along with the Profession (biologicals) 3, Science (chemistry) 3 skills.

TL:	11
Tons:	0.1 per crewmember or passenger
Cost:	MLv1 per ton

'Soylent Green is People!'

ESA researchers discovered a profoundly unsettling aspect to the Tree of Life endurance life support system. Examination of the organism's genome revealed that the 'Tree' was based heavily on human genetics. In fact, the brain that runs it is not a five-lobed Pentapod brain but a two-lobed human brain, albeit barely recognisable. The foodstuffs output by the system are chemically perfect for humans and in the case of proteins, a little too perfect…

SYSTEM TRAVEL

Few human ships need to make use of non-stutterwarp propulsion systems. Stutterwarp is much faster and more efficient, making this sort of drive almost a lost art. Nevertheless, they are used in some applications. Belt mining is the most common use of reaction drives, as mining boats have to match velocities and often spin, with their targets. Orbital space is another key environment for reaction drives, since stutterwarp does not work below the Wall. However, for the short distances of orbital space, the standard magneto-plasmadynamic thruster is used by most craft, along with more conventional liquid fuel rockets.

Of the three spacefaring non-human species, only the Sung make use of deep space drives. The Kaefers and Pentapods rely on stutterwarp, with the Pentapods making use of organic rockets for interface travel, while Kaefers make use of high-efficiency magneto-plasmadynamic drives, much like human designs.

Deep Space Drives

Aside from asteroid mining boats, few human vessels use long-duration deep space drives. Until the advent of stutterwarp, however, they were heavily-utilised and even now the Sung nations use them while waiting for humans to fulfil their obligations and provide stutterwarp drives.

There are a variety of drive types available, although the most common one in human use is the variable plasma drive. Sung, however, make greater use of ion drives and sailcraft.

Compared to stutterwarp vessels, these deep space drives move at a crawl, taking weeks or months to arrive at their destinations.

All propulsion mechanisms here are continuous-thrust. Travel times are based on the same travel time formula found on page 154 of the *Traveller Core Rulebook* but using far lower acceleration rates. See the description of each type to find the acceleration used.

System drives are finely-tuned to give the best fuel performance possible. All other considerations are secondary. Due to this, there are few variations in the basic designs.

ADVANCED ION

The advanced ion drive is a more efficient version of the ion drive. Human nations never developed ion drives of this efficiency and they are only available to the Sung. Power and fuel consumption in the advanced ion drive is effectively the same as the standard ion drive but the drive accelerates reaction mass to a much higher velocity, resulting in a much faster system. Advanced ion drives accelerate at 0.002 G.

TL:	12
Power:	0.1 per ton of ship
Fuel:	0.0025% of hull tonnage per day of operation
Tons:	1% of the hull tonnage
Cost:	MLv5 per ton of drive

ION DRIVES

Ion drives are an earlier form of the technology used in plasma rockets and, while efficient, the thrust produced is miniscule. Over time, however, it can add up. Ion drives are rarely used, although some rock-hoppers are still equipped with them. The Sung make use of them for crewed ships within their solar system. Standard ion drives accelerate at 0.001 G.

TL:	9
Power:	0.1 per ton of ship
Fuel:	0.005% of hull tonnage per day of operation
Tons:	1% of hull tonnage
Cost:	MLv4 per ton of drive

VARIABLE PLASMA

The most common reaction drive in human use, the variable plasma drive is related to the plasma thruster used in interface operations but trades power for efficiency. As the name suggests, the efficiency of a variable plasma drive can be altered to fit the circumstance. At one end, some variable drives can develop as much as 0.1 G of thrust, enough to land on asteroids and small moons, or produce as little as 0.01 G, ideal for long burns during interplanetary travel. Mining boats use variable plasma drives, as plasma thrusters cannot be throttled as efficiently. In many ways, the variable plasma drive is a highly-advanced ion drive and uses some of the same principles.

A variable drive in high-thrust mode is equivalent to an orbital thruster, with equivalent Power and Burn requirements. In high-efficiency mode, a variable plasma drive has an acceleration of 0.01 G. In high-thrust mode, is has an effective acceleration of 0.1 G but burns through fuel much faster.

TL:	9
Power:	1 per ton of ship
Fuel:	0.5% of hull tonnage per day of operation
Tons:	5% of hull tonnage
Cost:	MLv1 per ton of drive

SOLAR SAILS

Solar sails are enormous sheets of reflective material that capture the light energy from the local star, as well as its solar wind. Solar sails tend to be very slow but consume no fuel. Sung sailships are unmanned cargo carriers, although there are a few crewed examples in operation for training purposes.

Solar sails are seldom used by humans. The Pentapods made extensive use of interstellar solar sails during their pre-stutterwarp period to distribute Seeds, biological colonisation and exploitation packages, and even now there are very likely Seeds in transit to new worlds.

Solar sails are normally found in the heliogyro configuration, with two to six vanes of ultra-thin reflective material set spinning like a windmill. The spin is induced by morphological structures in the sail and does not require energy. The effective acceleration of a standard solar sail is 0.00001 G.

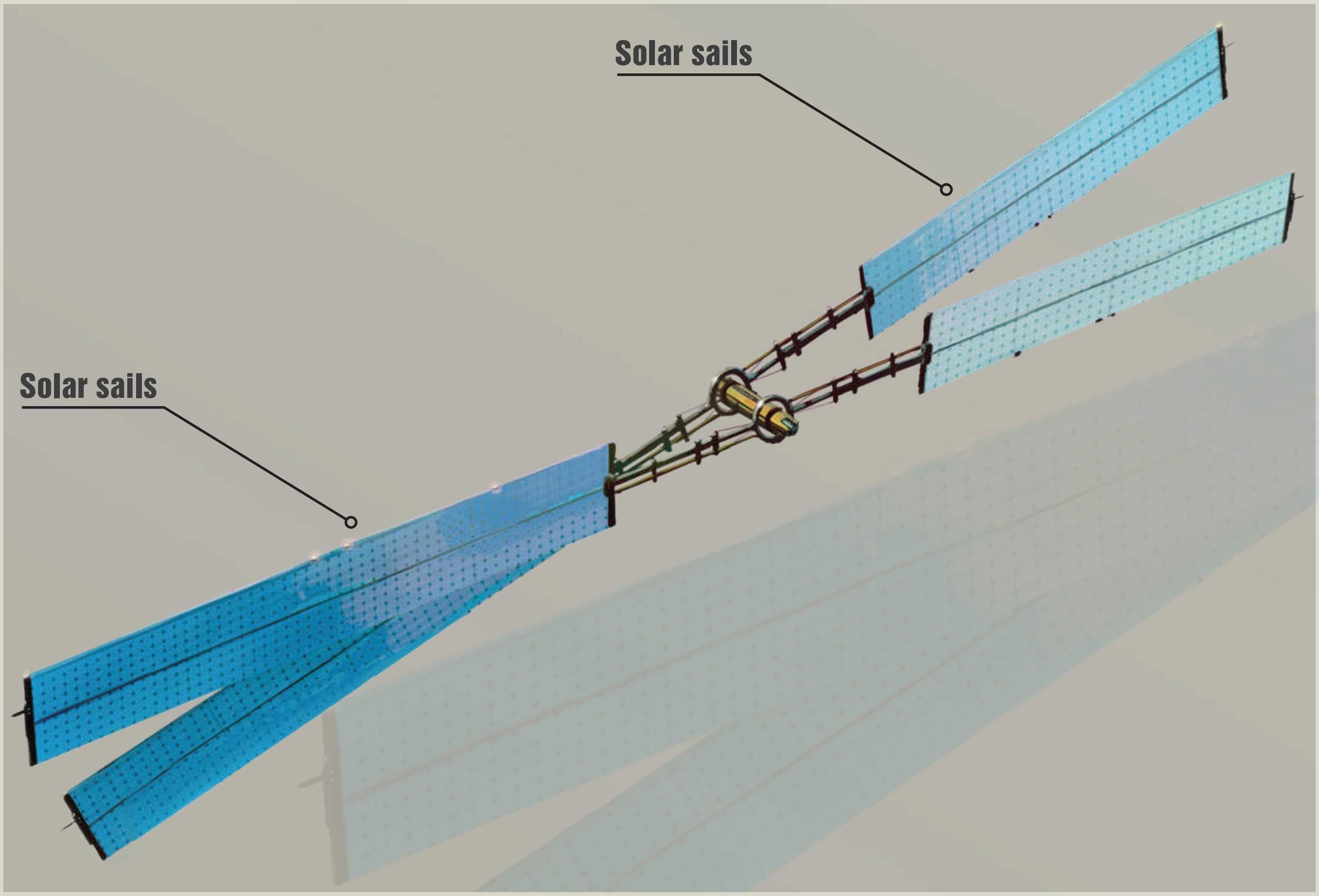
TL:	8
Tons:	1 per 50 sq. kilometres of sail
Sail Size:	1 sq. kilometre per ton of ship
Cost:	MLv0.1 per sq. kilometre, double if it can be furled

TRAVEL TIMES

The times shown on the Travel Times table for system drives represent craft that continuously accelerate to the halfway point, turn 180° and then decelerate to the destination.

Travel Time

Kilometres	AU	Solar Sail	Ion	Advanced Ion	Variable Plasma (High)
1,000	0	5.18 Days	12.42 Hours	8.78 Hours	3.93 Hours
10,000	0	16.37 Days	39.28 Hours	27.78 Hours	12.42 Hours
100,000	0	51.76 Days	5.18 Days	87.84 Hours	39.28 Hours
300,000	0	2.99 Months	8.97 Days	152.15 Hours	68.04 Hours
400,000	0	3.45 Months	10.35 Days	7.32 Days	3.27 Days
1,000,000	0.01	5.46 Months	16.37 Days	11.57 Days	5.18 Days
15,000,000	0.1	1.76 Years	2.11 Months	44.83 Days	20.05 Days
30,000,000	0.2	2.49 Years	2.99 Months	2.11 Months	28.35 Days
75,000,000	0.5	3.94 Years	4.73 Months	3.34 Months	44.83 Days
150,000,000	1	5.57 Years	6.68 Months	4.73 Months	2.11 Months
300,000,000	2	7.88 Years	9.45 Months	6.68 Months	2.99 Months
450,000,000	3	9.65 Years	11.57 Months	8.18 Months	3.66 Months
600,000,000	4	11.14 Years	13.36 Months	9.45 Months	4.23 Months
750,000,000	5	12.45 Years	14.94 Months	10.57 Months	4.73 Months
1,500,000,000	10	17.61 Years	21.13 Months	14.94 Months	6.68 Months
3,000,000,000	20	24.9 Years	2.49 Years	1.76 Years	9.45 Months
4,500,000,000	30	30.5 Years	3.05 Years	2.16 Years	11.57 Months



DRIVE TUNERS

Stutterwarp drives require tuning once installed. Counterintuitively, the easiest way to do this in a gravity well, like a planet-based or orbital shipyard with a gravity of at least 0.01 G. This was the first generation of drive tuners.

DRIVE TUNER, 2ND GENERATION

The drive tuner was originally-intended for use in shipyards to align components of a drive. The 2nd generation drive tuner was able to do the same thing in unstressed space, allowing stutterwarp drives that were offline to be brought back online in interstellar space.

TL:	11
Power Requirement:	10 x drive Power requirement
Tons:	10 + 5 x drive unit tonnage
Cost:	MLv1 per ton

DRIVE TUNER, 3RD GENERATION

The 3rd generation drive tuner passed engineering trials in late 2298 and entered limited production in mid-2299. To date, an estimated eight devices have been built at the Hyde Dynamics Advanced Development facility in far orbit above Mars. All but one have been purchased by the American government, with the remaining unit delivered to France in early January, 2300.

The advanced drive tuner requires less time and less Power than the previous model and is smaller as well.

TL:	12
Power Requirement:	5 x drive Power requirement
Tons:	5 + 2 x drive unit tonnage
Cost:	MLv5 per ton

WEAPONS AND SCREENS

Weapons are not common on civilian ships and those tend to be low-powered. Point Defence clusters are the most-commonly encountered weapon in civilian hands and most are sanctioned by a government or recognised quasi-national entity, like a TransNat or Foundation. Heavy weapons like particle beam weapons and bomb-pumped missiles are only found in the hands of military units and the occasional recognised private defence contractor.

Unless otherwise stated, all weapons in this chapter are Spacecraft scale.

Hardpoints

A hardpoint is a shorthand way of determining the number and size of weapons a ship may mount; it is a design limitation. All large ships can have one hardpoint per 100 full tons. A hardpoint takes no space itself but each costs Lv100000 and must be created when the ship is built. Adding a hardpoint as a design revision costs MLv2 and consumes one ton, in addition to the requirements of the weapon mounted.

Small Craft

Small craft do not have hardpoints in a conventional sense. Hardpoints on larger vessels are effectively modular, allowing weapon systems to be exchanged relatively easily. Small craft tend to be built around their weapons and swapping them out is often a major engineering exercise.

Fighters (<50 tons)

Fighters cannot mount turrets, only fixed weapons and submunitions. Vessels of this size can mount a single fixed weapon and streamlined vessels must have them in a retractable mount. Such weapons are often called 'lances' since they are fixed-forward. Along with the single fixed mount, they can also deploy up to five tons of submunition dispensers.

Small craft can mount missiles in bays or external slings. Bays are limited solely by their size but can have only one launch port on ships of this size. If they forego a fixed mount weapon, they can have two launch ports. Fighters can carry one ton of missiles per 10 tons of craft in external slings. Carrying a full load of drones will reduce warp efficiency by 10% until half have been released. Craft of less than 50 tons cannot mount missile packs.

Gunboats (50–99 tons)

Gunboats, often called bombers, are considerably more effective. A gunboat of up to 70 tons can mount a single surface mount, while larger craft can mount two. Gunboats can also mount two fixed weapons instead of a turret, so conceivably a large example could have four lances, assuming it can meet the power requirements. Along with turrets or fixed mounts, gunships can carry up to 10 tons of submunitions.

Gunboats can carry missiles internally, limited only by size considerations and can have two launch ports. Externally, the gunboat can carry one ton of missiles per 10 tons of hull or one missile pack per 50 tons. To carry a missile pack it must have a sling capable of accepting the pack. Carrying a missile pack or full load of missiles will affect the handling of the craft, granting DM+1 to attack rolls made against it until the pack has used half of its ordnance.

For both fighters and gunships, appropriate fire control and missile controllers (at least one per launch port or missile pack) are required.

FIXED MOUNT

A fixed mount can accommodate any weapon, limited by the size and power capabilities of the carrying spacecraft. The fixed mount itself consumes no tonnage.

Fixed mounts can only fire at targets directly ahead of the ship and inflict DM-1 to attack rolls. These weapons require a single gunner, with the Gunner (turret) skill, although a single gunner can fire multiple fixed weapons.

Interface craft must have their weapons in retractable mounts due to the size and fragility of laser and particle beam arrays. Starship weapons cannot be used while a ship is in atmosphere and moving.

TL:	7
Cost:	MLv0.1

SURFACE MOUNT (TURRET)

Many different weapons can be installed in surface mounts, ranging from laser drills and laser weapon arrays to particle beam weapons. A surface mount uses one hardpoint.

If a turret is equipped with a Unified Tracking and Engagement System (UTES), then one gunner is required per turret. If the ship uses a TTA or Light TTA, then one gunner is required per weapon battery (all weapons connected to a single TTA). Ships can have multiple TTAs and batteries and each weapon or battery requires a gunner, with the Gunner (turret) skill.

TL:	7
Tons:	1
Cost:	MLv0.5

HEAVY SURFACE MOUNT (BARBETTE)

Heavy surface mounts are large turrets, often called barbettes, built to handle heavy starship weapons including lasers, particle beam weapons and railguns. A barbette uses two hardpoints.

Each weapon or battery requires a gunner, with the Gunner (turret) skill.

TL:	8
Tons:	2
Cost:	MLv1.0

RETRACTABLE MOUNT

This can be applied to any surface mount or fixed mount. The weapon system is concealed in a pod or recess on the hull to protect delicate emitter arrays and allow a spacecraft to retain its streamlining for use in atmosphere. Interface-capable spacecraft must place their weapons in retractable mounts.

TL:	10
Tons:	x2
Cost:	x2 (minimum MLv1)

Weapon Mounts

Mount	TL	Tons	Cost
Fixed Mount	—	0	MLv0.1
Heavy Surface Mount (Barbette)	8	2	MLv1.0
Surface Mount (Turret)	7	1	MLv0.5
Retractable Mounting	10	x2	MLv1

STARSHIP WEAPONS

There are a number of weapons available for military starships. Civilian starships can only legally install a limited set of weaponry but licences are possible for heavier weapons.

Laser Weapons

Laser weapons are large, multi-segmented focal arrays that can be folded away when not in use. The lighter weapons have six metre focal arrays, while heavier versions have eight metre or even 10 metre arrays.

LL-88

The French-made LL-88 is an older weapon that is out of service with France but still in use with smaller nations. It was one of the first practical laser weapons to use the now standard focal/emitter arrays that allowed combat at stutterwarp speeds and ranges.

LL-98

The LL-98 is an improvement on the LL-88, with enhanced focusing and heat dispersion. Like other beam weapons, the sustained beam can sweep across a target's probability cone, increasing the chances of an effective hit.

EA-12

One of the first pulse lasers available, the EA-122 utilises capacitors to discharge its energy in a series of short, powerful blasts. While less accurate than its beam-based counterparts, it has superior range and damage. The focal/emitter array is a different size and configuration from a beam weapon, although it takes a close visual inspection to determine the difference.

Laser Weapons

Weapon	TL	Range	Power	Damage	Tons	Cost	Traits
LL-88	9	Close	10	1D-1	1	MLv0.25	Accurate
LL-98	9	Close	10	1D	1	MLv0.50	Accurate
EA-122	11	Short	10	2D	1	MLv1	—
EA-1000	12	Short	10	2D+2	1	MLv2.5	Accurate
G3 Drill	9	Adjacent	10	4D	0.5	Lv150000	Slow

Particle Beam Weapons

Weapon	TL	Range	Power	Damage	Tons	Cost	Traits
ALS-22	10	Close	20	3D+3	2	MLv4	AP 2, EM, Slow
Allen PBWS	9	Close	40	3D-3	2	MLv1	AP 2, EM, Slow

EA-1000

The Quinn Optronics EA-1000 is a modern pulse laser with an advanced focal array that allows it to track targets with greater accuracy than the older EA-122. This improved focal array also improves the energy delivered to the target, resulting in greater damage.

DARLAN G3

The Darlan G3 is more tool than weapon, used by belters and scavengers to cut into asteroids and derelicts. However, in an emergency the laser drill makes for a potent, if very short-ranged, weapon. The G3 does not require targeting to be used as a drill but if it is to be used as a weapon then this is required, either a TTA or UTES array.

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Particle Beam Weapons

Particle beam weapons accelerate a beam of charged particles through a linear accelerator. They cause damage through a combination of kinetic impact, heat and electromagnetic discharge.

DUNARMCO ALS-22 LIGHT PARTICLE BEAM WEAPON

The ALS-22 is a modern and advanced particle beam weapon small enough to be mounted in a turret. It is not only more powerful than the average ship-mounted laser but can cause electromagnetic cascades that damage internal fittings even if the beam does not penetrate the hull.

ALLEN BMZ-50 PARTICLE BEAM WEAPON SYSTEM

One of the first compact particle beam weapons systems on the market, the BMZ-50 is definitely showing its age. It is inexpensive, however.

Point Defence Weapons

Point defence weapons are clusters of fast-cycling lasers intended to engage drones and fighters at close range.

POINT DEFENCE CLUSTER TYPE 17

The Giscard PDC-17 is the most commonly encountered weapon on civilian vessels in the French Arm. While of little use as an offensive weapon, it can protect a ship from drones, fighters and even other ships that get too close. The PDC-17 has its own short-range target tracking system and does not require a TTA or UTES.

POINT DEFENCE CLUSTER TYPE 29

Using technology licensed from Giscard, the PDC-29 is an American weapon often found on military starships, an advanced and updated version of the Type-17. The PDC-29 has its own short-range target tracking system and does not require a TTA or UTES.

Heavy Starship Weapons

These are the heaviest weapons commonly used in starships. Manchuria fields a ship with a spinal mass driver for orbital bombardment but it is one of a kind.

Railguns require ammunition, at 50 shots per ton. Each 'shot' represents a burst of small diameter slugs travelling at very high speed. If the weapon also has the 'Ortillery' trait, then each 'shot' represents a single large slug of very dense material.

ALLEN-BMZ PX50 HEAVY PARTICLE BEAM WEAPON

Taking advantage of the increased power efficiencies and space available to a barbette, this is a much larger and more powerful particle weapon than something like the ALS-22.

Point Defence Weapons

Weapon	TL	Range	Power	Damage	Tons	Cost	Traits
PDC Type 17	10	Adjacent	20	1D	2	MLv1.75	Accurate, Point Defence, Rapid Fire
PDC Type 29	12	Adjacent	20	1D+1	2	MLv2	Accurate, Point Defence, Rapid Fire

Heavy starship Weapons

Weapon	TL	Range	Power	Damage	Tons	Cost	Traits
PX50	10	Close	50	5D	4	MLv8	AP 3, Slow
LD-90	11	Short	60	4D-4	4	MLv2	Accurate
HLC-72	11	Short	60	4D+4	4	MLv2.5	Rapid-Fire
ARG-56	12	Adjacent	60	3D+3	5	MLv4	AP 10, Ortillery, Slow

DARLAN LD-90 HEAVY LASER

Using a larger, more powerful laser than turret-mounted versions, the barbette-mounted LD-90 has a good punch at long range. The ability of the beam weapon to sweep the sky makes up for any loss in striking power. This weapon was one of the first of the heavy laser arrays available and it is starting to show its age.

QUINN OPTRONICS HLC-72 HEAVY LASER ARRAY

Taking advantage of recent improvements in heat-transfer materials, the HLC-72 can operate at higher capacitor loads than the older LD-90. This allows it to conduct better sustained fire operations, sweeping through space.

ARG-56

The Advanced Railgun, 56 mm (ARG-56) is an American design intended for hard orbital targets and surface targets. It is not intended for use against stutterwarp starships. Although this weapon is technically a coilgun, 'railgun' is the common term in use for a magnetically-accelerated gun, especially on a spacecraft.

WEAPON TRAITS

Some weapons have traits, as noted in their descriptions. Some traits can be found in the *Traveller Core Rulebook*, while the effects of new traits are noted:

Accurate: This trait indicates a weapon with improved focal acuity, whether the focal array for a laser or the electromagnetic collimation rings of a particle beam weapon or mass driver. This grants DM+1 to attack rolls.

EM: Weapons with electromagnetic effects cause electrical damage to their targets. When an attack roll is successful, they cause an additional critical hit on a 2D roll of 8+.

Hardened: Hardened weapons are designed with multiple redundancies to make them resistant to damage. This allows them to ignore the first critical hit or surface fixture hit (see page 84) scored against them.

Ortillery: Ortillery weapons are designed for orbital bombardment and do not suffer the normal DM-4 for attacking ground targets from orbit. Ortillery weapons must be used from Low Orbit and cannot effectively target a ship in stutterwarp.

Point Defence: Point Defence weapons are designed with small focal arrays and high rates of fire, optimised to attack small, fast, close-in targets. They gain DM+2 to attack rolls against vessels under 100 tons and missiles.

Rapid Fire: Rapid Fire designates a weapon with a very high rate of fire weapon, granting DM+2 to attack rolls.

Slow: Slow weapons have a reduced rate of fire, resulting in reduced hit probabilities. DM-4 is applied to attack rolls made against stutterwarp ships. These weapons do not suffer this penalty against non-stutterwarp spacecraft or other targets.

FIRE CONTROL

Separate from sensors, which are used to detect other spacecraft, fire control systems are designed to develop targeting solutions and lock-on to targets. There are three types of fire control available for modern spacecraft. A TTA, Light TTA or UTES is required per weapon or battery.

TARGET TRACKING ARRAY (TTA)

This is a centralised tracking and fire control system and a ship may mount more than one. A group of identical weapons can be formed into a battery under a single TTA, with all weapons engaging the same target.

TL:	10
Power:	10
Tons:	5
Cost:	MLv0.5

LIGHT TARGET TRACKING ARRAY (LTA)

This smaller array is typically used on fighters and small warships. It can only be used to control up to four weapons at a time; these weapons do not have to be of the same type, unlike a TTA, but must be used against the same target.

TL:	11
Power:	5
Tons:	2
Cost:	MLv0.25

UNIFIED TRACKING AND ENGAGEMENT SYSTEM (UTES)

This system puts a fire control director at each weapon, allowing weapons to target independently. In the year 2300, this technology is only available to France, Britain, Germany (via Bavaria) and the United States. The Kaefers are thought to make use of a similar system, termed the KUTS (Kaefer Unified Targeting System).

TL:	12
Power:	5
Tons:	1
Cost:	MLv0.6

SUBMUNITIONS

Submunitions are a class of ordnance, nuclear bomb-pumped laser warheads dropped by a ship and then fired once at a safe distance. They are carried and launched from a dispenser, which also includes the equipment required to maintain contact with the device and direct its fire. Firing solutions must come from a UTES system or TTA of some sort. It has no integral fire support control; UTES can be added to a dispenser for the normal cost or it can make use of a TTA. Submunition dispensers can also be combined into batteries, controlled by a TTA, although this is rare.

The use of submunitions is controversial, given the number of nuclear warheads they carry.

Submunitions are not usable in any launcher other than the one they were designed for. The launcher size includes the listed magazine; the listed tons per submunition round is in case they are carried as cargo or reloads.

LHH-637 LIGHT TARGET TRACKING ARRAY (LTA)

This German-made design is compact, making it ideal for fighters and smaller escort vessels. The Hanoverian government began deploying it in the years leading up to the War of German Reunification and it became standard for United Germany afterwards. The small magazine size limits its combat endurance, however.

LL-2

In response to targeting challenges with smaller ship-mounted weapons prior to the Central Asian War, the Procurement Directorate put out a call for a combat submunition system capable of engaging multiple targets. Darlan submitted the winning design but difficulties in warhead design meant that the weapon was not delivered until after the end of the war, following the coup. At first the generals were not interested in another space-based system but lobbying by Darlan and the remaining admirals allowed a trial deployment.

GRAPESHOT

In an unusual departure from most American designs, the Grapeshot dispenser trades sheer destructive power for magazine capacity and rate of fire. Each individual submunition is relatively weak but it can fire many within a short period of time.

HYDE DYNAMICS HLSD-97 BIG CLIP

The American-made ‘Big Clip’ launcher (the preferred American nomenclature is launcher rather than dispenser) fires the most powerful warhead available in a submunitions system. The warhead is on par with that of large combat drones. The Big Clip is designed for easy reloading, with three submunitions mounted on a rail that is inserted into the weapon, rather than the individual reloading all other designs require.

Submunition	TL	Damage	Magazine	Tons	Cost	Tons/ Round	Cost/ Round	Traits
LHH-76	11	1D	4	2.7	MLv2.52	0.45	MLv0.56	Blast 6, Radiation
LL-2	12	1D	5	2.25	MLv2.1	0.3	MLv0.75	Blast 4, Radiation
Grapeshot	11	1D	24	5.4	MLv05.04	0.15	MLv0.19	Auto 4, Blast 2, Radiation
Big Clip	12	2D	3	5.4	MLv5.04	1.5	MLv1.5	Blast 8, Radiation

SCREENS

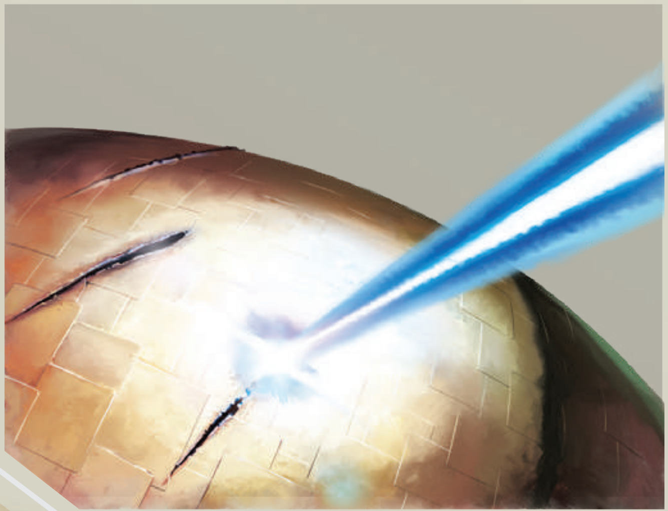
The military protective screen consists of thousands of reflective foil strips held in a dense protective sphere around the hull by an electromagnetic field generator. These strips serve to reflect and dissipate a significant fraction of energy directed at them. The strips are not perfectly reflective, however, and absorbing even a small portion of the energy in a laser or particle beam is enough to destroy the reflectivity of the foil strip, which leads to it being vaporised in milliseconds. It is thus possible to burn through a protective screen but this reduces the effectiveness of the weapon used. Only one screen can be in operation at a time, as the fields interfere with each other.

Defensive screens marginally degrade the effectiveness of the sensors of the protected ship. All Electronics (sensors) checks suffer DM-1 when screens are engaged. At the same times, using screens makes the vessel more visible to opponents. Add DM+1 to Electronics (sensor) checks made by other ships against the screened vessel.

Screen Rating is used to determine if the screen intercepts incoming fire and by how much it reduces damage. Screens can be overwhelmed with multiple shots and that is one of the reasons for using detonation lasers, which can overwhelm even the most powerful screen.

The Screen Rating is added to the vessel's Armour against laser and particle beam attacks, including those from submunitions and detonation lasers. Each shot in a round degrades the screen's effectiveness by -1, so a screen can get saturated by weapons fire.

For example, the Lessard*, an Aconit-class frigate in service with the Darkseid mercenary group, is on patrol near Hochbaden. It has been retrofitted with a TL11 Rating 3 Screen. The ship has Armour 4. A Kaefer ship pops from behind a moon and gives chase. As it closes, the Lessard's engineer activates the screen, sending thousands of reflective, ablative particles spinning around the ship, encased in a magnetic field. When the Kaefer ship fires its weapons, the first shot must penetrate Armour 7 (Armour 4 + Screen Rating 3) but the second shot only has to penetrate Armour 6 (Armour 4 + 2 Screen Rating 2).*



Screens use power to maintain the electromagnetic field that holds the foil strips in place. Power costs are halved if the ship does not move.

SCREEN RELOAD

Degraded screens can be restored by dispensing additional particles from carried stores. A screen dispenser normally carries six reloads, included in the size and cost of the system, with additional reloads being available. It takes a combat round to reload a screen launcher.

Tons:	0.25
Cost:	MLv0.05

SCREEN (TL11)

TL11 screens consume significant amounts of power and are restricted to the very largest ships with excess power capacity.

Rating	Tons	Power	Cost
1	1.5	10	MLv1.5
2	2	20	MLv3
3	3	40	MLv5
4	4	80	MLv7

ADVANCED SCREEN (TL12)

These screen systems are more efficient and effective than earlier designs. They can also maintain a denser screen of foils strips, giving them a higher maximum rating than earlier screens.

Rating	Tons	Power	Cost
1	0.75	5	MLv2
2	1.5	10	MLv3.5
3	2	20	MLv6
4	3	40	MLv8
5	4	80	MLv12
6	6	160	MLv15

SPACE STATIONS

Space stations range from small workstations up to giant orbital habitats. All but the smallest have some provision for artificial gravity. In the very largest, the entire station spins to produce gravity, while the smallest might make do with a single spin habitat.

Designing space stations uses almost the same process as for designing starships. Exceptions and guidelines are noted throughout this chapter.

SPACE STATION DESIGN

Space stations vary widely, from asteroids to modular stations to large rotating ring stations. Even larger habitats are possible, but are outside the scope of this system. Istria Station in the Bessieres system, for example, a hollowed-out asteroid spun for gravity, is over 5 billion tons.

Asteroid stations consist of surface structures accompanied by buried facilities. There are further details regarding asteroids stations on page 102.

Modular stations are a smaller design, with few over 1,000 tons. They do not typically have artificial gravity and then only for a small part of the station. The International Space Station of the late 20th and early 21st Centuries is an early example of a modular design and many key features of modern stations can be seen in this early iteration.

Ring stations are large, rotating structures that provide artificial gravity on the rim of the station. While an artificial gravity system on a starship may have a rotation radius of up to 90 metres, ring stations usually start with a radius of 500 metres or more.

Modular Stations

Modular stations consist of the support truss, power and support systems, and the modules themselves. Temporary stations, like survey installations around a new world, often make use of inflatable elements for many modules. These are easier and cheaper to transport, with an operational life of 10–15 years.

Rigid modules are used in more permanent structures and often used to replace inflatable modules over time. The support truss for a modular station is a lightweight open framework that provides the anchor and structural support for the modules, solar panels, heat management systems and any other features of the station. The truss also serves as a guide channel for cabling, piping and other support infrastructure. The open framework makes it easy for space-suited personnel and repair drones to manoeuvre around the station and provides multiple attachment points for safety tethers and repair kits.

Some very small stations do without the truss, as they have no more than one or two modules, all power and support handled through pylons attached to connectors between modules.

THE TRUSS

The support truss, sometimes called the keel, is the foundation of most modular stations. If the station has more than two modules then a truss is required. The truss also contains station-keeping thrusters and antenna for communications. The tonnage of a truss is 5% of that of the modules and other equipment attached to it, such as solar cells and radiators.

Cost:	Lv100000 per ton

MANIPULATOR RAIL

An option for the truss is a rail with a small truck for manipulators or loading arms. This allows the arm to be moved around the station, giving the remote operator in the station access to practically any exterior location to perform or assist with EVA and repair activities. Manipulators and loading arms can be added as normal and with the rail can reach any part of the station.

TL:	10
Cost:	25% of truss cost

CONNECTOR

A connector joins two or more modules and is required to join all modules, regardless of size. Connectors are available with a number of access points. Each can attach to a separate module and comes standard with an airtight manual hatch. Connectors can also serve as emergency airlocks.

Access Points	Tons	Cost
Two	4	Lv10000
Three	5	Lv15000
Four	6	Lv20000
Five	7	Lv25000
Six	8	Lv30000

The Modules

There are a variety of standard modules available, essentially off-the-shelf. Modules can also be designed as a ship hull, usually as aligned crystal steel spaceframes, following the normal design rules to create a hull. In any case, the module is purchased, then the interior is customised.

STANDARD MODULES

Orbital factories churn out modules for the space industry. The models here are empty shells and must be customised. The Life Support columns show the Power requirement and cost to make the module shirt-sleeve habitable.

Any module up to 50 tons can be ordered as an inflatable structure, at half the cost of a rigid module and only requiring 5% of the inflated size to store as cargo. Rigid modules take up their entire size for shipping purposes but can be delivered fully stocked and outfitted. The interior of inflatable modules must be built on site.

Each module in a station is generally designed to serve a specific function. One might be a laboratory, another living quarters and another a defence module.

SERVICE MODULE

At least one module in a station is outfitted as the service module, containing life support equipment, power and communication routing, and other centralised functions. This will be placed in a module of the appropriate size, although can also be split among multiple modules.

Power:	1 per 100 tons of station
Tons:	2.5% of station tonnage
Cost:	MLv0.5 per ton

Power Plant

Power for small stations located in a system's life zone or closer to the star is usually provided by solar panels, possibly with battery backup. For stations in unsuitable locations, fuel cells or even nuclear power plants become the preferred solution. Solar power can still function far from a star but the arrays must be enormous. Otherwise, small stations use the same power plants as ships.

Radiators and Heat Management

Radiators for modular stations are the same as starships, although AHDR radiators are seldom used.

Bridge

Modular stations do not require a distinct bridge or control centre. A systems module can function as a bridge if need be but command functions can be undertaken anywhere from a portacomp.

Computers

The normal range of computers can be found in modular stations.

Standard Modules

Module Size	Hull	Reflected Signature	Life Support Power	Life Support Cost	Cost (w/o life support)
10-ton	1	1	0.1	MLv0.01	MLv0.18
20-ton	2	1	0.2	MLv0.02	MLv0.36
30-ton	3	1	0.3	MLv0.03	MLv0.54
40-ton	4	1	0.4	MLv0.04	MLv0.72
50-ton	5	1	0.5	MLv0.04	MLv1
100-ton	10	2	1	MLv0.1	MLv2

Sensors and Electronics

Any sensor or electronic system available for starships is available for small stations except for GADS, which requires an operating stutterwarp. Due to the presence of the truss and the way modular stations are laid out, they do not have the size restrictions for sensors that starships do.

Militarised space stations are rare, as they are sitting ducks for stutterwarp ships. For this reason purely military electronics like ECM systems are almost never seen on a small station. The only exception might be agents or criminals using ECM to distort their signature, making them look like something they are not.

Weapons and Screens

Few stations are armed, and armed stations are prohibited in orbit around Earth and Tirane by the Melbourne Accords. In combat, an armed station would be lucky to get off a single shot, let alone hit something, before it was obliterated. An armed station can be equipped with a TAC, with the same requirements as a ship.

Drones

Modular stations can be equipped with drones and would require drone controllers just like a ship.

Small Craft and Berths

Stations can carry and berth any ship; with the additional room possible on a station, craft are usually housed in full hangars. Inflatable modules are not suitable as hangars or berths, as their structure depends on internal pressure. Spacecraft with docking collars do not need a berth, just an airlock with a matching collar.

Crew

Modular stations are normally crewed as non-commercial ships. They do not require bridge watches or multiple crew redundancies. Life support consumables are also handled in the same way as ships.

Accommodations

Transfer stations may have short term accommodations like acceleration couches, available for the comfort of passengers waiting to transfer from ship-to-ship, but most station accommodations are of the long-term variety. While any accommodation option can be installed in a modular station, the small size of most modules makes bunks and rack capsules the most common form of accommodation.

Acceleration Couch

Fittings

Most fittings can be installed in any station. However, some medical fittings, like medbays and operating theatres, can only be used in areas that have gravity. Bleeding in zero gravity is difficult to manage and control.

Engineering fittings can be installed and used without modification. Many orbital factory complexes are built around modular stations equipped with autofactories.

While modular stations are unsuitable for combat, there are military stations used for border patrols, orbital quarantine measures and the housing and training of troops, especially marines. All troop fittings are suitable for modular stations.

All external fittings can be added to a modular station as normal, although the boarding tube would be rare.

Artificial Gravity

While modular stations cannot be spun to provide artificial gravity, special spin assemblies can be attached to them. These assemblies consist of a 30-45 metre radius spin habitat, with either a single 50-ton module and countermass or two 50-ton modules. An internal flywheel that is part of the system counters the torque from the habitat. A long tunnel with a ladder connects the module to the spin hub, which is attached to the station well clear of solar panels, radiators or vehicle bays. Larger spin assemblies are possible but are uncommon.

SINGLE MODULE WITH COUNTERMASS

This variant of the spin habitat has the main component at the end of a long 45 metre arm. The other part, the countermass, is on a much shorter arm, giving it an asymmetrical appearance. This countermass is often filled with water and can be used as an emergency shelter in case of a radiation event like a solar storm or flare. The shorter arm allows a smaller mass to compensate for the habitat.

TL	10
Power:	1
Tons:	68
Cost:	MLv4

DUAL MODULE

This variant uses two 50-ton modules. It is less common in small stations but can be found in transfer stations where passengers or crew may have to layover for a day or two. If more accommodation space is required, it might be more effective to build a small ring station.

TL	10
Power:	2
Tons:	110
Cost:	MLv7

Airlocks

Only the standard airlock is normally used on modular workstations. Factory modules may have larger airlocks installed to move raw materials and finished goods in and out.

STANDARD AIRLOCK

A normal airlock can be installed in place of a connector on a module. This airlock is designed to support EVA operations and can be equipped with a docking collar. This is the only airlock that can be used on an inflatable module.

TL	9
Tons:	2
Cost:	MLv0.02

DOCKING COLLAR

A docking collar allows ease of access for orbital craft and other ships to the station.

TL	9
Cost:	MLv0.01

SIGNATURE

Each module in a station adds its Reflected Signature to that of the whole station. Radiated Signature is dependent on power plant output but Reflected Signature is likely to be very high, eclipsing power output.

SOLAR POWER STATIONS

Orbital solar power stations can be used to beam energy to ground-based receiving antenna (rectenna) or other orbital stations. These stations are usually built around a small modular station as the core, providing a maintenance hub and monitoring station. They are usually unmanned, although have limited space for visiting maintenance crews.

Solar power stations are built in segments and can be expanded over time. Each segment is 100 tons in size and the cost and amount of Power generated varies by Tech Level. Most colonial worlds have TL11 arrays, although the occasional TL10 array can still be found.

TL	Power	Tons	Cost
10	400	100	MLv10
11	500	100	MLv20
12	600	100	MLv30

POWER REGULATOR MODULE

Power regulation electrical equipment and electronics is required to handle the energy generated by the solar panels attached to the station. This is then routed to the ground or other stations by the microwave transmitter array.

Tons:	10% of solar panels tonnage
Cost:	MLv1 per ton

MICROWAVE TRANSMITTER

A microwave transmitter beams power to other stations or the surface of a moon or planet. Transmission through vacuum is lossless but transmission to the surface loses 5% of the transmitted Power per Atmosphere code.

For example, a solar power satellite beams Power 400 down from orbit to a ground rectenna on Earth. Earth has Atmosphere 7, so the microwave beam loses 35% (7x5%) of this Power. The amount that is lost to attenuation is therefore (35% x 400) Power 140, so the rectenna receives (400–140) Power 260.

Tons:	0.1 per Power transmitted
Cost:	MLv0.1 per ton

MICROWAVE RECEIVER ANTENNAE (RECTENNA)

Stations can also have microwave receivers, allowing them to relay power from powersats currently in sunlight to ground stations during the night.

Tons:	1 per Power received
Cost:	MLv0.01 per ton

RING STATIONS

Even the smallest ring stations are very large next to modular stations and even dwarf most starships. They are usually completed in sections in orbital shipyards and towed to permanent locations to be assembled there. These stations tend to grow over time, often along the spin axis.

Ring stations consist of a core and the ring. The ring rotates to provide gravity on the outer rim, while the core does not spin. Each section is designed separately.

Create the Ring

The primary structure of a large space station is the ring itself, where most of the crew and visitors will live, work and play.

The Ring Stations table identifies several common ring station sizes by diameter and provides their details. The station's core must be a spaceframe of at least the size shown, although it can be greater.

Most stations are in the 400–1,000 metre diameter range. Larger stations are found in the Core or in orbit around important worlds like Chengdu, Nibelungen and Beta Canum. Another example of a large station is the Orbital Maternity Complex at King, with its three different-sized rings, generating the equivalent of 0.9 G in the smallest, to 1.5 G in the second, all the way to 3.06 G in the largest, the same as the surface gravity of King.

Due to their size, ring stations are almost always constructed of aligned crystal steel. When possible, asteroidal or lunar rubble is cemented to the exterior to provide additional radiation shielding.

Located in the ring are homes, shops, gardens, hotels, processing facilities that require gravity and even, depending on the size of the station, parks and pools. Control centres are often here, with a backup in the core.

Ring Stations

Diameter	Circumference	Decks	Width	Power	Tons	Cost
200 m	628 m	1	8 m	11	1,100	MLv22
400 m	1,257 m	1	10 m	27	2,700	MLv54
600 m	1,885 m	1	12 m	48.5	4,850	MLv97
1,000 m	3,142 m	2	14 m	188.5	18,850	MLv377
1,500 m	4,712 m	2	16 m	323	32,300	MLv646
2,000 m	6,283 m	2	18 m	485	48,500	MLv2424

Diameter	0.5 RPM Gravity	1 RPM Gravity	RPM for 1 Gravity	Min. Core Size
200 m	0.03 G	0.11 G	3	110 tons
400 m	0.06 G	0.22 G	2.12	270 tons
600 m	0.08 G	0.34 G	1.73	485 tons
1,000 m	0.14 G	0.56 G	1.34	1,885 tons
1,500 m	0.21 G	0.84 G	1.09	3,230 tons
2,000 m	0.28 G	1.12 G	0.95	4,850 tons

REGOLITH RADIATION SHIELDING

Lunar or asteroid regolith (gravel) can be attached to the exterior of the ring, providing additional protection from radiation and minor impacts. This layer provides Armour 15 and total radiation protection of 1,000 rads. It cannot be used on starships due to the high mass of the material; on an immobile station, this does not matter. While the material is nearly free to acquire, it must be transported, shaped, cemented and attached to the station.

Tons:	10% of ring tonnage
Cost:	MLv0.005 per ton of ring

SPIN MACHINERY

Small ships with spun hulls do not need to allocate space for machinery to maintain spin operations. The enormous spin habitats of stations, however, require additional equipment to maintain balance and stability. The cost is included in that of the ring.

Tons:	5% of ring tonnage

Create the Core

The Ring Stations table gives the minimum size of the station core, which is 10% of the size of the station. The core is designed as a normal spaceframe made from aligned crystal steel. It can be armoured and have any other applicable hull options installed, although few apply (i.e. heat shield, stealth, STOL, VTOL, frontier operations). It will not normally have a reaction drive or stutterwarp.

Station Keeping Drive and Fuel

While stations are not generally mobile, they do require an array of small thrusters for stability and maintaining orbit. While thrusters are subsumed into the hull size and costs, fuel must be accounted for. This fuel is sufficient for a year of operation.

Tons:	1% of station tonnage

Power Requirements

As in starships, the size in tons of the core x 0.05 gives the Power requirement. This is added to the Power requirement of the ring.

Power Plant

Power requirements for ring stations are usually high and most efficiently met by a nuclear power plant. Fission plants are usually used in smaller stations, while larger ones require fusion plants. The smallest can use solar panels.

Ring stations can make use of conventional solar panels connected to the station core. Another alternative are large co-orbital arrays that beam power to the station in a similar fashion to solar arrays that feed power to colony worlds. Stations with solar power will have backup power of some type, usually batteries or an MHD turbine.

Stations can mount microwave receivers to get power from orbital powersats. These receivers use the same size and costs as on page 75.

Radiators and Heat Management

Ring stations use the normal rules for radiators. ADHR systems are seldom used.

Bridge (Command Centre)

As space considerations are not at a premium on ring stations, most will use a standard or large bridge as the primary control centre, usually located in the ring to take advantage of artificial gravity. There is almost always a backup command centre in the core as well. The cost of this is 10% of the cost of a ship's bridge.

Computer

Any of the computers and computer cores and options from page 27 can be installed in stations. Larger stations will have multiple networked cores.

Software

Rather than the Manoeuvre program, stations use the Operations program, which requires Bandwidth equal to total station tonnage divided by 1,000. Bigger stations can install multiple computers or cores as required. The cost of this software is included in the cost of the station.

Sensors and Electronics

Any sensor or electronic system may be installed on a station except for GADS, which requires an operating stutterwarp.

Weapons and Screens

Stations are seldom armed, although point defence clusters can often be found. Stations are very vulnerable to hostile weapons fire, with railguns being a particular threat. In combat, they use the same weapons and targeting rules as starships. Most stations will use TTAs rather than UTES, if available. An armed station can be equipped with a TAC, at double the normal cost and tonnage.

Drones
Any drone can be fitted to a station. Combat drones and gunships are the best line of defence for a station, to keep enemies at a distance. Point defence drones are very popular as well, if available. Drones are usually housed in hangars rather than berths, to make maintenance easier and cheaper.

Small Craft and Berths
Stations can carry and berth any ship. With the additional room possible on a station, craft are usually housed in full hangars.

Docking Facility
A full-scale docking facility allows large ships to dock with the station. These docks are at the zero-G core. The rotating ring cannot be used for docking, due to both the rate of spin and the balance and torque issues of having unequal loads around the rim.

All space stations are capable of externally docking a number of ships whose total tonnage does not exceed twice the tonnage of the core. Many crews elect to 'park' their ships nearby and use local small craft to transit to and from the station, avoiding berthing charges.

The largest space stations are capable of receiving ships within internal hangars. This provides ships with protection and makes their repair or the transfer of goods and passengers much easier. A docking facility is usually divided up into multiple bays, the size of which are fixed at time of construction.

Docking facilities require one crewman for every 100 tons of docking facility.

Tons:	Total tonnage of docked ships x3
Cost:	MLv0.25 per ton

Crew
Stations are crewed as ships, although any station open to the public will be staffed at military levels. The ring and core each have their own crews, many of whom will alternate back and forth. Determine crews for each as if they were a military starship. If the station is armed, both ring and core will have a fully-staffed Tactical Action Centre.

Accommodations
In addition to the accommodation for ships, other options are available.

APARTMENTS
Apartments come in various sizes and quality. Prices listed are for installation and the average monthly rent. An apartment can be assumed to have a kitchen, living and dining area, and one fresher for every two bedrooms. The apartments listed are for lower class (SOC 1-5) inhabitants. For middle class inhabitants (SOC 6-8), increase size by 10% and the monthly rental and purchase price by 25%. For upper class inhabitants (SOC 9-11) increase size by 50% and cost by 100%. For the elite (SOC 12+), increase size by 150% and cost by 300%.

Apartment Type	Rent	Tons	Cost
Studio	Lv300	8	MLv0.1
One Bedroom	Lv500	12	MLv0.2
Two Bedroom	Lv700	16	MLv0.3
Three Bedroom	Lv900	24	MLv0.4

DORMITORIES
Dormitories are blocks of bedrooms with shared communal spaces, including freshers, galleys and entertainment space. Each room in a dormitory is 3 m x 3 m, and contains one or two desks and beds, closet and dresser space. Each block contains 30 rooms, two large freshers and 15 tons of communal living space.

Tons:	80
Cost:	MLv0.5

RESIDENTIAL ZONES
For larger stations, designating housing zones is more efficient than trying to fill the station with individual staterooms or apartments. The number of people housed within residential space will depend on the resources and space allocated to it. One maintenance crewman is required for every 50 tons of residential zone.

Quality	SOC	Tons per Person	Power per 100 tons	Cost per Ton
Low	1+	1	1	MLv0.05
Medium	4+	2	2	MLv0.1
High	8+	3	3	MLv0.25
Luxury	10+	5	5	MLv0.75

COMMON AREA
A common area on a space station can be anything from a simple open space to sports pitches (complete with odd behaviour of balls in spin gravity) to parks,

Coriolis Effect

Even in large stations, spin imparts notable effects on the way objects move. Liquids will curve in a direction opposite to the spin. A football kicked in the direction of spin will curve down, against spin it will curve up and if kicked sideways will curve away from the spin. To someone used to 'normal' gravity, objects in spin gravity will operate in unusual ways. At the referee's discretion, some Athletics checks, in particular DEX-based ones, might suffer DM-1 until the Traveller is accustomed to the spin, which takes 2D days.

with trees, water features and even tame (often synthetic) animals. Other options include gardens, open-air restaurants and just about anything else.

Large common areas have design challenges on a ring station. The ring of a station must be kept in balance and a system of counterweights and fluid transfer systems help to maintain this balance. Common areas are usually placed as pairs, threes or fours, spaced equally around the rim of the station to maintain balance. When allocating tonnage for common areas allowances must made for this. This is important when crafting deck plans and maps of a ring station.

The large, open area must have additional reinforcement and of course there is a cost associated with the contents.

Cost (open space):	Lv10000 per ton
Cost (sports pitch):	Lv50000 per ton
Cost (greenscape/park):	MLv0.1 to MLv1 per ton

Fittings

In addition to basic accommodations, a variety of other features can be installed on a station to make it more comfortable, add industrial capability or add commercial and economic enhancements.

TRANSIT SYSTEM

Very large rings can have a circumference of many kilometres, although the width is generally low. An automated system of transit cars can make access around the ring easier. The transit cars are small, usually three to five linked together depending on traffic volumes, with one set running in each direction. The standard car can carry 10 people in somewhat cramped conditions.

Power:	10
Tons:	1 per 100 metres of ring circumference
Cost:	MLv1 per ton

MIRRORS AND WINDOWS

The default design for a station assumes the ring is solid, without windows or other openings. In order to improve quality of life, some are built with windows on the inner ring, the 'sky' to people inside and a system of mirrors directs light coming into the station. This ensures that the armoured rim of the station faces the local star, the primary suspect for radiation spikes.

Windows can be designed with half or full coverage. Farmland and parks might be open to starlight, while residential, commercial and industrial areas are closed. These windows include external shades to simulate day/night cycles if required and provide some protection in case of an incident.

Cost (full coverage):	Lv5000 per ton of ring
Cost (half coverage):	Lv2500 per ton of ring

There are usually two sets of mirrors. One is on the station itself, angled panels surrounding the core, sitting between the spokes that join the two sections of the station. They direct light towards the station from the other mirror. These angled mirrors are included as part of the core tonnage.

Cost:	Lv1000 per ton of ring

The other mirror is a soletta, co-orbital with the station to direct light from the star to the first set of mirrors. The size of this mirror is 0.1 tons per ton of station in the inner zone of a system and 0.3 tons per ton of station in the outer zone of a system.

Cost:	Lv5000 per ton

Engineering Fittings

Any ship-based engineering fittings can be placed in a space station. Depending on the process, some might require gravity, while many do not and can thus be housed in the zero-G core. In general, if liquids or gases are being processed, they benefit from gravity.

Industrial and Commercial Fittings

Stations are not simply waypoints, bumps in the starlanes between where one is and where one wants to be. A station is a living place and serves not just transients but residents as well. Industries may well be how a station pays for and justifies its existence.

Fuel Refinery

TL	Fuel Produced (under spin)	Fuel Produced (zero-g)	Power	Crew	Cost per ton
10	12 tons	9 tons	2	1 per 100 tons	MLv1
12	16 tons	12 tons	2	1 per 500 tons	MLv0.5

COMMERCIAL ZONE

Shops, offices, trading halls, restaurants and trinket stalls, all are required to attract custom to a space station. At the low end, commercial zones can simply be partitioned areas adapted by tenants but advanced space stations are likely to offer extensive business and commercial facilities, such as trading networks, conference centres and attractive plazas.

Power:	1 per 200 tons
Cost:	MLv0.2 per ton

FUEL REFINERY

The production of refined fuel in space has three distinct steps from start to finish; gathering unrefined fuel, refining, then storing and distributing it. Fuel is usually obtained from ice, which is common in the outer regions of most systems. The station need not be near the source of the ice; ice can be shipped from distant parts of the system, either by moving the entire chunk or breaking it down into chunks and transporting it, by ship or mass driver. While it may take time to start the pipeline of ice, once it is started, it will be a steady supply.

Fuel refining and cracking works more efficiently under gravity, so refineries are often located in the ring. These sections are separated from the rest of the station by vacuum firewalls, to prevent fire or other calamities from spreading into inhabited portions. The areas next to these refineries are often parks or other open areas, or else low-value housing. Refineries are always located on a spoke, so water can flow from the core and refined fuel can flow back for storage and distribution. If a fuel refinery is located in the zero-gravity portion of the station, it produces less fuel per ton per ton, for the same Power and Size.

A fuel refinery is a collection of high-end processing machinery that turns water into starship fuel, separating it into both hydrogen and oxygen. Thrusters, fuel cells and MHD turbines all require both. The table shows how much fuel a refinery is capable of outputting per day, per ton dedicated to it, along with its Power requirement per ton and how many crew are needed to service the refinery.

FUEL STORAGE TANK

Fuel must be stored in special tanks rather than cargo space. This tankage is split into two sets of tanks, hydrogen and oxygen, which is factored into the cost.

Tons:	10
Cost:	Lv5000 per ton

MANUFACTURING PLANT

Orbital manufacturing facilities allow the manufacture of goods that can be exported without having to pay the high costs of lifting them up from a gravity well. Building in space keeps planets clear of polluting industrial facilities and in some cases enable processes that would be uneconomic or impossible planetside. The type of goods created is dependent on the type of manufacturing plant, which will be one of Basic, Advanced, Specialist and Agricultural, as shown on the Manufactured Goods table. This table also shows the cost and Power requirement per ton and how many tons of manufacturing plant is needed to produce one ton of goods per day. Manufacturing plants require an input of raw materials equal to the output tons. The type of raw material required depends on the goods produced.

Manufacturing Plant

Plant	TL	Plant Tonnage per Ton of Goods	Power	Crew	Cost
Basic	10	5 tons	1	1 per 10 tons	MLv0.2
Advanced	11	12.5 tons	2	1 per 4 tons	MLv0.4
Specialist	10	25 tons	2	1 per 6 tons	MLv1
Agricultural	10	10 tons	1	1 per 20 tons	MCr0.5

Manufactured Goods

Goods	Raw Material	Plant Type	Trade Code or Planet
Common Electronics, Machine Parts, Manufactured Goods	Common Raw Material (75%)	Basic	None
Common Consumables	Common Raw Material 100%	Agricultural	None
Advanced Electronics, Machine Parts, Manufactured Goods	Common Raw Material 35%, Uncommon Raw Material 50%, Polymers 10%, 5% others	Advanced	Industrial
Advanced Weapons	Common Raw Material 25%, Uncommon Raw Material 60%, Polymers 10%, 5% others	Advanced	High Tech
Advanced Vehicles	Common Raw Material 35%, Uncommon Raw Material 20%, Polymers 40%, 5% others	Advanced	High Tech
Biochemicals	Petrochemicals 100%	Specialist	Kimanjano or Dukou
Cybernetics	Common Raw Material 25%, Uncommon Raw Material 20%, Polymers 50%, 5% others	Specialist	High Tech
Luxury Consumables	Common Raw Material 100%	Agricultural	Agricultural
Luxury Goods	Uncommon Raw Material 60%, Polymers 40%,	Specialist	High Population
Medical Supplies	Common Raw Material 35%, Uncommon Raw Material 30%, Polymers 10%, 25% Biochemicals	Specialist	High Tech
Pharmaceuticals	Uncommon Raw Materials 20%, Petrochemicals 20%, Biochemicals 60%	Specialist	Asteroid
Robots	Common Raw Material 35%, Uncommon Raw Material 20%, Polymers 40%, 5% others	Specialist	Industrial
Spices	Uncommon Raw Materials, 80%, Biochemicals 20%	Agricultural	Desert
Textiles	Common Raw Materials 60%, Petrochemicals 40%,	Basic	Agricultural
Wood	Common Raw Materials 100%	Agricultural	Agricultural
Vehicles	Common Raw Material 55%, Uncommon Raw Material 20%, Polymers 20%, 5% others	Basic	Industrial

MINERAL REFINERY

Mineral refineries convert ore into useful metals and materials. The source for the ore can be asteroids, moons or even planets, lobbed into orbit with a catapult. A refinery and the metals and materials it produces are often the backbone of a system's economy.

These refineries rely on a steady supply of resources. Sometimes a mining company will locate a refinery station in a belt, close to where the mining is, but more often the refining is performed on a multi-use platform close to the inhabited world (if any) in a system.

There are several ways to supply a refinery. Output from small mines can be brought by ship or tug. The output from larger mines is a steady flow, either from asteroid-based mass drivers that throw partially refined ore to giant nets located near the refineries or by moving the asteroid (or fragments of it) into close proximity of the refinery. There, teams of humans and drones can disassemble it at leisure, ensuing a stable supply for the refinery.

Once asteroids are delivered to the station, they must be crushed, the ores and other by-products sorted and waste managed. This waste can often be recycled into radiation shielding for stations and bases on moons and asteroids. Little is actually discarded. The products of the refinery are split between 50% Common Ore, 30% Uncommon Ore, 15% Crystals and Gems and 5% Precious Metals (as defined on page 220 of the *Traveller Core Rulebook*). So, for example, for every 100 tons of produce from the refinery, 50 tons will be Basic Ore, 30 tons will be Uncommon Ore, 15 tons Crystals and Gems, and 5 tons Precious Metals.

The Mineral Refinery table shows how much each refinery is capable of outputting per day, per ton dedicated to it, along with its Power requirement and how many crew are needed to service the refinery.

Mineral Refinery

TL	Plant Tonnage per ton of Ore	Power	Crew	Cost per Ton
10	1 ton	2	1 per 20 tons	MLv1
12	1 ton	1	1 per 50 tons	MLv2

SMELTER

Ores are the normal end-product of a mineral refinery but many stations also conduct on-board processing to create more valuable materials. A smelter allows Common Ores to be processed into Common Raw Materials and Uncommon Ores into Uncommon Raw Materials. Each ton of smelter allows the processing of 0.2 tons of Ores into 0.1 tons of Raw Materials per day.

Power:	1 per ton
Cost:	MLv0.5 per ton

VOLATILES REFINERY

Liquids and gases can be recovered from gas giants, Type-C asteroids, icy moons and comets, among other sources. These raw materials can be processed into industrially useful materials and are often a key component in the fabrication of composite and synthetic materials and chemical feedstocks. The products of a volatiles refinery are 50% Common Raw Materials, 25% Petrochemicals, 20% Polymers and 5% Biochemicals.

If the volatiles refinery is installed in the core rather than under spin, output is halved. It takes 10 tons of volatiles to produce one ton of product.

Volatile Refinery

TL	Plant Tonnage per ton of Volatiles	Power	Crew	Cost per Ton
10	3 ton	3	1 per 20 tons	MLv1
12	2 tons	2	1 per 50 tons	MLv2

Shipyard: The smallest shipyards are on civilian stations for the construction of small craft but far larger construction sites can be found on the stations of TransNats and national governments. Shipyards provide the facilities needed to build ships to the Tech Level of the space station or rebuild badly-damaged craft.

In order to construct ships with stutterwarp drives, a shipyard must be of a suitable Tech Level, as defined on page at least TL10, and the TL of the shipyard is used to determine the Tech Level Modifer. Shipyards capable of building ships with stutterwarp drives have their cost increased to MLv0.75 per ton.

Power:	1 per 10 tons
Tons:	1 per 4 tons of built spacecraft
Cost:	MLv1 per 10 tons

Troop Fittings
Any troop-oriented fittings can be applied to stations.

Endurance Life Support
All large stations should be fitted with endurance life support. A station close to an inhabited world may be able to get away with constantly importing food and other consumables but away from these systems it becomes an absolute requirement.

Shiplock
Along with the standard airlocks available to ships, stations often make use of shiplocks, enormous airlocks large enough to hold an entire ship, allowing vessels to be brought to central loading and maintenance areas without requiring the entire space to be evacuated.

A ship lock requires twice the tonnage of the largest ship it is meant to accommodate and costs MLv0.1 per ton.

Cargo
Station cores are often used for cargo storage for internal use or later transhipment. While these will often be open, buffered spaces, stations will have cargo space for liquids and gases as well. The cargo options for ships can be used without modification.

Signature
Just from their size alone, ring stations have very high Signatures. There is no effective way to hide a giant chunk of metal two kilometres across from active sensors and the power systems required make them blaze across the cosmic background to passive sensors.

A station calculates Radiated Signature normally, based on output from the power system. For Reflected Signature, divide the station tonnage (combined ring and core) by 1,000. Stations are easy to spot, one of several factors that make them dangerous places to be in combat.

ADVANCED SPACECRAFT COMBAT

These rules are presented as options to the starship combat system presented in the *2300AD* box set. They add some complexity to combat, which may slow things down.

SENSORS

All sensor suites have both active and passive capability.

Active Sensors

Active sensors are used to gain precise information on a target using radar and lidar. They are emitters and when in use add DM+4 to a ship's Radiated Signature. UTES and TTAs of both types are active sensors. Survey sensors have some active components and when in use increase Radiated Signature by +2.

Passive Sensors

Passive systems use energy emitted by the target, both heat and electromagnetic radiation. They do not provide as detailed results but have longer range and are undetectable in operation. GADS, DSS and telescopes are all passive sensors.

Range

Sensors have a range, based on their type. Passive sensors have a longer range but do not provide as precise a reading to the target. Each is listed on the Sensor Range table.

Sensor Range

Sensor	Active Range	Passive Range
Minimal	Adjacent	Close
Basic Nav Array	Short	Medium
Basic Military	Medium	Long
Advanced Military	Long	Very Long
Very Advanced Military	Very Long	Distant
DSS	—	Long
GADS	—	Distant
Survey Sensor	Adjacent	Short

Sensors grant DM+1 on Electronics (sensors) checks when a target is at less than the indicated range and inflict DM-2 when at greater than this range.

When using the Sensor Target table on page 150 of the *Traveller Core Rulebook*, use only the columns for Active Radar/Lidar and Passive Radar/Lidar. Thermal and EM are all part of a ship's Radiated Signature, detected by passive sensors. The Passive Radar/Lidar column is used for all passive systems.

Passive and Active Signature

Signature in the *2300AD* box set is abstracted to a degree, with the overall Signature being equal to the higher of either Radiated or Reflected Signatures. In advanced play, these should be used separately. Reflected Signature is used when opposing ships are using active sensors, while the Radiated Signature is used for passive sensors.

Using active sensors increases Radiated Signature by +4.

Power Plants and Heat

MHD turbines and nuclear reactors of both sorts can be 'throttled back' to produce less power and thus less heat. The turbine can be powered right off but reactors cannot reduce Power below 10% of maximum. A ship that reduces its power output sufficiently can lower its Radiated Signature and also give radiators an opportunity to shed excessive heat. Use the value on the Powered-Down table to determine current Radiated Signature.

Powered-Down

Power	Radiated Signature
≤1	0
≤10	1
≤100	2
≤1,000	3
≤10,000	4

Radiator Damage
When radiators take damage, the ability of a ship to shed heat can also be affected. For this reason, many military craft have oversized radiators to absorb damage and minimise loss of capability. For each 10% of capacity a radiator loses, ships will have a chance of suffering a critical hit due to the rising heat. With the first 10%, this will only occur on a 2D roll of 14+. For each 10% thereafter, DM+2 is applied to this check. An additional DM+1 is applied for every 10 points of damage inflicted by energy weapons, even if they did not penetrate armour. They still dump heat energy into the hull, which must be dealt with.

WEAPONS AND DAMAGE
Many surface fixtures on a starship are not protected by hull armour, including sensor arrays, most weapons, solar panels and radiators. Externally carried craft, drones or cargo can also be damaged.

If an attack strikes a ship but fails to penetrate armour, there is a possibility that it will strike a surface fixture instead. Roll 2D. On 8+, an external fixture has been struck. Consult the Hull Fixture Hit table to determine what was hit.

A hit to an external fixture will normally disable it and a second hit will destroy it. Solar panels and radiators lose 10% of their capacity with each hit. Hardened fixtures can absorb the first hit, are disabled on the second and destroyed on the third.

Hull Fixture Hit

2D	Fixture
2	Sensor Array
3–5	Weapon Fixtures
6–8	Radiator or Solar Panel
9–11	External Craft, Drones or Cargo
12	Drone Controller

Giant Emitters
Nuclear weapons, including submunitions, are ‘giant emitters’, with heat, light and electromagnetic radiation produced by their detonation. Giant emitters inflict DM-4 to all Electronics (sensor) checks for the combat round they detonate and the next.

Drive Plumes
The drive plume of thrusters and rockets is impossible for passive sensors to miss. While a thruster or rocket is in operation it adds +8 to a ship’s Radiated Signature. Neither radiators nor heatsinks can reduce this.

Nuclear thrusters can act as giant emitters. If the drive plume of a nuclear thruster is pointed towards a ship, the light and heat will overwhelm both active and passive sensors, inflicting DM-4 to Electronics (sensors) checks. However, the ship will be visible to all sensors.

Sensor Blinding
Beam laser weapons can be used to blind optical components of sensors on both active and passive systems. This is done instead of a normal attack, at DM-4. The attack does not have to penetrate a ship’s armour in order to be successful. Upon success, the target ship suffers DM-4 to all Electronics (sensors) checks for this combat round and the next.

ORBITAL COMBAT
Below the Wall, ships must use reaction drives to manoeuvre. Submunitions cannot be used, as the dispensing ship cannot get far enough away from the warhead to avoid detonation. In a similar vein, combat drones are unusable, as they rely on stutterwarp drives. While it is possible to attach a booster to a drone so it can manoeuvre, the relative close quarters makes detonation lasers unfeasible.

To make matters worse, a combat drone beyond the Wall can attack a ship beneath it, making orbital space a very dangerous place. Ships cannot manoeuvre effectively, combat drones and detonation lasers are too dangerous to everyone and ships are effectively stationary to a stutterwarp vessel, not able to even effectively return fire.

Detonation Lasers
Detonation lasers, as found on some drones and in submunitions, are very dangerous in orbital space. Any time one is fired, the controlling ship will be hit as well. In addition, the controlling ship must make a Very Difficult (12+) Pilot check (1D seconds, DEX). Any negative Effect is applied as additional damage to the controlling ship.

Orbital Manoeuvring
Below the Wall, ships cannot use stutterwarp drives. However, they can use Burns to manoeuvre, with each Burn expended granting DM+1 to the Pilot’s phase of the Firing Solution. In addition, ships can use Burns to evade, with each Burn granting DM+1 to Pilot checks made for evasive manoeuvring.

SURFACE TO ORBIT OPTIONS

While conventional interface craft like spaceplanes and landers perform the bulk of surface to orbit duties, there are other means of attaining orbit. Most of these options are seldom used because of the initial start-up costs, although lower operational costs do pay off in the end.

ORBITAL ELEVATORS (BEANSTALKS)

The two Beanstalks currently in operation, one on Earth and one on Beta Canum, are the most advanced, and largest, structures ever constructed.

A Beanstalk extends from the surface of the world to geostationary orbit and then extends from that point to an equal distance beyond. It is only viable on worlds with relatively fast rotation, as the system depends on this to keep the Beanstalk balanced and under tension for its entire length. It then behaves like a rigid structure, over 75,000 kilometres high.

Constructing a Beanstalk is out of scope for this book but constructing climber cars is not. A climber car is designed as a ballistic hull and all spacecraft options apply. They usually do not have a bridge and are robot-controlled. Some small climbers have a cockpit or even a flight deck but that is rare.

Climber cars have a different motive system, the climber, which uses a linear induction motor to pull the car up and down the Beanstalk. The climber does not make physical contact with the Beanstalk rail and has no moving parts. This is essential for the 35,000 kilometre (each way) journey a climber car must make. However, in the event of a power failure, or some other emergency, climbers are equipped with brakes that can grip the rail. This is included as part of the climber propulsion system.

A climber requires a continuous input of Power equal to climber tonnage x 0.05 x the world Size code. The tonnage is 10% of the Power requirement, costing is MLv0.5 per ton. It requires Power for a minimum of five days, although longer is advised.

While climbers often use batteries or fuel cells for power, they can also draw power directly from the Beanstalk. The tonnage and cost are based on the Power draw. Power receivers consume tonnage equal to 5% of the Power input, costing MLv1 per ton.

Climbers should still have batteries or a fuel cell as backup power.

LASER LIFT SYSTEMS

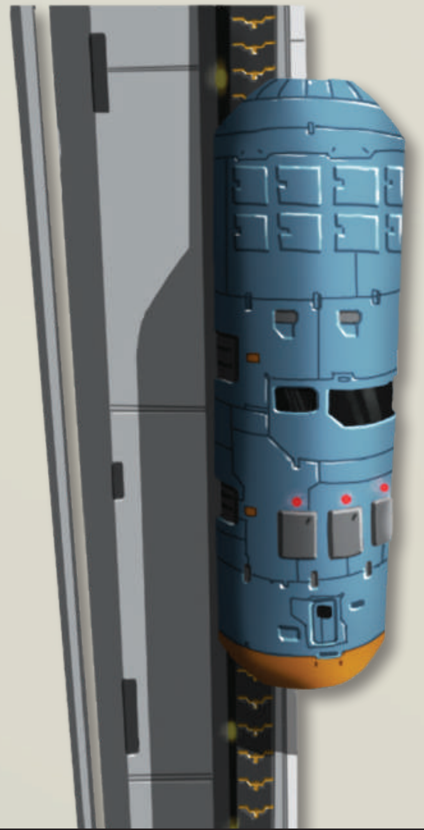
A laser lift system uses a powerful ground-based laser to vaporise atmospheric gases underneath a lift vehicle, called a lightcraft. When atmospheric gases are no longer available, a solid ablative material that coats the underside of the lift vehicle is vaporised instead. Laser lift systems leave their power source at home; a ground-based laser superheats the air at the base of the vehicle, which then explodes to propel the craft. The laser continues to do this until the flight runs out of sufficiently-dense atmosphere (any atmospheric gas will suffice) and at that point it must make use of internal fuel. This is sufficient to drive the lightcraft to Low Orbit, after which it is too difficult to hold focus on the beam. Unless another laser is placed in orbit, a lightcraft is unable to manoeuvre or ascend to a higher orbit.

The laser-powered vehicle has a manoeuvre drive, which consumes 1% of the hull tonnage per world Size and costs MLv0.1 per ton. The ablative reaction mass uses 5% of the hull tonnage per Burn but the laser lift system subtracts -3 from the world Size for purposes of determining Burns required. It cannot make use of any drive-based traits.

The ground-based laser costs MLv0.1 x world Size x lightcraft tonnage and requires Power input equal to the cost x 10 but since the power source remains on the ground that is usually not an issue. It is worth noting that a ground-based laser like this could do enormous damage to a spacecraft (4D), if it could somehow be aimed.

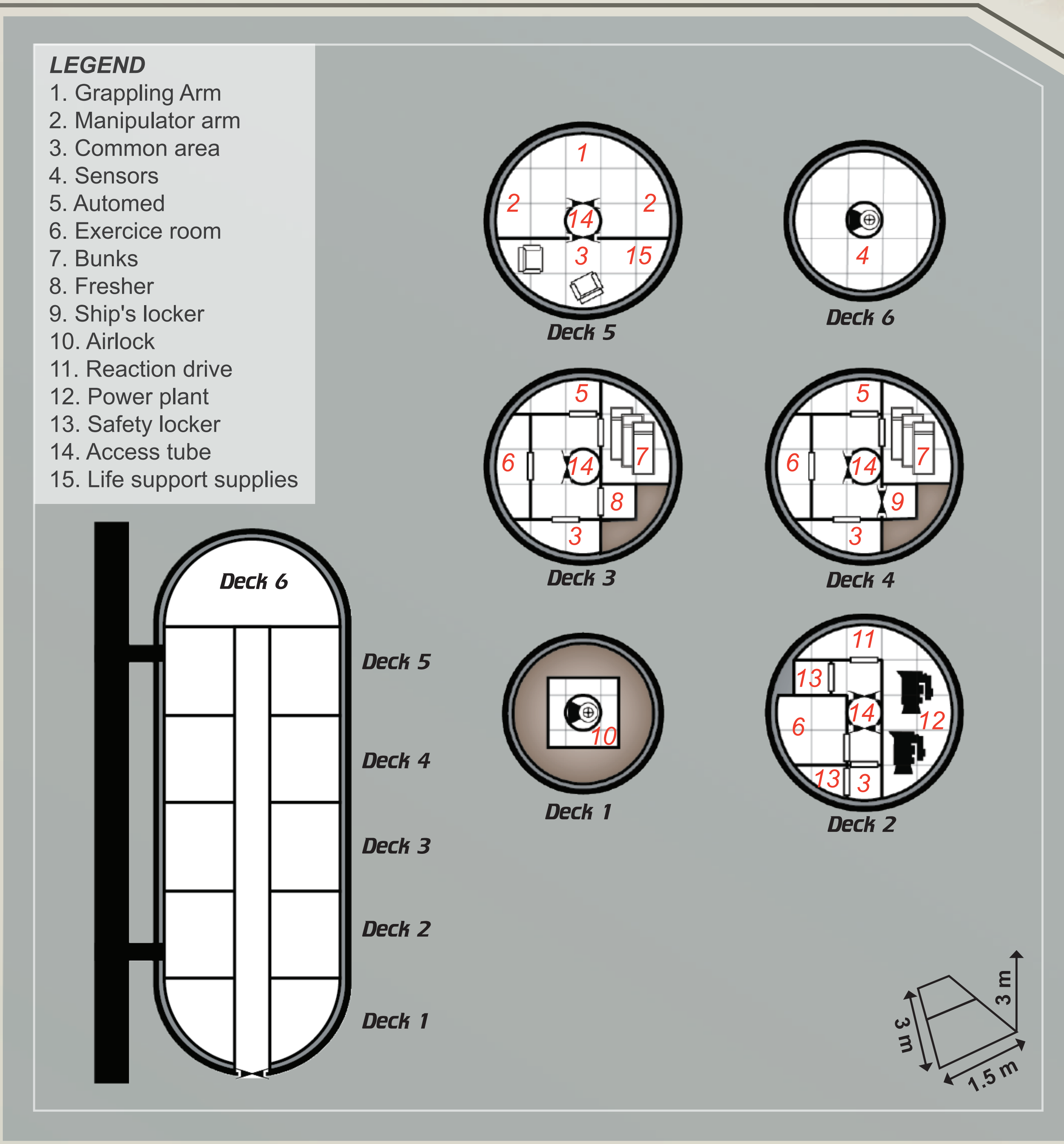
LITTLE BEAN MAINTENANCE AND INSPECTION CLIMBER

NATION: France
FIRST EXAMPLE LAID DOWN: 2291
MANUFACTURER: L'Étage Aerospace
PRODUCTION STATUS: Out of Production
CONSTRUCTION TIME: 62 Days
SERVICE STATUS: In Service
FLEETS OF SERVICE: France
NUMBER IN SERVICE: 6
LENGTH: 22.51 m
WIDTH: 8.44 m
TAKE-OFF MASS (FULLY FUELLED): 360 tons
POWER PLANT: 2.7 MW Fuel Cell
REACTION DRIVE: 2.7 MW Linear Induction Drive System



The so-called Little Bean is only little in comparison to the full-sized passenger climber. This maintenance and inspection vehicle contains the equipment to inspect and make minor repairs on the tracks and power distribution system of a Beanstalk. Since it can be self-powered, it can also be used as a rescue vehicle in case of an emergency.

TL12		Tons	Cost (MLv)
Hull	40-ton Composite Ballistic	—	1.2
Hull Features	—	—	—
Reaction Drive	Climber	1.6	0.8
Power Plant	External (Power 27, indefinite), Secondary Power (fuel cell, Power 27)	3.28	12.92
Emergency Power	Power 0.4, for 24 hours	0.0096	0.0096
Fuel Tanks	Power Plant (2 weeks)	4.05	—
Radiators	Conventional	2.7	0.135
Bridge	Autopilot, with Neural Link	—	0.6
Computer	Primary: Computer/20 Secondary: Computer/15	—	3.5
Sensors	Advanced Military, Telescope	5	7
Systems	Automeds x2, Common Areas x6, Exercise Equipment x3, Safety Lockers x2, Ship's Locker, Simple Fresher	10.25	2.055
	Grappling Arm, Manipulator x4	6	0.65
Airlocks	Standard Airlock	2	0.02
Accommodations	Bunks (for 3) x2	2	0.05
Software	Archive, Manoeuvre, Neural Interface, Robotic Control (advanced, skill 2, voice/speech recognition, interactive, personality)	—	2.2
Life Support Consumables	28 days for 6 people	0.34	—
Cargo		2.28	—
Total: MLv27.68			



Crew	Passengers	Hull Points	Signature: 2
Autopilot: Pilot 2 Technicians x6 **Comfort Rating**: -2	—	273	Base Reflected: 1 Base Radiated: 2

Running Costs

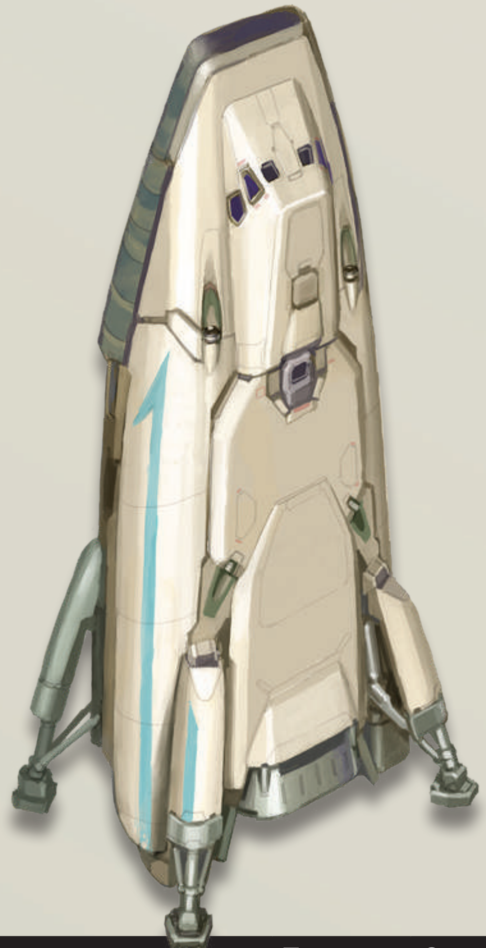
Maintenance Cost: Lv2306.67/month Purchase Cost: MLv27.68

Power Requirements	Power
Basic Ship Systems	21
Climber	16
Sensors	10

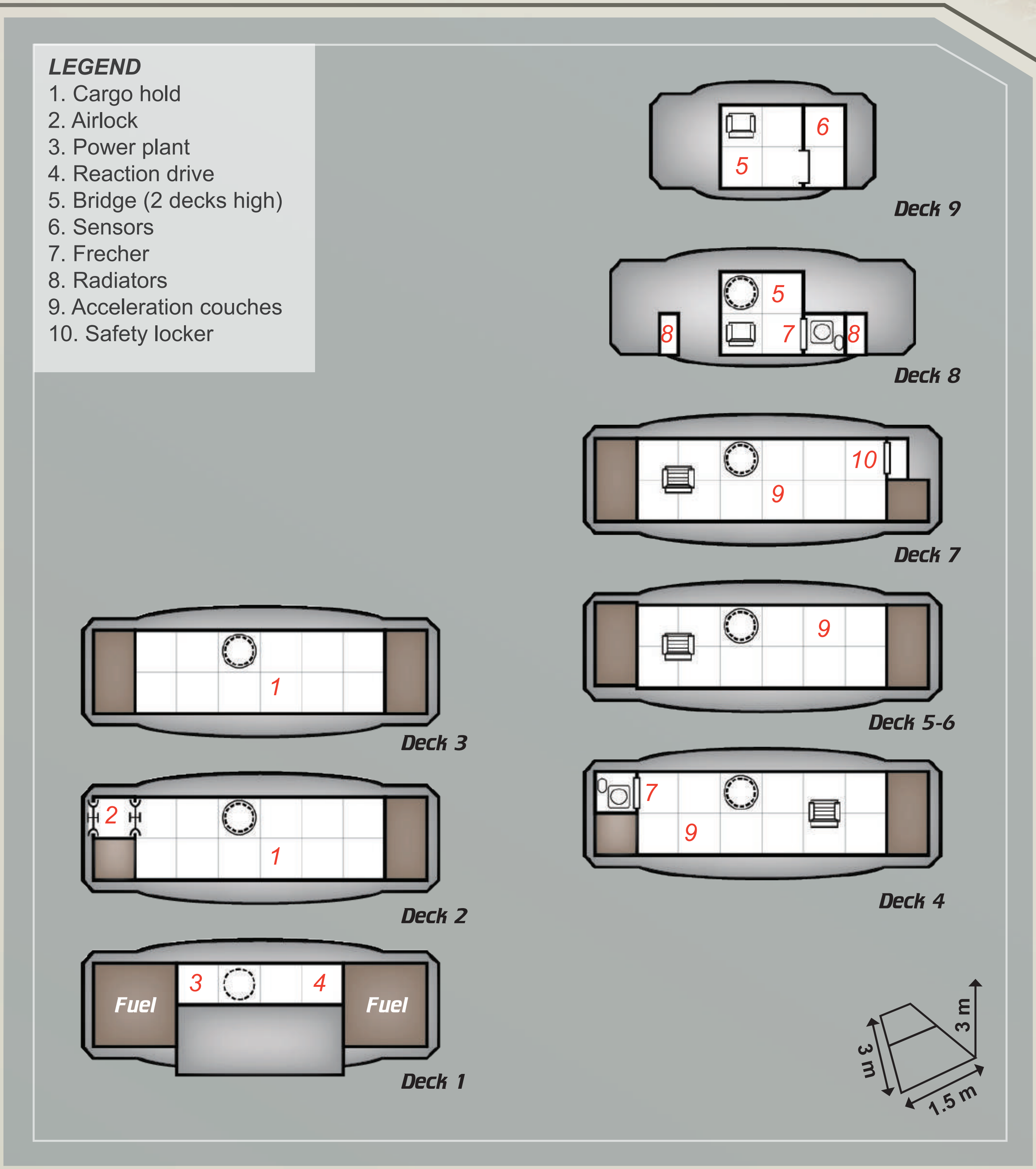
SUNDOG LIGHTCRAFT

NATION: France
FIRST EXAMPLE LAID DOWN: Unknown
MANUFACTURER: Giscard Aerospace Division
PRODUCTION STATUS: Out of Production
CONSTRUCTION TIME: 11 Days
SERVICE STATUS: In Service
FLEETS OF SERVICE: France
NUMBER IN SERVICE: 8
LENGTH: 24.25 m
WIDTH: 9.09 m
TAKE-OFF MASS (FULLY FUELLED): 375 tons
POWER PLANT: 0.5 MW Fuel Cell
REACTION DRIVE: 40 MW Laser Lift System, 1,250 tons thrust

The Sundog is one of two lightcraft employed at Nous Voila, the other being a cargo lifter of the same size. Flight on a lightcraft is often described as 'unpleasant', as it has a mid-range vibration caused by the explosions that propel the vehicle, dozens of times a minute. It is easy and inexpensive to operate, although requires a fusion power plant to supply the needs of the laser. When the system fires, the nearby colony has a brownout, as it draws so much power.



TL11		Tons	Cost (MLv)
Hull	50-ton Synthetic Ballistic	—	1.2
Hull Features	Heat Shield	—	0.5
Armour	0	—	—
Reaction Drive	Laser Lift Array (Size 8)	0.5	0.0375
Power Plant	Fuel Cell (Power 5)	0.42	1.67
Fuel Tanks	Ablative Propellant (5 Burns)	12.5	—
	Power Plant (24 hours)	0.108	—
Radiators	Conventional, Capacity 5	0.5	0.025
Bridge	Flight Deck	3	0.25
Computer	Primary: Computer/10 Secondary: Computer/5	—	0.095
Software	Archive, Intellect, Manoeuvre	—	1
Sensors	Basic Nav Array	1	0.1
Systems	Safety Locker, Simple Freshers x2,	0.5	0.06
Airlocks	Standard Airlocks	—	—
Accommodations	Acceleration Couches x80	20	2.4
Life Support Consumables	1 day for 85 people	0.17	—
Cargo		11.31	—
	Total: MLv6.71		



Crew	Passengers	Hull Points	Signature: 1
Pilot, Co-Pilot, Stewards x2, Security **Comfort Rating**: N/A	80	5	Base Reflected: 1 Base Radiated: 1

Running Costs
Maintenance Cost: Lv550/month Purchase Cost: MLv6.6

Power Requirements	Power
Basic Ship Systems	0.5
Reaction Drive	400

Orbital Mirrors

The French Colony at Nous Voila makes use of a system of orbiting mirrors, termed 'solettas', to provide additional energy to the expanses of engineered Dark Bloom algae melting glaciers and warming the planet. Nous Voila is also one of the few worlds in human space that uses a laser lift array. The system of solettas could well be used to aim the laser from the lift system but they would likely only last for one, maybe two, firings.

CATAPULTS

The electromagnetic catapult is a maglev launcher that accelerates a payload to orbital velocity before releasing it. The long launch rail is usually sited to be able to bank up the side of mountain, with the launch point having as high an altitude as possible. On atmospheric worlds, the launch rail is enclosed in an evacuated tunnel, similar in some ways to the maglev tube trains of the Core. On vacuum worlds, the enclosed tunnel is not required.

Catapults are most often used on mining worlds to launch refined or semi-refined ore into orbit, cheaply and effectively. With a sufficient power source, a catapult could launch a payload every minute, enabling it to potentially loft 7,200 tons of ore per day. In practice, catapults are not run constantly.

CATAPULT SLEDS AND SLUGS

There are two types of catapult payloads – sleds, which are usually used for cargos like bulk grain and ice and single-use slugs, used for launching solid cargos like refined ores. Slugs are often launched at far-higher velocities than the sleds, as they are more heavily-reinforced.

Reusable sleds are designed like drop gliders, with lifting body airframes and heat shields. They are more heavily reinforced than a normal hull and lose 10% of their available tonnage. Cost is MLv0.1 per ton and they become available at TL10. Sleds do not require any other features.

Slugs are designed as ballistic hulls and always disposable. If the catapult is sited on an airless world then slugs are designed as spaceframes. Slugs cost MLv0.01 per ton, become available at TL10 and do not lose any tonnage to the hull. The hull *is* the cargo.

Neither sleds nor slugs are suitable for launching live cargo. The acceleration is immense, several hundred to several thousand Gs and would reduce anything living or indeed anything fragile, to a smear on the aft bulkhead.

CAPTURE DRONES

Once in orbit, sleds and slugs are captured by drones using a carbon fibre net and high-burn thrusters. These drones are designed as small spaceframes with OMS rockets or thrusters that are double the normal size and require double the fuel. They generally only require two to three Burns to capture a number of payloads and return them to a ship or station for processing.

CATAPULT DESIGN

The catapult requires two parts; the catapult head that loads the payload and manages power, and the rail itself. Command and control facilities are usually sited a few kilometres from the catapult head. The catapult head's tonnage is 10 x payload size and costs MLv1 per ton. It is often manufactured elsewhere and dropped in an aeroshell to the build site.

The length of rail required to accelerate a sled to orbital velocity depends on the size of the sled and planet. Multiply world Size x 2 x sled tonnage, to get the length of rail required in kilometres. On a Size 8 world like Earth, a five-ton sled would need (8x2x5) 80 kilometres of rail to fire the sled into orbit. On a world with an atmosphere, the cost of the rail is MLv1 per kilometre, multiplied by the Atmosphere code (0 is 0.5 for this purpose). On Earth, that 80-kilometre rail will cost 80 x 7 (Atmosphere 7), or MLv560.

The catapult would require Power equal to world Size x slug/sled tonnage x 100. The 5-ton sled on Earth would require 8 (Size code) x 5 x 100, or Power 4,000. That input allows a sled to be launched at a rate of one per minute. Doubling the power input will double the launch rate but this is seldom done due to the low margin of error and stress on power management systems.

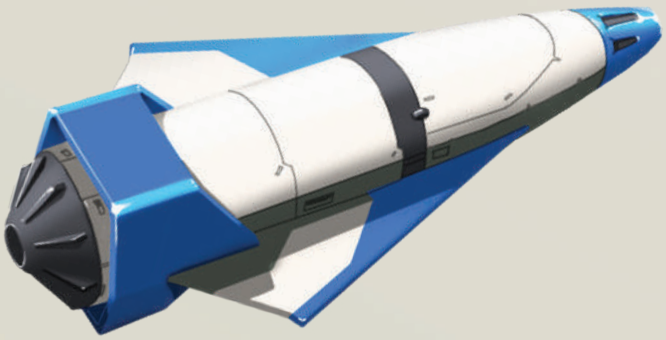
Dunkelheim Catapult

The colony world of Dunkelheim was established as a mining centre, exploiting the wealth of heavy metals and rare earths to be found there. Mineral ores are heavy and the cost of getting them into orbit is great. To address this, the German government built a catapult system, with the catapult head 25 kilometres away from the colony site.

In order to use standard sleds, the catapult head is designed to handle five-ton payloads. It is 50 tons and costs MLv50.

Dunkelheim is Size 4 and the catapult was designed to launch five-ton payloads. The catapult requires a rail 4 x 2 x 5, or 40 kilometres long. The system requires Power 4 x 5 x 100 (4,000), supplied by a nearby nuclear power plant. Dunkelheim has a thin Atmosphere 4, so the catapult rail will cost 40 x 4, or MLv160.

Total cost for the catapult would be MLv210, plus shipping costs to bring the components to Dunkelheim from where they were built, likely the Neubayern system.



RENNRODEL 5-TON SLED

NATION: Germany
FIRST EXAMPLE LAID DOWN: 2200
MANUFACTURER: Rheinmetall Aerospace Division
PRODUCTION STATUS: In Production
CONSTRUCTION TIME: 1 Day
SERVICE STATUS: In Service
FLEETS OF SERVICE: Germany, Others
NUMBER IN SERVICE: 1,000+
LENGTH: 8.44 m
WIDTH: 2.81 m
WINGSPAN: 3.38 m
TAKE-OFF MASS (FULLY FUELLED): 50 tons

The Rennrodel is an example of a basic aerodynamic catapult sled, designed to send four and a half tons of cargo into low orbit. It is just a reinforced airframe, with basic guidance computer to handle the return flight. It can be reused several dozen times before being replaced due to the wear and tear. It is used to handle lighter cargos, like ice and grain.

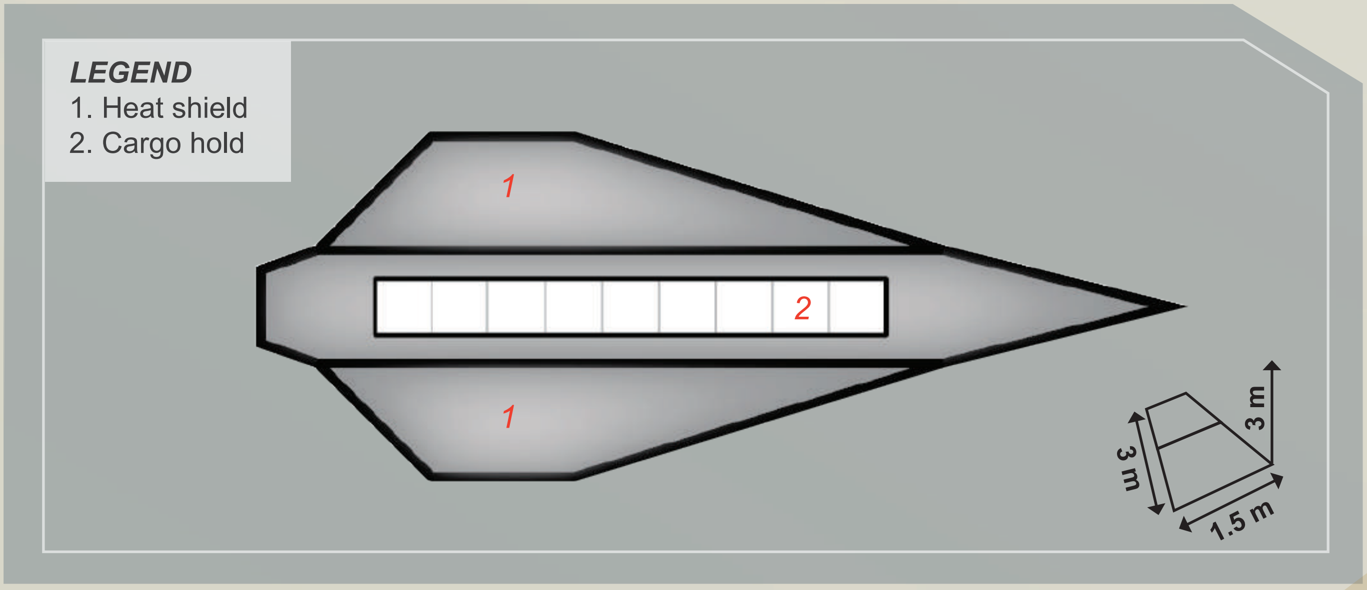
TL10		Tons	Cost (MLv)
Hull	5-ton Aligned Crystal Steel Lifting Body	—	0.6
Hull Features	Heat Shield	0.5	0.05
Bridge	Autopilot	—	0.05
Computer	Primary: Computer/5	—	0.03
Software	Manoeuvre	—	—
Cargo		4.5	—
	Total: MLv0.59		

Crew	Passengers	Hull Points	Signature: 1
Autopilot: Pilot 0	—	0	Base Reflected: 1 Base Radiated: 0

Running Costs

Maintenance Cost: Lv55/month Purchase Cost: MLv0.66

Power Requirements: none



TETHERS

A tether utilises material technology similar to a Beanstalk but on a far less grand scale. The cable for a tether is usually no more than 25 to 50 kilometres long each way. Like a Beanstalk, a tether extends in both directions from the central anchor point, usually a spacecraft or station in low orbit. The higher endpoint of the tether is moving faster than the central point, which itself is moving faster than the lowest endpoint. This causes the whole tether assembly to rotate, with the lower end rotating up and out of the atmosphere as the higher end slows and descends.

As the lower end moves through the thin upper atmosphere, it undergoes compression heating, much like a spacecraft on re-entry. It is possible to protect the endpoint with a streamlined composite frame and provide a safe region behind and below where an aircraft could approach the endpoint and attach a small cargo. The tether continues on its way as this happens, so there is only a small window of opportunity. Once attached, the cargo is rotated into orbit, where the ship or station at the anchor point could reel it in.

The amount of payload that can be affixed to a tether is small, so tends to be high-value like biological samples, pharmaceuticals, electronics and secure data.

Tether Design

There are three components to a tether system; the tether itself, the spool and cargo handling equipment at the anchor and the endpoint.

The most expensive component is the tether. Each section of the tether should be at least world Size x five kilometres in length but in practice most commercial tethers are at least 50% longer. Compared to a Beanstalk cable, the tether is extremely small, around five centimetres in diameter. This still takes up substantial space when 80 kilometres of it is reeled inside a hull.

Tethers are rated and priced by the payload tonnage and the world Size. The size per kilometre of the tether is 0.001 tons per ton of payload, multiplied by one plus the world Size. This gives a margin of error in the tether's load capability. The size of the payload must include the size of the endpoint as well. The cost of a tether is MLv2 per ton and becomes available at TL11.

For Earth, with Size 8, a tether for a 10-ton payload would be 10 x 0.001 x (8+1) or 0.09 tons per kilometre. The tether length should be 120 kilometres total, so 10.8 tons of tether is required. The tether itself is valued at MLv21.6; The amount of tether in a ship is often worth comfortably more than the ship itself.

The tether handling equipment is equal in size to the tether and costs MLv0.5 per ton. This equipment also requires Power 1 per ton of endpoint.

The endpoint is designed as a ballistic craft with an armoured composite hull and heat shield. It must have enough space onboard for the cargo and any cargo handling equipment. Endpoints are typically unmanned and there is no connection between the ship and the endpoint until the tether is completely reeled in.

AMERICO FAST DELIVERY SYSTEM

NATION: United States
FIRST EXAMPLE LAID DOWN: 2294
MANUFACTURER: Darlan Aerospatiale and AmeriCo Aerospace
PRODUCTION STATUS: Out of Production
CONSTRUCTION TIME: 114 Days
SERVICE STATUS: In Service
FLEETS OF SERVICE: AmeriCo
NUMBER IN SERVICE: 6
LENGTH: 28.87 m
WIDTH: 9.62 m
WINGSPAN: 11.55 m
TAKE-OFF MASS (FULLY FUELLED): 1,500 tons
POWER PLANT: 2.5 MW MHD Turbine
REACTION DRIVE: Air-Breathing Thruster, 6,000 tons thrust
STUTTERWARP: 1.5 MW Gen II Jerome-effect Stutterwarp
ATMOSPHERIC FLIGHT SPEED (STANDARD DENSITY/ PRESSURE): 800 km/h
TAKE-OFF ROLL: 800 m
LANDING ROLL, UNPOWERED: 1,350 m
LANDING ROLL, POWERED: 450 m

The AmeriCo Fast Delivery System is used by AmeriCo for expedited delivery and pickup of valuable cargo. The system is emplaced in the cargo bay of a modified Thorez courier. The company runs at least five of these ships on the American Arm. American Law Enforcement strongly suspects these ships are involved in smuggling, which a tether system is perfect for.

The endpoints, tether handling equipment and the tether itself are placed on the port side of the cargo bay, leaving the starboard side open. Potentially, a Sabre combat module could be installed on that side of the bay but then the ship would have almost no cargo-carrying capability, aside from whatever is being carried by the endpoint.

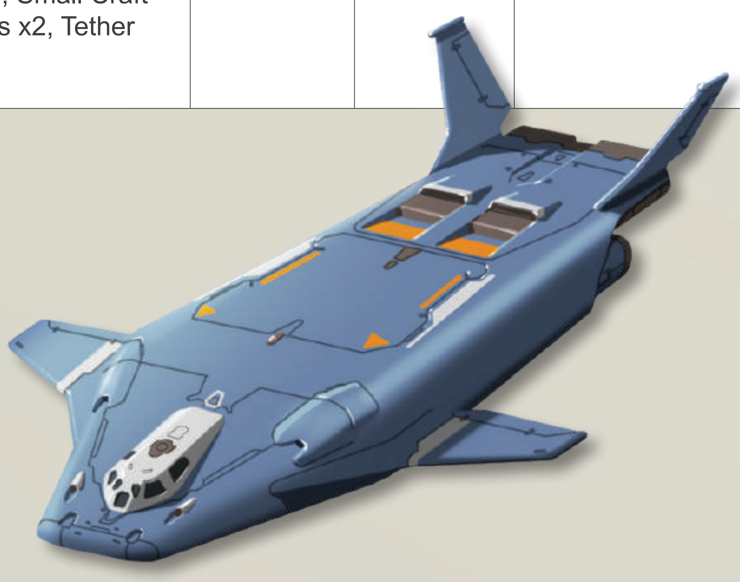
TL12		Tons	Cost (MLv)
Hull	200-ton Synthetic Lifting Body	—	5.6
Hull Features	Heat Shield, STOL, Frontier Operations	2	4.2
Reaction Drive	Thruster (air-breathing, advanced, Size 8)	5	6.25
Stutterwarp	2.18 ly/day, Tac Speed: 2	2.11	2.64
Power Plant	MHD Turbine (Power 40)	5	1.25
Emergency Power	Power 2, for 24 hours	0.48	0.48
Fuel Tanks	Thruster (6 Burns)	30	—
	Power Plant (2 weeks)	12.5	—
Radiators	Conventional, Capacity 50	5	0.25
Bridge	Small	5	1
Computer	Primary: Computer/15 Secondary: Computer/10	—	2.16
Sensors	Basic Nav Array, DSS	3	1.6
Weapons	Hardpoints x2	—	0.2
Systems	Exercise Equipment, Safety Locker, Ship's Locker, Simple Fresher	2.25	0.605
	Cargo Arms x2, Tether (120 km), Tether System	23.6	27.3
Sub-Craft	2 Olympia Endpoints in Berths	22	3.32
Airlocks	Standard Airlocks x2	—	—
Accommodations	Staterooms x11, Small Staterooms x4	52	5.9
Software	Archive, Intellect, Manoeuvre, Stutterwarp Control	—	1.72
Life Support Consumables	28 days for 28 people	1.57	—
Cargo		20.49	—
Total: MLv58.13			

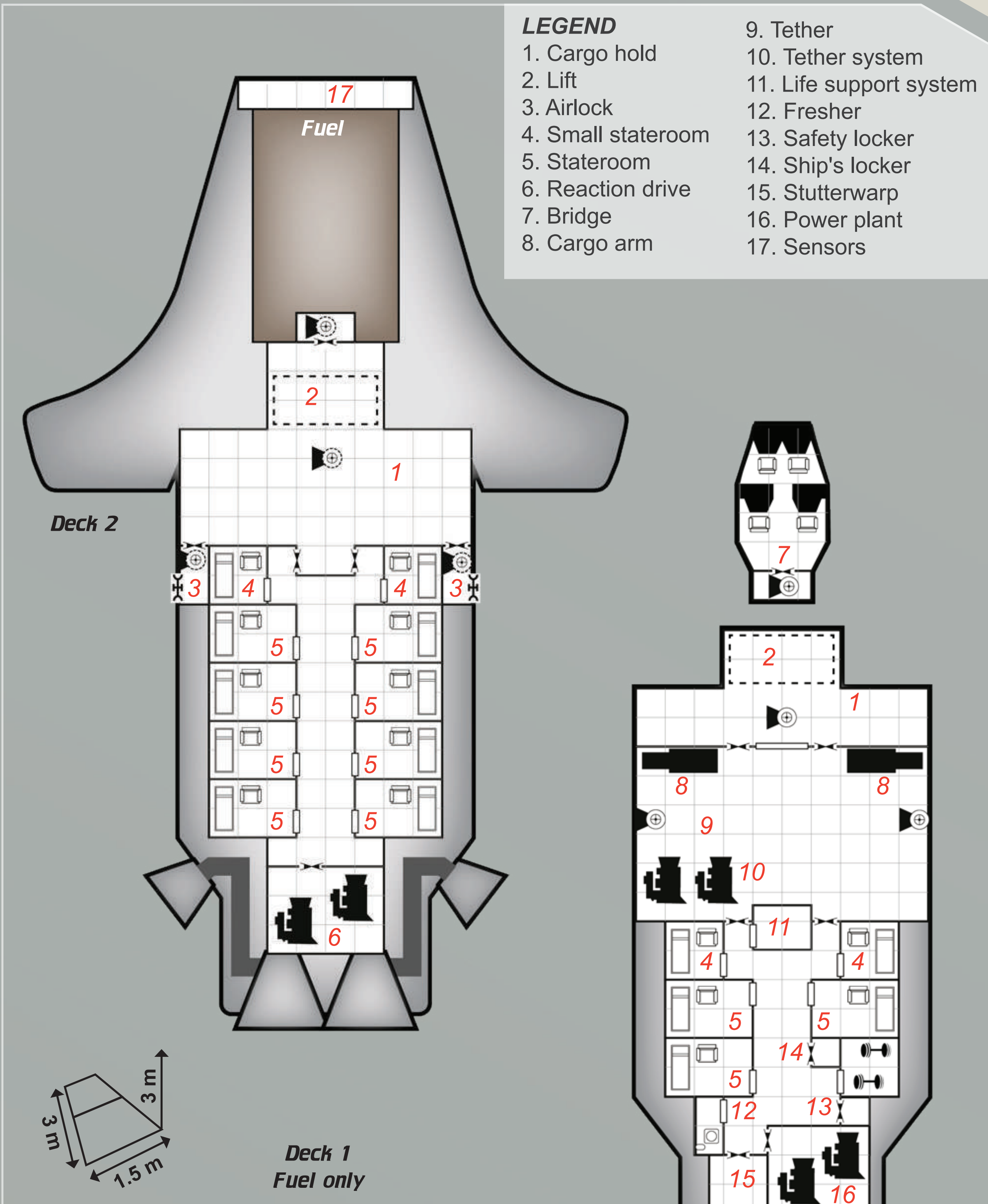
Crew	Passengers	Hull Points	Signature: 2
Captain, Bridge Officer, Astrogators x2, Flight Engineers x2, Pilots x2, Sensor Techs x2, Reaction Drive Engineers x2, Stutterwarp Engineers x2, Power Engineers x2, Small Craft Tech, Life Support Techs x2, Electronics Techs x2, Tether Systems Specialists x4 **Comfort Rating**: -1	—	20	Base Reflected: 1 Base Radiated: 2

Running Costs

Maintenance Cost: Lv4844/month Purchase Cost: MLv58.13

Power Requirements	Power
Basic Ship Systems	2
Reaction Drive	20
Stutterwarp	20
Tether System	20
Sensors	2





Maximum Airspeed	Subsonic
Cruising Airspeed	Very Fast
Endurance	1 Hour per Burn

AMERICO OLYMPIA TETHER LIFT SYSTEM ENDPOINT

NATION: AmeriCo
FIRST EXAMPLE LAID DOWN: 2294
MANUFACTURER: Hyde Dynamics
PRODUCTION STATUS: In Production
CONSTRUCTION TIME: 3 Days
SERVICE STATUS: In Service
FLEETS OF SERVICE: AmeriCo
NUMBER IN SERVICE: 10
LENGTH: 12.41 m
WIDTH: 1.77 m
WINGSPAN: 10.64 m (Folded: 2.66 m)
TAKE-OFF MASS (FULLY FUELLED): 91.8 tons
POWER PLANT: 0.2 MW Fuel Cell

Tether lift systems are new, taking advantage of material advances that allowed the construction of Beanstalks. The Olympia Lift System from AmeriCo is one of the few in service, although other governments are thought to have them as well.

The Olympia endpoint is an armoured airframe designed to grapple and lift up to 6 tons of cargo to orbit. It is designed to operate only in the uppermost reaches of the atmosphere and even then the fast-moving airframe blazes across the sky as compression heating makes the leading edges glow white-hot. Only a hypersonic aircraft can match speed with the endpoint long enough to transfer a small amount of cargo and so use of this system is rare.

TL12		Tons	Cost (MLv)
Hull	10-ton Composite Airframe	—	0.32
Hull Features	Heat Shield, Advanced, Folding Wings	0.2	0.4
Armour	4	0.2	0.12
Power Plant	Fuel Cell (Power 2)	0.14	0.86
Fuel Tanks	Power Plant (12 hours)	0.0216	—
Radiators	Conventional, Capacity 2	0.2	0.01
Bridge	Autopilot	—	0.1
Computer	Primary: Computer/5	—	0.03
Sensors	Basic Nav Array	1	0.1
Systems	Cargo Arms x2	2	0.3
Software	Manoeuvre	—	0.025
Cargo		6.44	—
	Total: MLv2.04		

Crew	Passengers	Hull Points	Signature: 1
Autopilot: Pilot 1	—	2	Base Reflected: 1 Base Radiated: 1

Power Requirements	Power
Basic Ship Systems	0.2
Sensors	2

Running Costs
Maintenance Cost: Lv206/month Purchase Cost: MLv2.47

BELTERS AND ASTEROID OPERATIONS

Asteroid mining and resource exploitation is a critically important component of the economic and technological infrastructure of human space. The discovery and recovery of these resources is a key driver of space exploration and colonisation. Many planetary colonies were established to support nearby asteroid mines and the rise of Belter communities followed this expansion. The need for skilled labour and specialised spacecraft gave Belters power and agency against governments and corporations.

The Consolidation Era on the French Arm diluted the power and influence of Belters but now that expansion is being driven by former colonies and smaller nations, Belter expertise is becoming desired again.

ASTEROID TYPES

There are four common classifications for asteroids: Type-C, Type-S, Type-M and Ice. The Ice category includes comets and smaller Kuiper belt objects.

Type-C, or carbonaceous, asteroids are the most common, comprising anywhere from 50%–75% of asteroids. These are dark objects with a high proportion of carbon compounds in the outer crust and usually comprise silicate rocks and clay. Type C asteroids often have water-bearing minerals, and larger and more stable objects are the preferred choice for Belter homesteads, although these asteroids tend to be the least valuable for mining.

Type-S, or stony, asteroids are the next most common. They are a mix of silicate rock and nickel-iron, with a scattering of other metals. Small Belter co-ops can eke out an existence by recovering the most valuable metals from these objects, including platinum-group metals, (platinum, iridium and palladium primarily).

Type-M, or metallic, asteroids are the rarest and most valuable. They are chunks of largely nickel-iron ores, with some heavier metals as well. The discovery of one of these objects can make a Belter community rich.

ASTEROID BELT ZONES

Inner Zone

In the light and heat of the inner zone, volatiles are driven out by heat, radiation and stellar wind. Most asteroids found in this zone are Type-M, although with a sizable minority of Type-S. There are very few Type-C, withered husks of carbon and silicates, and no Ice objects.

Middle Zone

The middle zone is a transition region between the inner and outer regions. The asteroids in this zone are a mix of Type-M and Type-C, with a healthy mix of Type-S.

Outer Zone

The frigid outer zone is conducive to the preservation of Type-C and ice asteroids and objects, which are more common here than in the inner or middle zone. The majority of objects in the outer zone are Type-C with a smattering of Type-S and very rare Type-M asteroids.

Trojans

These are asteroid clusters found at the Trojan points of large gas giants, if present. Trojan points are islands of gravitational stability, where the pull of the gas giant and star are in equilibrium. Objects at a Trojan point remain in place as long as they are not disturbed. Trojan points are remarkably stable points and tend to collect asteroids. The type of asteroid depends on what zone the gas giant (and Trojan point) is in. These objects are found in the same orbit as the gas giant but 60° ahead of and behind the planet.

Kuiper Belt

The Kuiper belt is a very large zone of space that circles a star at a distance of 30–50 AU. While much more diffuse than a typical asteroid, it can contain up to 200 times the mass of a main belt. The vast majority of objects are ice and other frozen volatiles, with a scattering of Type-C asteroids. It can also hold a number of minor planets, some of which may be used as discharge points.

The Kuiper belt is very large and very diffuse. Finding a minor planet, let alone one suitable for discharge, is not an easy task. This requires a deep system scanner and a Very Difficult (12+) Science (astronomy) check (1D weeks, EDU). If a GADS sensor is available, the time increment becomes 1D days.

MINING

There are a variety of mining operations performed at various scales by both Belters and large corporations. At the lowest end sit the seekers, individual Belters and Belter families who search asteroid belts for major finds. As they are typically unable to exploit these major finds, they end up selling them to others, larger Belter groups if at all possible. At the opposite extreme are the mining megacorps, whose operations can swallow whole asteroids and spit out ingots of refined metals at the other end. Both extremes often hate each other passionately.

Seekers are the desperate fringe of the Belter culture, too small or too poor to prosper and too proud to subjugate themselves to another family or clan. A few among them are true loners, preferring to be alone among the stars. If a seeker group makes a major find, they will register it as soon as they can, then seek to sell it to the highest bidder, with a preference for other Belters.

'Independents' is a catch-all term for Belter families or cooperatives that have the financial and industrial resources to mine and process an asteroid, at least to some extent. These groups will often move onto a particularly rich find and use the tunnels created from mining as living and working quarters. They often work with seekers to extend their reach and many join up with independents after getting sick of seeker life.

The largest of the Belter groups are the so-called 'Belter corps', registered corporations, complete with limited liability clauses, investors and stock dividends. Their investors are all Belters and dividends paid are to themselves. Belter corps are trying to beat the mining corporations at their own game, without losing their souls in the process. Each Belter corp is tied to a single system and usually take their name from the system. The largest, of course, is Solcorp, rivalling smaller megacorps in money and power. They are no less ruthless either and as a result many independents and seekers have left Sol for freer pastures.

Belter corps have large, centralised facilities and prefer to move large, valuable finds to them, both to process ore more efficiently and protect it.

At the top, of course, are the mining megacorps, huge conglomerates whose activities revolve around finding, mining and refining the metals and minerals that feed the ever-growing demand for goods and technology. Although megacorps are bound by the laws of their native countries and are not powerful enough to dictate the terms of those relationships, they still have a great deal of money and influence.

Megacorps own massive mining ships that move in and digest asteroids, breaking them apart with explosives, then collecting and refining the pieces. Most are equipped with large mass drivers to send cargos of processed minerals and metals to market. One of these ships can stay for months or years on a valuable find, grinding away until all that is left is a drifting pile of gravel and slag.

The megacorps regard Belters as, at best, a nuisance. When they can get away with it, they will step on any Belters that get in their way. Belters, for the most part, regard megacorps as an existential threat. A few feel they have to partner with megacorps to have any hope of surviving on the Frontier. In turn, they end up being ostracised by other Belters as 'sell-outs' or worse yet, 'traitors'. Many a barroom brawl has been started between independents and former friends who now toe the megacorp line.

Mining Megacorporations

While not as big or as diversified as the mighty TransNats, mining megacorps nonetheless wield a great deal of power. Their products are critically important to interstellar commerce and maintenance of the high technology that supports civilisation on worlds and stations across human space.

Corporation	Nationality
Gerais Resources	Brazilian
Imperial Mines	French
Quinto Mining	Australian
CaNICO (Canadian Nickel-Iron Corporation)	Canadian
Somerset Resources	British
Zajin Mining Group	Manchurian

The odds of making a rich strike depend on a number of factors, like belt density, asteroid distribution and distance from the star. In general, asteroids in the inner system are more likely to be metallic and stony, with a greater likelihood of valuable metals or minerals. The farther out, the rarer the finds and fewer Belters work belts in the outer system. Ice is often the most valuable resource in the outer system but due to the way it is sold and used, it is not something a desperate Belter can make a quick Livre on. Sometimes, however, in the dark far from the star, a Belter can make the find of a lifetime.

Asteroid prospecting is performed as a task chain:

- The first check is determining likely areas to search, which is a Very Difficult (12+) Science (astronomy or planetology) check, (1D weeks, EDU). DM-2 is applied to this check in the outer and Kuiper belt regions.
- The next check is searching the region for likely candidates, requiring a Difficult (10+) Astrogation check (2D weeks, EDU). DM+2 is applied to this check in the inner belt, DM-2 for outer belt and DM-4 for the Kuiper belt.
- The final check is testing the candidate rock to see if there is anything valuable. This is a Difficult (10+) Profession (belter) check (2D days).

The Effect determines the value of the find. 1–3: 3D x Lv10000, 4–5: 2D x Lv100000, 6+: 1D x MLv1.

MOVING ASTEROIDS

There are several ways to move an asteroid, depending on time available and the desired destination. The most common is using a surface-mounted mass driver, with material from the asteroid itself as reaction mass. Some asteroids are not suited to this method, in particular 'gravel pile'-type asteroids; loose, gravitationally-bound piles of rubble. The only way to divert these objects is with a contactless method, like a gravity tractor. Kinetic and nuclear strikes are practically useless. Fast-rotating asteroids also present a problem, since they are too difficult to land on to deploy a mass-driver. Fast spinners can be diverted with a gravity tractor, along with techniques like nuclear blasts and kinetic impactors.

Mass Drivers

An asteroid-based mass driver uses a chain of magnetically-driven buckets to launch material excavated from the asteroid itself. This requires landing on the asteroid and digging in to support the mass driver. The mass driver requires a great deal of power and a support base to maintain it, along with either people or robots to mine the asteroid for reaction mass. They are normally used to move asteroids into new positions, either somewhere to make it easier to mine or to a new location to build a base or habitat. Belters make more use of this technique than the megacorps, who are more likely to just deploy a factory ship to process the asteroid in situ.

There is a risk attached to mass driver operations in the chain of debris from the asteroidal material flung out to provide thrust. In systems where asteroids are moved in this manner, the trajectory of debris has to be clearly marked in system navigation data. Another option is to use a net, similar to the technology used for retrieving catapult launches and gather material launched.

A mass driver is designed as an OMS reaction drive, with some changes. Thrust from a mass driver is weak but can continue for months. Power and reaction mass requirements increase sharply as the size of the asteroid increases. The largest practical size for mass driver movement is a 200-metre diameter asteroid, which is around 300,000 tons.

MASS DRIVER

A Burn for a mass driver takes a month. The number of Burns required is based on the Effect from an Average (8+) Astrogation check. If the Effect is 1–3, then 3 Burns are required. Effect 2–5 requires 2 Burns and Effect 6+ needs only 1 Burn. The time required for the asteroid to reach its target is 1D years.

Power:	Asteroid tonnage divided by 100
Tons:	0.1 per Power
Burns:	0.5% of asteroid tonnage per Burn
Cost:	MLv1 per ton

For example, a 200 metre diameter asteroid masses 300,000 tons. A mass driver to move this asteroid requires Power 300. It will be 30 tons in size and cost MLv30. A Burn for this mass driver requires 1,500 tons of mass for a month or 50 tons per day

GRAVITY TRACTOR

The gravity tractor method has only been attempted a few times, as it requires a level of control and precision difficult to attain. A gravity tractor uses a smaller object to pull a larger one through gravity. Both objects will pull on each other but if the small object compensates with an ion or plasma drive, it can continue to pull the asteroid onto a new course. A gravity tractor diversion can take years to effect, so the farther away the asteroid is, the better.

The Math

The math is based on the volume of a sphere and for these purposes it is assumed that the asteroid is a rough sphere. To determine the size in tons of an asteroid based on its radius, determine its size in cubic metres, then divide that by 14 tons to get the tonnage.

$$V(tons) = (4/3\pi r^3)/14$$

Conversely, if the size in tons is known, then the following formula will find the radius, in metres.

$$R = \sqrt[3]{\frac{14 \times t}{\frac{4}{3\pi}}}$$

Or, determine the product of 14 x tonnage and then divide that by 4/3. Then take the cube root of that result.

A gravity tractor is usually a small asteroid that has been moved into place and equipped with a long-duration ion drive to keep the 'shepherd' away from the asteroid being pulled.

The gravity tractor requires a suitable long-duration robotic tug on a shepherd that is at least 1% of the tonnage of the asteroid being moved. A 200 metre diameter asteroid, like the one in the previous example, would require a 3,000 ton shepherd rock. An ion drive for such a rock would be designed as shown on page 62.

Successfully moving the rock requires a task chain:

- The first task is outfitting the shepherd, with an Average (8+) Engineer (m-drive) check, (1D weeks, EDU).
- The next is plotting the course properly, using an Average (8+) Astrogation check (1D weeks, EDU).
- The last check is to set the shepherd to fire its drive properly and on the right course. This requires a Difficult (10+) Pilot check (1D days, INT).

Nuclear Weapons and Kinetics

Like the original 2075 NM2197 diversion mission in 2089, nuclear or kinetic diversions give the asteroid a nudge into a new trajectory. The diversion is small but over time adds up to a significant distance. The aim is seldom to destroy an asteroid, as that could multiply the problem, but to nudge it into a new orbit where it poses no danger. The size of the charge or impact is keyed to the asteroid but the farther away the diversion starts, the better. Nuclear weapons are the preferred method, as they can be precisely targeted and always have the option of not detonating in case of an emergency. Once a kinetic is fired, however, the deed is done.

Kinetic impactors are large slugs that would be fired by a lunar or asteroid-placed linear catapult. Somerset Resources has one in Queen Alice's Star, emplaced on a 420 kilometre minor planet called Barghest. It successfully tested a kinetic diversion in 2290, diverting the 20 metre diameter QA 127540 from its long solar orbit into one out of the ecliptic, thereby removing a potential danger to the colonies on Beowulf. The fact that QA 12740, a stony asteroid with rare earth deposits, had previously been claimed by the Charest Belter family was, of course, incidental.

Determining the correct place to put a diverting charge or kinetic requires a task chain:

- The first task is an Average (8+) Science (geology) check (1D days, EDU).
- The second is an Average (8+) Astrogation check (1D days, EDU).
- The final is an Average (8+) Gunner check (1D minutes, DEX). If this final check is successful, the asteroid has been diverted without breaking it up.

On a failure, use the negative Effect to determine the outcome. 1–2: Asteroid is off-course by 2%, 3–4: Asteroid is off-course by 5% and 10% of the asteroid is blown off as debris, 5: Asteroid is off-course by 10% and has broken into 1D chunks; 6: Asteroid is off-course by 20% and has broken into D66 chunks.

Breaking Up Asteroids

Only small asteroids are amenable to being moved. Larger ones must be broken up first. To break up an asteroid, a hole is drilled to the mass centre of the asteroid. A powerful explosive is then placed at the base of the shaft and the hole plugged with debris and slag.

Next, a net is wrapped around the asteroid. If the charge was sized and placed properly, the asteroid will not explode violently outward but crack and break apart, with pieces drifting. The net will prevent the chunks from drifting far and gravity will loosely hold the whole thing together.

This requires a task chain:

- The first task is a Difficult (10+) Science (geology) check (1D days, EDU) to determine the proper location and depth of the charge.
- The second is an Average (8+) Profession (belter) check (1D days, INT) to properly drill the tunnel and emplace the explosives.
- The third task is to properly fill the tunnel, which requires an Average (8+) Profession (belter) check (1D days, EDU).
- The last is to properly time the detonation, which requires a Difficult (10+) Astrogation check (1D hours, EDU). If this last check succeeds, the asteroid breaks up as planned.

On failure, the negative Effect determines the consequences. 1–3: Asteroid breaks in more, and smaller, chunks than intended and 1D % of the asteroid escapes the net. 4–5: Asteroid is reduced to gravel and D66 % escapes through the net. 6: Charge causes the asteroid to break up violently. The net is destroyed and any ships within Adjacent range are hit by 1D chunks, each doing 1 damage.

Pushing Ice

Ice is a valuable commodity. In some systems, it is required for water and life support, while in others it is the main source for fuel and reaction mass. The lack of available ice in a system makes prospects for settlement and exploitation minimal at best.

It is possible to move large chunks of ice, requiring a nudge to send them spiralling in on a long orbit. With a steady, predictable supply, ice becomes a usable commodity. It does not matter how long a chunk of ice takes to reach its destination, as long as the next follows in short order. Chunks of ice moved in this matter should be relatively small to maintain structural integrity. The larger the chuck, the weaker it is, the harder it is to catch and the more inertia it has. Most ice chunks moved in this way are in the 2,000–5,000 ton range. Larger chunks can be broken up as with asteroids, although with DM+2 at every stage of the task chain.

Shifting the orbit of an object this size requires precise calculations and perfect timing. Any error introduced at the beginning of the push makes the task of receiving much more difficult.

There are two ways to accomplish this. The first is simply to mount a small, disposable OMS rocket on the asteroid. The rocket should be designed based on the tonnage of the ice chunk, with 3 Burns worth of fuel. This is expensive, however, and the shock to the ice chunk can break it up.

Moving the ice chunk properly and avoiding breakup uses a task chain:

- The first task plotting the proper course, which requires a Difficult (10+) Astrogation check (1D days, EDU).
- The next check is properly preparing the push point, where a rocket or a tug will be attached to give the ice a push to send it coasting towards its target. This requires a Routine (6+) Profession (belter) check (1D days, EDU), with DM-1 per 1,000 tons of ice.
- The last check is to compute and execute the burn, which will send it on its way. This requires a Routine (8+) Pilot check (1D hours, INT).

The Effect (positive or negative) indicates the DM to the check required to intercept it at the other end. An Effect of -6 or worse means the ice chunk fragments into D66 smaller chunks.

Playing Catch

Catching asteroids or ice is a specialised profession, requiring large nets held in place by multiple drone tugs. These drones are large and must carry a heavy fuel load for their OMS systems.

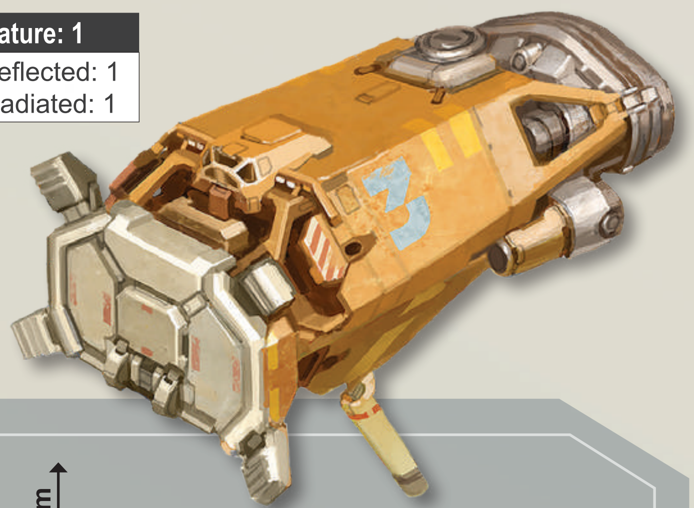
DRONE TUG

NATION: United States
FIRST EXAMPLE LAID DOWN: 2293
MANUFACTURER: Belter groups
PRODUCTION STATUS: In Production
CONSTRUCTION TIME: 17 Days
SERVICE STATUS: In Service
FLEETS OF SERVICE: Belters, various others
NUMBER IN SERVICE: Unknown
LENGTH: 24.25 m
WIDTH: 12.12 m
LAUNCH MASS (FULLY FUELLED): 500 tons
POWER PLANT: 0.2 MW Fuel Cell
REACTION DRIVE: Advanced OMS Rocket, 500 tons thrust

Drone tugs are unmanned craft that operate in support of Belter fleets. They have a variety of purposes, including pushing ice, shepherding rocks and grappling nets and flung cargos. Most of a drone tug is fuel, with a reinforced sling in front.

TL10		Tons	Cost (MLv)
Hull	50-ton Aligned Crystal Steel Spaceframe	—	1
Hull Features		—	—
Reaction Drive	OMS Rocket (advanced)	0.9	0.6
Power Plant	Fuel Cell (Power 2)	0.2	0.4
Fuel Tanks	OMS Rocket (20 Burns)	31.5	—
	Power Plant (8 weeks)	2.4	—
Radiators	Conventional, Capacity 2	0.2	0.01
Bridge	Autopilot	—	0.5
Computer	Primary: Computer/15 Secondary: Computer/15	—	4
Sensors	Basic Nav Array	1	0.1
Systems	Sling 250 tons	12.5	2.5
Software	Manoeuvre, Robotic Control (advanced, skill 2, voice/speech recognition, interactive, personality)	—	0.25
Cargo		0.8	—
Total: MLv8.42			

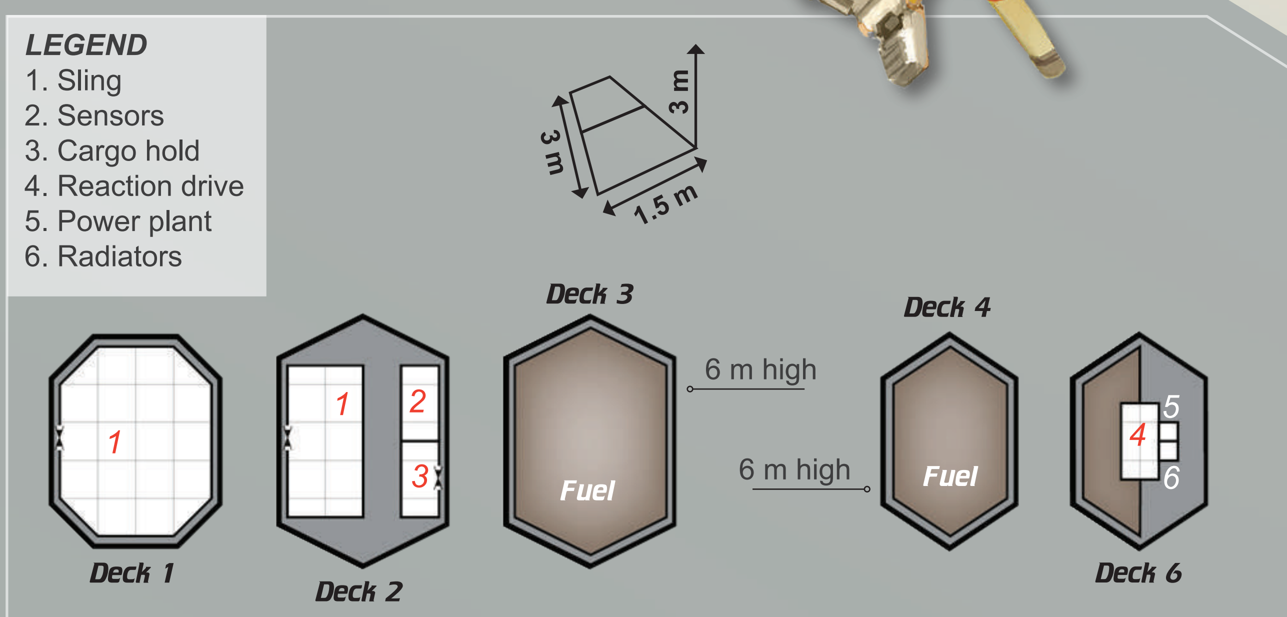
Crew	Passengers	Hull Points	Signature: 1
Autopilot: Pilot 2	—	5	Base Reflected: 1 Base Radiated: 1



Running Costs

Maintenance Cost: Lv702/month Purchase Cost: MLv8.42

Power Requirements	Power
Sensors	2



ASTEROID BASES AND STATIONS

Temporary Work Camps

Temporary work camps are built around inflated pressure shelters and other such equipment, most of which can be found in the *2300AD* box set or *Tools for Frontier Living*. These are very temporary, as most Belters would prefer to remain on their ships rather than spend time in fragile domes on the exposed surface of an asteroid. Power supplies for these camps is provided by solar panels, batteries or fuel cells. Some additional equipment valuable for setting up temporary work camps and more permanent facilities follow.

LARGE PRESSURE TENT

The large pressure tent is a multi-room inflatable structure. The squat dome has a central room and four smaller rooms arrayed around it. It even includes an airlock, plumbing, power and data connections, although all fittings have to be added after inflation. For long-term occupation, the inflatable envelopes are filled with foam that expands and hardens. Then the whole structure is buried for protection.

TL:	9
Tons:	Deflated 0.5, inflated 10
Cost:	Lv10000, foam kit Lv5000

SALAZAR LONG DURATION LIFE SUPPORT SYSTEM

Long term habitations require long-term life support but these bases are too small for endurance life support systems. The Salazar system was developed by the Libertine engineer Jaska Salazar. It is a compact system that uses tailored algae and nanopore filters to clean air, recycle water and reduce solid waste to powder. In operation, it has a faint odour that some find offensive, however for a long-term family outpost it is well worth it.

Power:	1 per 10 people
Tons:	0.5 per Power
Cost:	MLv0.1 per ton

SAMPLE DRILL

The sample drill is used to obtain core samples from within an asteroid, which can then be examined and analysed for any valuable minerals or ores.

The drill sits in a stand firmly anchored to the asteroid. It is equipped with a counterweight rotating in the opposite direction of the drill to counter torque in almost non-existent gravity. Five-metre-long drill pipes are fed through the machine, which automatically connects the pipes to reach the desired depth. The drill is then reversed and drill pipes removed in reverse order. The cores inside the pipes are then extracted and analysed.

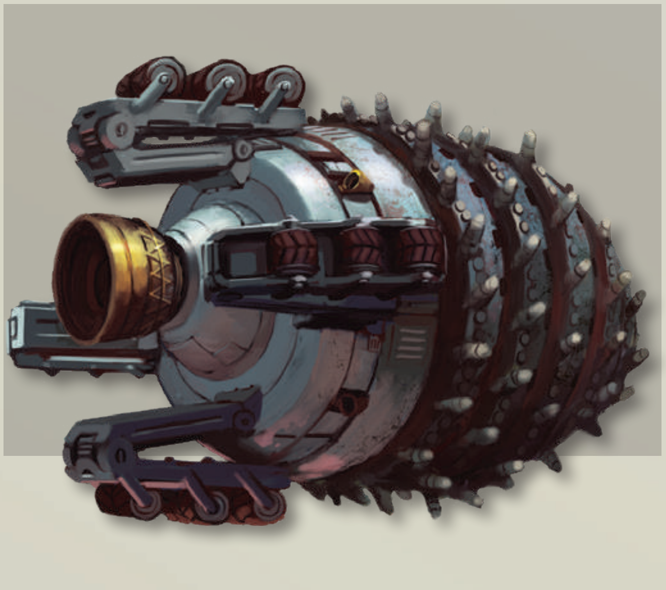
This drill is not designed to work on a nickel-iron asteroid; only a plasma borer can cut through one of those.

Item	TL	Kg	Cost
Sample Drill	10	30	Lv15000

TUNNELLING ROBOT

The tunnelling robot can easily cut round passages two and a half metres in diameter in all asteroids except nickel-iron types. The tunnelling robot uses inertial and laser guidance to drill straight passages without intervention. For anything more complicated, it requires an operator. The robot itself has a two and a half metre drill head and behind that are four articulated treads arranged to hold it firmly in the tunnel while it digs.

Robot	Hits	Speed	TL	Cost
Tunnelling Robot	12	3 m	10	Lv60000
Skills	Profession (construction) 2			
Sensors	Basic, Seismic and Engineering			
Attacks	None			
Traits	Armour (+8)			
Programming	Basic (tunnelling), Personality (none)			



PLASMA BORER

This robot can cut a hole in nickel-iron, although it cannot be used in Type-C or ice asteroids; the plasma bursts are hot enough to flash water to steam, potentially causing an explosion. The plasma drill is complemented by a cooled conventional drill head. The system uses a small-diameter shaft to transfer heat directly into the body of the asteroid.

Robot	Hits	Speed	TL	Cost
Plasma Borer	12	3 m	11	Lv120000
Skills	Profession (construction) 2			
Sensors	Basic, Seismic and Engineering			
Attacks	Plasma Borer (5m, 4D, AP 10, Blast 2)			
Traits	Armour (+8)			
Programming	Basic (tunnelling), Personality (none)			

WHIPPLE SHIELD

Although conditions in an asteroid belt are not the careening mountains of fantasy epics, there is still a slightly higher incidence of micrometeoroids and debris. Temporary camps need protection from these hazards, while permanent bases burrow into the rock for protection. A Whipple shield consists of a thin metallic outer layer, a layer of kevlex, another metallic layer and a final layer of kevlex. A set of shields is placed around vital areas, like pressure tents and equipment, with a gap of 2–3 metres. Whipple shields are not designed to stop debris and impacts; rather, the intent is to slow and divert them, lessening the chance of anything important being damaged.

Whipple shields are made in prefab panels 3m x 3m that can be folded when not required. Most in Belter service are much patched and show considerable wear and tear but function as intended. A Whipple shield gives Protection +8 against hypervelocity impacts and Protection +2 against anything else.

Item	TL	Kg	Cost
Whipple Shield	11	20	Lv500

GEOANALYSIS KIT

The geoanalysis kit tests drill core samples to determine the mineral content of an asteroid. Several cores are required to provide an accurate analysis. Analysing a sample with the geoanalysis kit requires an Average (8+) Science (geology) check.

Item	TL	Kg	Cost
Geoanalysis Kit	10	30	Lv10000

Permanent Facilities

When a Belter clan strikes a particularly rich asteroid, it will often build a more permanent settlement. These will usually start on the surface of an asteroid, but if the clan is there longer than a year or so they will start to tunnel into the asteroid itself.

Surface Facilities

Surface Facilities are designed as modular stations but do not require the truss and most modules are built as half-cylinders and domes. After construction, the modules are covered by rubble or slag to shield the habitat from radiation and micro-meteoroid impacts. The cost to bury them is Lv500 per ton but most Belters will do the work themselves.

Sub-surface Facilities

Subsurface facilities must be tunnelled into the rock of the asteroid, with a cost determined by the type of asteroid. It should be noted that some asteroids are very loose structures, more like floating piles of gravel than solid objects. These are not suitable for bases or even for mining.

Tunnelling costs depend on the asteroid classification. Most Belters will do this work themselves, provided they have access to the proper tools.

Asteroid	Cost per ton
Type-S	Lv2500
Type-M	Lv5000
Type-C	Lv1000
Ice	Lv500

Asteroid facilities

Tunnelled asteroid bases can be outfitted just like a conventional space station. All ship fittings can be used.

Drive Systems

Neither reaction drives nor stutterwarp drives can be fitted to most asteroids.

Power

The power supply for asteroid stations like this is usually provided by large solar panels, which Belters will make themselves. Nuclear power plants are very rare. There is no need for radiators, however, as the bulk of the asteroid can absorb and radiate waste heat on its own, with no action required.

Spin Gravity

It is possible to add spin gravity, either in a ring or spin habs. This can be internal, in which case a volume equal to three times the ring size would have to be hollowed out. For internal spin habs, it is a little more complex, as they still require a cylindrical volume to be excavated in order for them to be able to spin freely. This requires a volume of 50 tons x the spin radius.

Conversely, a spin hab or ring station could be placed outside the asteroid. This would require a support column that is 10 x the spin radius, in tons.

Asteroid Hulls

While by no means common, small asteroids can be turned into ships. There are few examples of these, all within the Belter community.

These require an asteroid to be dragged from its orbit and hollowed out to be used as the exterior hull of a spacecraft. The cost depends on the asteroid type (see Sub-Surface Facilities on page 103) but only 80% of the volume of an asteroid is useable as a spacecraft.

Asteroid spacecraft effectively have a built-in radiator and can handle heat equal to 20% of their tonnage. Anything over this requires the installation of radiators with capacity to handle the overflow.

An asteroid's Hull points are calculated on the total volume of the planetoid, not the useable space.

ZELAZNA CHWAŁA

NATION: Libertine
FIRST EXAMPLE LAID DOWN: 2284
MANUFACTURER: Baxtalo Station
PRODUCTION STATUS: Out of Production
CONSTRUCTION TIME: 132 Days
SERVICE STATUS: In Service
FLEETS OF SERVICE: Krasny Family
NUMBER IN SERVICE: 1
LENGTH: 50 m
WIDTH: 32 m
LAUNCH MASS (FULLY FUELLED): 10,000 tons
POWER PLANT: 12 MW MHD Turbine
REACTION DRIVE: OMS Thruster, 10,000 tons thrust
STUTTERWARP 6 MW Gen II Jerome-effect Stutterwarp

In 2284, the Krasny Libertine family limped into the Chengdu system with their ship, the *Chwała* (Glory), heavily damaged, apparently by weapons fire. The drives and power plant were relatively unscathed, however. The Libertine and Belter families at Baxtalo Station got together to assist but the hull was deemed irreparable and there was nothing suitable to be found at Baxtalo.

The Belters had an idea, however. They had recently come across a small nickel-iron asteroid, perhaps a total of 1,000 tons displacement. They offered to donate the asteroid as a hull, along with any required tunnelling. Between the two groups, they stripped the hulk of the *Chwała* and installed drives and any other fittings they could in the 800 tons excavated out of the asteroid. Other fittings as required were donated by the various families. The new ship lacks the spin gravity of the original *Chwała* and has less cargo space but the cost to the Krasny family was effectively zero.

It took several weeks to redesign and outfit the ship but at the end the Krasny family had a new ship, dubbed the *Żelazna Chwała* (Iron Glory). It now plies the routes of the Manchurian Arm, as far from the French Arm as possible. Although it was never revealed publicly what happened to the *Chwała*, suspicion among other Libertines is that they were caught smuggling and ran afoul of some military force. The Krasny family, for their part, denies this but offers no other explanation.

ZELAZNA CHWAŁA

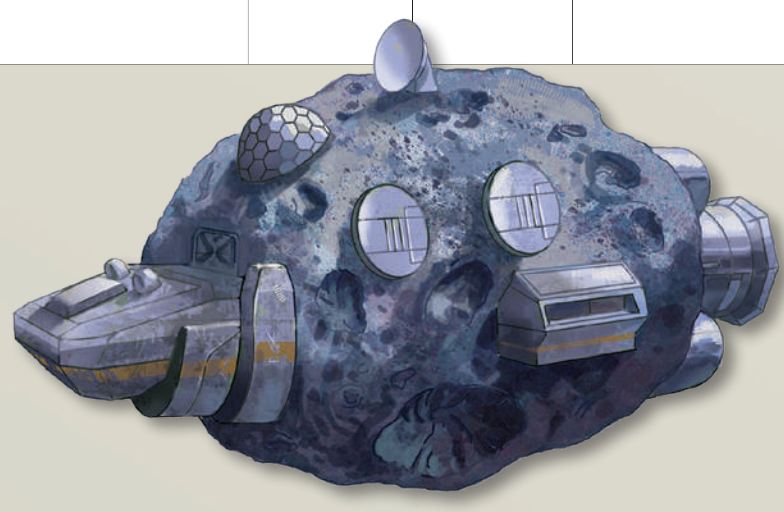
TL10		Tons	Cost (MLv)
Hull	1,000-ton Asteroid Hull	200	5
Hull Features	Radiation Shield	—	5
Reaction Drive	OMS Thruster	30	12
Stutterwarp	1.1 ly/day, Tac Speed: 1	4.14	5.18
Power Plant	MHD Turbine (Power 120)	15	3.75
Emergency Power	Power 10 (24 hours)	2.4	2.4
Fuel Tanks	OMS Thruster (4 Burns)	120	—
	Power Plant (2 weeks)	60	—
Radiators	Asteroid, Capacity 200	—	—
Bridge	Standard	20	5
Computer	Primary: Computer/25 Secondary: Computer/10	—	10.16
Sensors	Basic Nav Array, DSS	3	1.6
Weapons	Hardpoint	—	0.1
Systems	Exercise Equipment x8, Safety Lockers x2, Ship's Locker, Simple Freshers x2, Common Areas x10, Library, Galleys x6, Automed	29.25	4.26
	Cargo Arms x4	2	0.4
Drones	Repair Drones x5	0.55	1.055
Airlocks	Standard Airlocks x10, Large Cargo Airlocks x2, Small Cargo Airlocks x2	32	0.24
Accommodations	Staterooms x5, Small Staterooms x56, Cryo Berths x10	137	13.1
Software	Archive, Auto-Repair/1, Intellect, Manoeuvre, Stutterwarp Control	—	6.44
Life Support Consumables	50 days for 70 people	2.28	—
Cargo		337.16	—
Total: MLv68.06			

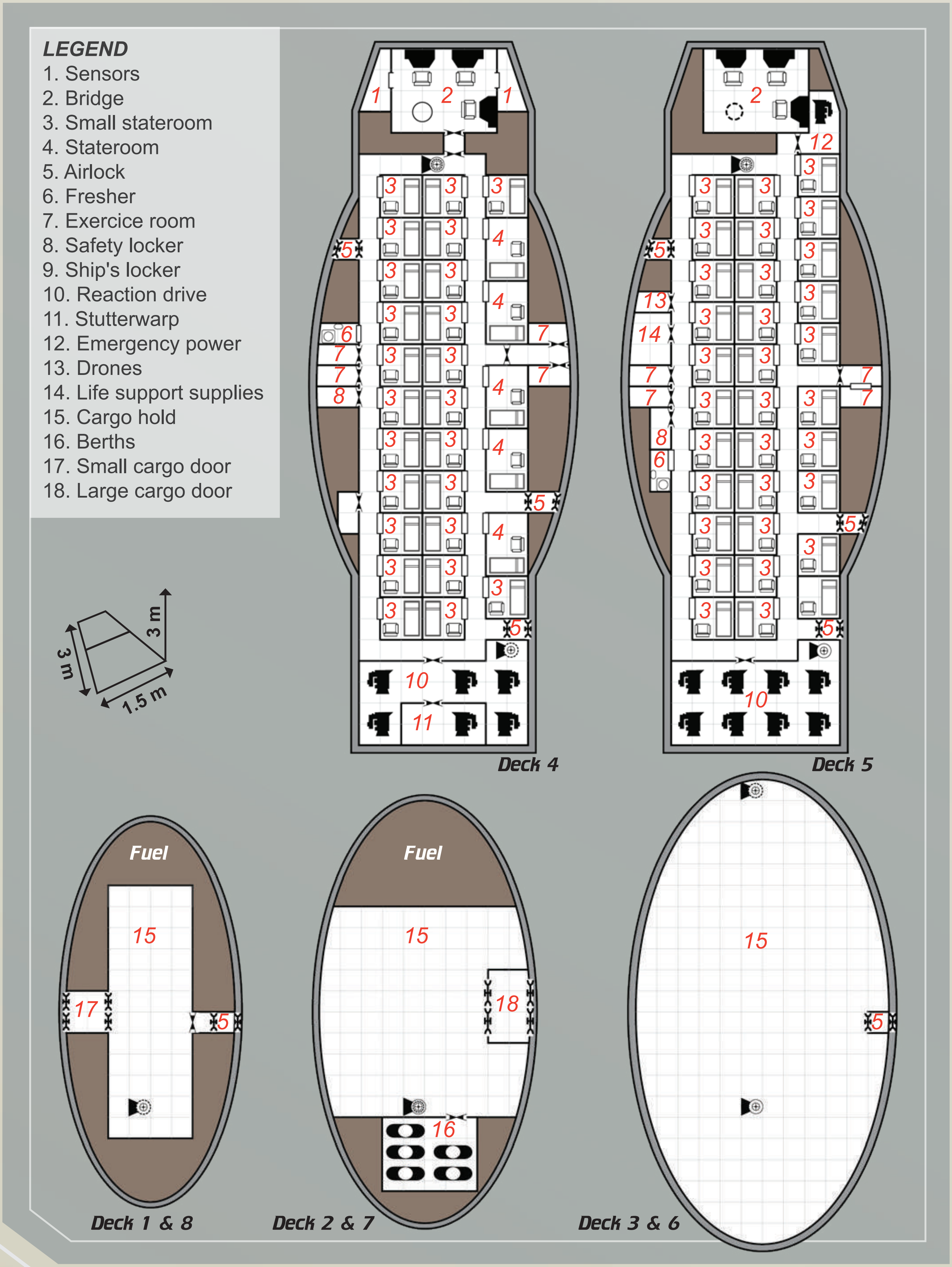
Crew	Passengers	Hull Points	Signature: 3
Captain, Bridge Officer, Astrogators x2, Flight Engineers x2, Pilots x2, Sensor Techs x2, Reaction Drive Engineers x2, Stutterwarp Engineers x2, Power Engineers x2, Life Support Techs x2, Electronics Techs x2, Administrators x2, Cargo Handlers x2 **Comfort Rating**: -1	—	100	Base Reflected: 3 Base Radiated: 2

Running Costs

Maintenance Cost: Lv5722/month Purchase Cost: MLv68.66

Power Requirements	Power
Basic Ship Systems	10
Reaction Drive	100
Stutterwarp	60
Sensors	2




LEGEND
1. Sensors
2. Bridge
3. Small stateroom
4. Stateroom
5. Airlock
6. Fresher
7. Exercice room
8. Safety locker
9. Ship's locker
10. Reaction drive
11. Stutterwarp
12. Emergency power
13. Drones
14. Life support supplies
15. Cargo hold
16. Berths
17. Small cargo door
18. Large cargo door
3 m
3 m
1.5 m
Deck 4
Deck 5
Fuel
Fuel
Deck 1 & 8
Deck 2 & 7
Deck 3 & 6

BELTER COMMUNITIES

Significant Belter communities exist in several systems. The oldest and largest is in the Core, within Sol. Although the Sol Belt is not in any danger of being played out, many Belters are leaving the Core behind to take their culture and communities to less-regulated regions of space.

The Alpha-Beta Centauri system has an extensive asteroid belt or rather a set of them. However, there is no extensive Belter community; asteroid mining here is dominated by corporations, with Quinto Mining, an Australian company, being the largest. Quinto in particular has little tolerance for freelance Belters.

The Neubayern system has a rich belt feeding the industries and shipyards of Nibelungen. The Nibelungen colony was first established to support the orbital industries and asteroid mining. Neubayern has the largest freelance Belter community outside of Sol.

Queen Alice's Star has a wide, rich belt, although currently there is little activity. Unusually, the United Kingdom has laid claim to the entire region. No other nation recognises this claim, as it violates the Melbourne Accords. While France does not recognise the claim, they also do not object to the Royal Space Navy patrolling and harassing independents. Indonesia has recently championed independent miners and is taking their case to adjudication under the Melbourne Accords, which only recognises state-level actors. Sumatro-Fabrique, the Indonesian industrial conglomerate, is rumoured to have their eye on the belt and may be behind the action.

At one time, the Bessieres system, with its two wide asteroid belts and no terrestrial planets, was a magnet for Belters. The small gas giant was ignored by them but the Orgon Mining Company realised the relatively light gravity of 1.25 G made it accessible to atmospheric mining for hydrocarbons. Between hydrocarbons from the gas giant and silicates and metals from the asteroid belt, Orgon identified the system as an ideal site for manufacturing. Fifty years later, Orgon, now the Bessieres Corporation, controls the entire system from a hollowed-out asteroid, Istria Station. The independent Belters have fled and all who are left are temporary contractors in the employ of the company. The system has no permanent inhabitants, with even the most trusted corporate employees rotating out every six years. Most contracts are only for three years.

On the Manchurian Arm, Chengdu is home to the largest Belter community on the Arm and the largest outside of the Neubayern system. The Belter communities on the Manchurian Arm are tightly intertwined with the Libertines, even more so than on other Arms. If the Libertines can be said to have a 'home base', it would be with the Belters of Chengdu.

While the Heidelsheimat system lacks an extensive asteroid belt, next door at DM -56 328 there is a wide, rich belt but no habitable worlds. Not wanting to trust mineral development to independents, the Bavarians established a colony at Heidelshiemat to support operations in DM -56 328. However, despite that desire, there is a significant community of Belters in both systems. DM -56 328 has several large outposts, including the independent Boulder Station, which causes intense irritation to the mining corporations and Heidelsheimat government.

The relative paucity of worlds on the American Arm is also reflected in the shortage of Belter communities. The most significant is in the Mu Herculis system. An unusually dense asteroid belt circles the primary and radioactive ores have been discovered. However, there is conflict between the Belters and the American Space Force, which seems eager to keep them out.

LIBERTINES AND OTHER OUTSIDERS

There are many groups that, for whatever reason, do not fit in well with the established cultures and regulations of Earth or any Core nation. Many of these escaped to the stars as soon as it was viable, in starships that they bought, borrowed or stole.

LIBERTINES

The free traders and independent haulers are known as the Libertines, a loosely-affiliated group that can trace some of its roots to various nomadic communities, including Roma, Irish Travellers and migrant workers across the world. While there is some mystery around their beginnings, the first Libertines with ships appeared on the interstellar scene in the 2180s.

The name 'Libertines' was originally used in a derogatory fashion, a term used to describe people without moral principles or sense of responsibility. For their part, the Libertine families embraced the term, although leaning on the second definition, that of freethinkers, especially in matters of religion.

Libertines challenged large corporate and government interests, undercutting shipping rates and dealing directly with colonies, outposts and Belters alike. Often derided as smugglers, they nonetheless delivered an important service to many colonies, in particular the underserved worlds on the frontiers of the French and Manchurian Arms. The nations and worlds of the Core generally view the Libertines in an unfavourable light, as Fringers outside 'proper' society. On the Arms, however, colonists celebrate the Libertines and their ability to bypass the mercantilist and predatory actions of Core nations and corporations.

The heavily-regulated worlds of the Core are not popular with Libertines and they seldom approach closer than the system threshold, instead operating through agents and brokers. While there is some trade with the Core, this is more with go-betweens who can operate in the Core without attracting undue official curiosity. Many Libertine ships will only operate in the Core to acquire or renew ship registration as commercial operations in the Arms require commercial registration with a recognised nation. The Libertines have arrangements with Freihafen on Tirane and Vanuatu and Indonesia on Earth, to register their ships. These nations are well-known for their simple and inexpensive registration requirements.

Libertine ships are old but well-maintained. Many of them predate adoption of Generation II drives in 2190. However, their performance suggests they are equipped with newer drives. The source of these drives is unknown to most. It is believed by some that the Life Foundation has been surreptitiously funnelling drives to Libertines and Belters, likely from somewhere on the Manchurian Arm. No motivations have been convincingly ascribed to this, however, and it is widely considered to be just another conspiracy theory targeting the Foundation.

There are an estimated 40-60 Libertine groups, families and extended clans active in human space. Most are on the Manchurian Arm, with the remainder on the French Arm. For a variety of reasons, the American Arm is seen as hostile to the Libertines and avoided.

Chengdu on the Manchurian Arm is widely considered to be the 'home port' of most Libertine families. They have a very good relationship with the large Belter community in-system and local authorities give them remarkably little harassment. Every five years, the Libertines hold a 'Gathering of Ships' in the Chengdu Belt, at Baxtalo Station. Here, the family heads discuss politics and trade, and the young seek out fun and romance. Crews will often change ships at these Gatherings, whether to cross-train, because of committed relationships, romantic and otherwise, or just to see new people and new places. Here as well representatives from Vanuatu, Freihafen and Wellon offer to register and insure any new or changed vessels.

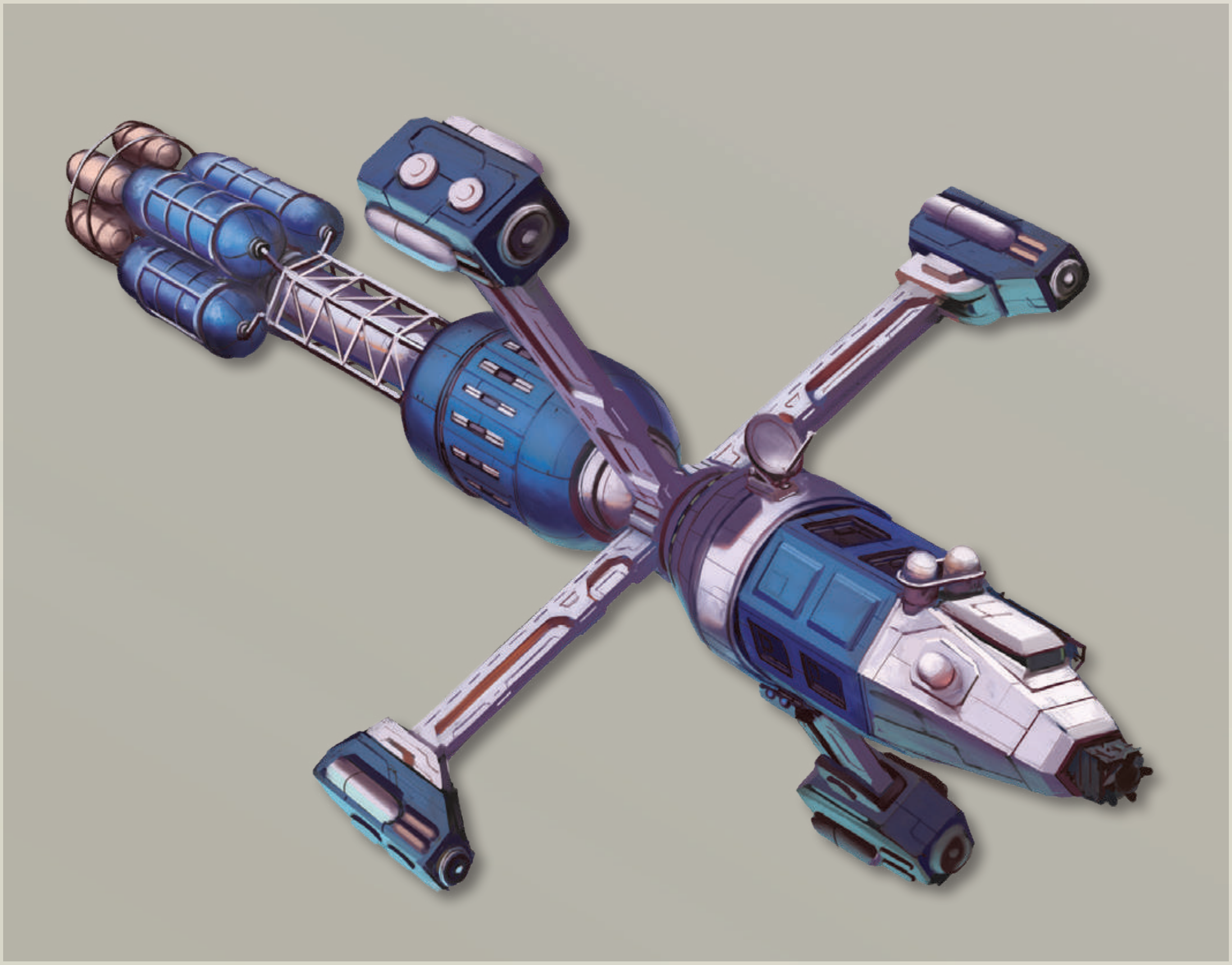
Libertines have a number of different vessel, some of which were clearly 'liberated' from orbital breaker yards before they were turned into scrap. Most notable of these is the reclaimed hulk of the ESAS *Vancouver*, an ESA exploratory cruiser and one of the first ships to venture out into what would later become known as the French Arm. Any of these 'liberated' ships would have had the stutterwarp removed long before they ended up at the breakers, leaving the mystery of where the Libertines get their drives from unanswered.

THE ROVER
(FORMERLY ESAS VANCOUVER)

NATION: Independent (originally ESA)
FIRST EXAMPLE LAID DOWN: 2210 (2144)
MANUFACTURER: Unknown (ESA Ship Consortium)
PRODUCTION STATUS: Out of Production
CONSTRUCTION TIME: 178 Days (estimated)
SERVICE STATUS: In Service
FLEETS OF SERVICE: Libertine
NUMBER IN SERVICE: 1
LENGTH: 58.45 m
WIDTH: 29.22 m
LAUNCH MASS (FULLY FUELLED): 7,000 tons
POWER PLANT: 7.5 MW MHD Turbine
REACTION DRIVE: OMS Thruster, 7,000 tons thrust
STUTTERWARP 5 MW Gen II Jerome-effect Stutterwarp

The hull of the old *Vancouver* has become so thoroughly gutted and rearranged that its internal layout is unrecognisable. Its external silhouette, however, is unmistakeable. One of the largest ships operating in the mid-22nd Century, it was designed to explore all the new worlds that had opened up past Wolf 359. It remained in operation until the advent of the Generation II stutterwarp, when it was retired from service.

Thirty years later, the hull of the ESAS *Vancouver* showed up as the *Rover*, an independent vessel registered under the rather loose laws of Vanuatu. Set up as a cargo hauler, the *Vancouver* had undergone a complete overhaul, equipped with a newer (but not new) stutterwarp and replacing the big spaceplanes of the ESAS cruiser with smaller ballistic landers. While the *Vancouver* had been nuclear-powered, the reactor had been the first thing to be stripped out, long before it hit the breaker yards. The *Rover* is powered by an MHD turbine, like so many other small to mid-size merchant vessels. The only thing that remained of the *Vancouver* was the hull; the rest was the *Rover*. It was the first Libertine ship but it would not be the last.



TL10		Tons	Cost (MLv)
Hull	700-ton Aligned Crystal Steel Spaceframe	—	14
Hull Features	Advanced, Radiation Shield	—	17.5
Reaction Drive	OMS Thruster	21	8.4
Stutterwarp	1.25 ly/day, Tac Speed: 1, System Speed: 0.81 AU/day	3.78	4.72
Power Plant	MHD Turbine (Power 100)	12.5	3.13
Emergency Power	Power 7 (24 hours)	1.68	1.68
Fuel Tanks	OMS Thruster (6 Burns)	126	—
	Power Plant (2 weeks)	50	—
Radiators	Conventional, Capacity 100	10	0.5
Bridge	Small	10	3.5
Computer	Primary: Computer/15 Secondary: Computer/10	—	1.08
Sensors	Basic Nav Array, DSS	3	1.6
Weapons	1 Hardpoint	—	0.1
Systems	Under Spin: Automed x4, Common Area (10 tons), Exercise Equipment x10, Library, Safety Lockers x2, Ship's Locker, Simple Freshers x2, Galley (8 persons) Zero-G: UNREP (10 tons), Simple Fresher, Workshop	52.25	14.615
Sub-Craft	Ballistic Landers x2	66	10.7
Airlocks	Standard Airlocks x7	—	—
Accommodations	Under Spin: Small Staterooms x60	120	6
Artificial Gravity	Spin Capsules (160.72 tons under spin)	17.68	8.84
	Radius: 30 m, 3 RPM, Gravity: 0.3 G, Spin Up/Down: 18 minutes	—	—
Software	Archive, Intellect, Manoeuvre, Stutterwarp Control	—	1.5
Life Support Consumables	56 days for 60 people	6.72	—
Cargo		198.89	—
Total: MLv87.98			

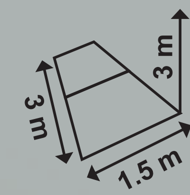
Crew	Passengers	Hull Points	Signature: 3
Captain, Bridge Officer, Astrogators x2, Flight Engineers x2, Pilots x2, Sensor Techs x2, Reaction Drive Engineers x2, Stutterwarp Engineers x2, Power Engineers x2, Small Craft Techs x2, Life Support Techs x2, Electronics Techs x2, Administrator, Cargo Handler, Small Craft/Fighter Pilots x4 **Comfort Rating**: +0	—	77	Base Reflected: 3 Base Radiated: 2

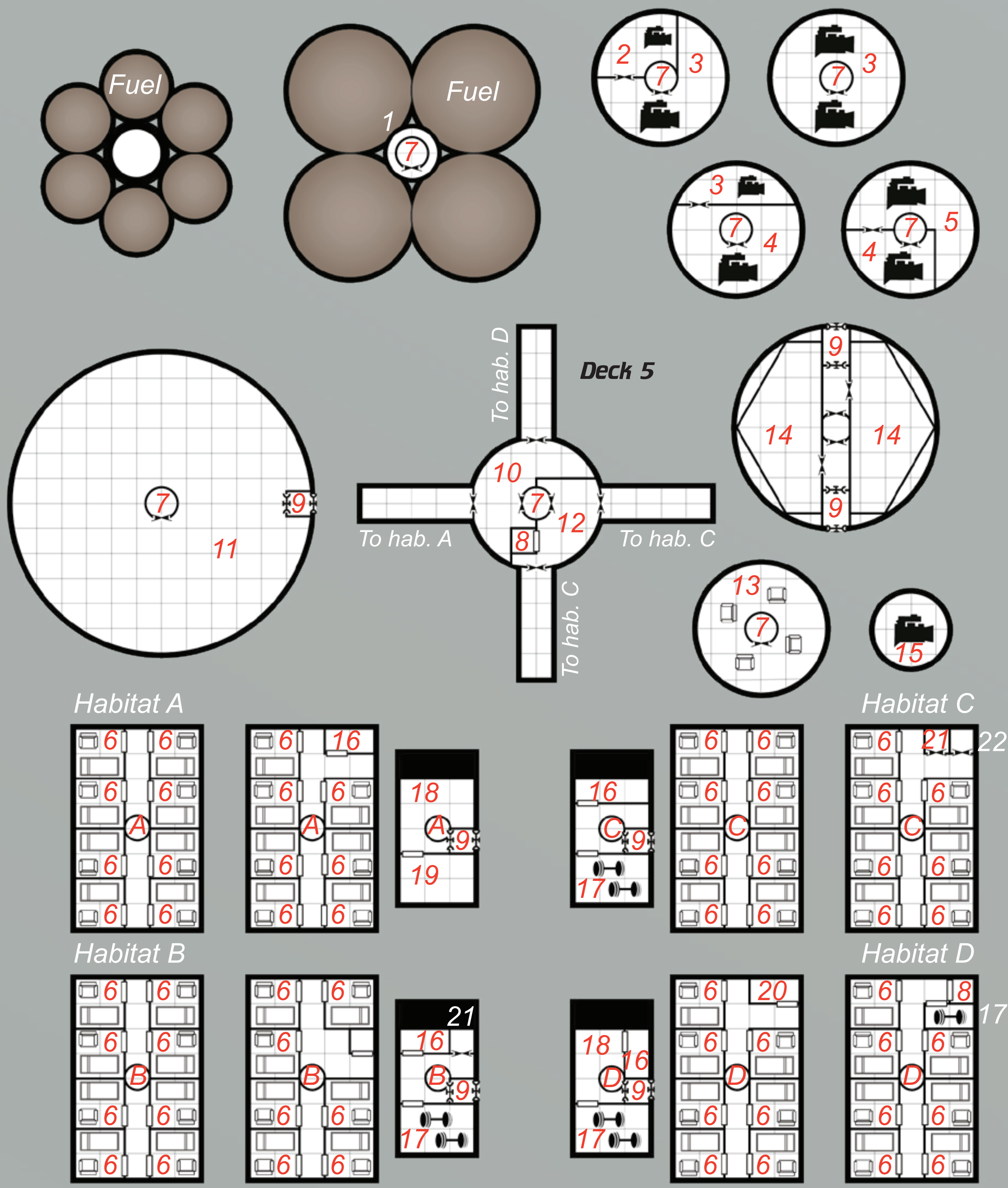
Running Costs
Maintenance Cost: Lv7421/month Purchase Cost: MLv89.05

Power Requirements	Power
Basic Ship Systems	7
Reaction Drive	70
Stutterwarp	50
Sensors	2

LEGEND

1. Emergency power
2. Stutterwarp
3. Reaction drive
4. Power plant
5. Life support supplies
6. Small stateroom
7. access tube
8. Fresher
9. Airlock
10. UNREP
11. Cargo (12m high)
12. workshop
13. Bridge
14. Craft bay
15. Sensors
16. Automed
17. Exercice room
18. Common area
19. Galley
20. Library
21. Safety locker
22. Ship's locker





TINKERS

The space above many inhabited worlds, especially the oldest or longest-settled, is full of satellites, space station, and spacecraft. Tinker society arose from the need to repair, maintain, refuel or recover these objects. Salvage is an important aspect of their operations, although there are dark rumours that they sometimes salvage equipment that is still operational.

Tinkers arose out of either Belter or Libertine society or in some cases a combination of both. The Tinkers in the Core are more directly the result of a schism in the Belter community. They maintain a good relationship with Libertines and a poor one with Belters. The latter often think of Tinkers as 'failed' Belters, unwilling or unable to do the work needed among the asteroids, who slunk back to the light and warmth of planets only to become scroungers and slackers.

In contrast to most outsider groups, the Tinkers prefer the Core. This is part of why the Belters feel such disparagement to them but one of the ways they are useful to Libertines. The Core worlds have the most extensive orbital infrastructures and wealth of satellites and stations, enough to provide a niche that Tinkers can inhabit. Out on the Frontier, pickings are much more meagre, with established Tinker communities only at Nibelungen, Beowulf, Chengdu, Syuhlam and Ellis.

Much like Belters, Tinkers live life in zero-G and the vast majority of the them have the same DNA modifications as Belters, allowing them to live and thrive in their weightless homes. Tinker families usually split their time between a workshack home and the orbital workboat they use to ply their trade. They provide repair, refuelling and even orbit shifts. They also provide services to small stations, the workshacks and orbital factories, by supplying crew with comforts and necessities.

Some Tinkers have taken to the stars like the itinerant tinkers of old, travelling from world-to-world providing technological services that might otherwise be unavailable. They are known to hitch rides on Libertine ships, snugging their workboats into an external sling and enjoying the ride. One of the most significant services Tinkers can provide is the use of an unlicensed fabricator and bootleg fab files. Although this is illegal in most nations, Tinkers, like Libertines, fall under the jurisdiction of a few very permissive regimes, notably Vanuatu, Indonesia and Freihafen. They cannot legally be arrested or charged for possession of an unlicensed fabricator but can, however, be charged with smuggling the products of the fabricator into a colony where they are illegal.

TINKER FAMILY WORKBOAT

NATION: Independent
FIRST EXAMPLE LAID DOWN: 2275
MANUFACTURER: Various
PRODUCTION STATUS: In Production
CONSTRUCTION TIME: 22 Days
SERVICE STATUS: In Service
FLEETS OF SERVICE: Independent (Vanuatu, Indonesia, Freihafen)
NUMBER IN SERVICE: Unknown
LENGTH: 27.13 m
WIDTH: 13.56 m
LAUNCH MASS (FULLY FUELLED): 735 tons
POWER PLANT: 0.3 MW Fuel Cell, 0.5 MW Solar Array
REACTION DRIVE: Advanced OMS Rocket, 700 tons thrust

The Tinker workboats may look patched-up and cobbled together but they are sound and sturdy. Their engineering spaces may be old but the equipment is very well-maintained. After all, technology and maintenance is their specialty, their most marketable skillset.

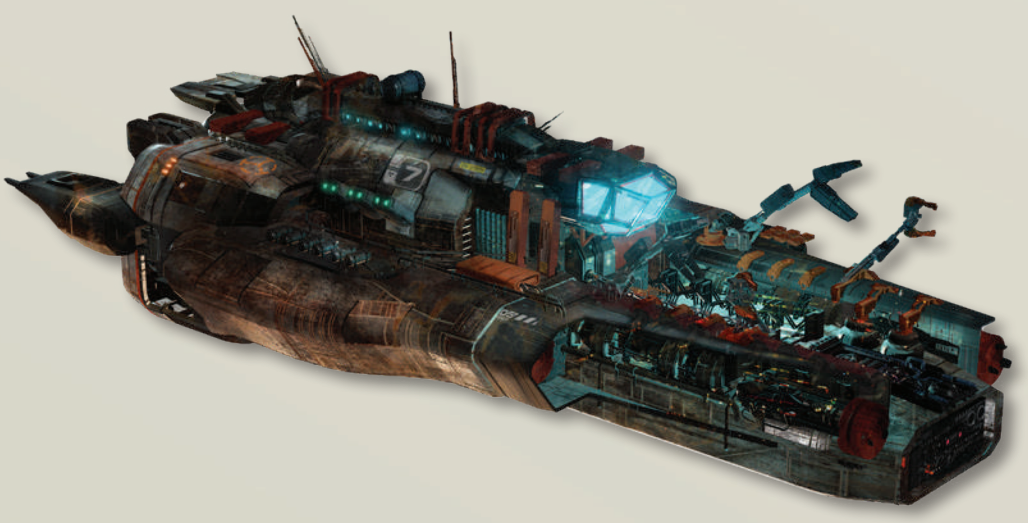
The workboat is equipped with grappling and manipulator arms, as well as an external sling. The armoured hull provides some protection from orbital debris and low-speed collisions. It is big enough for a small crew to live and work aboard for up to two months, with each member having their own quarters for a modicum of privacy.

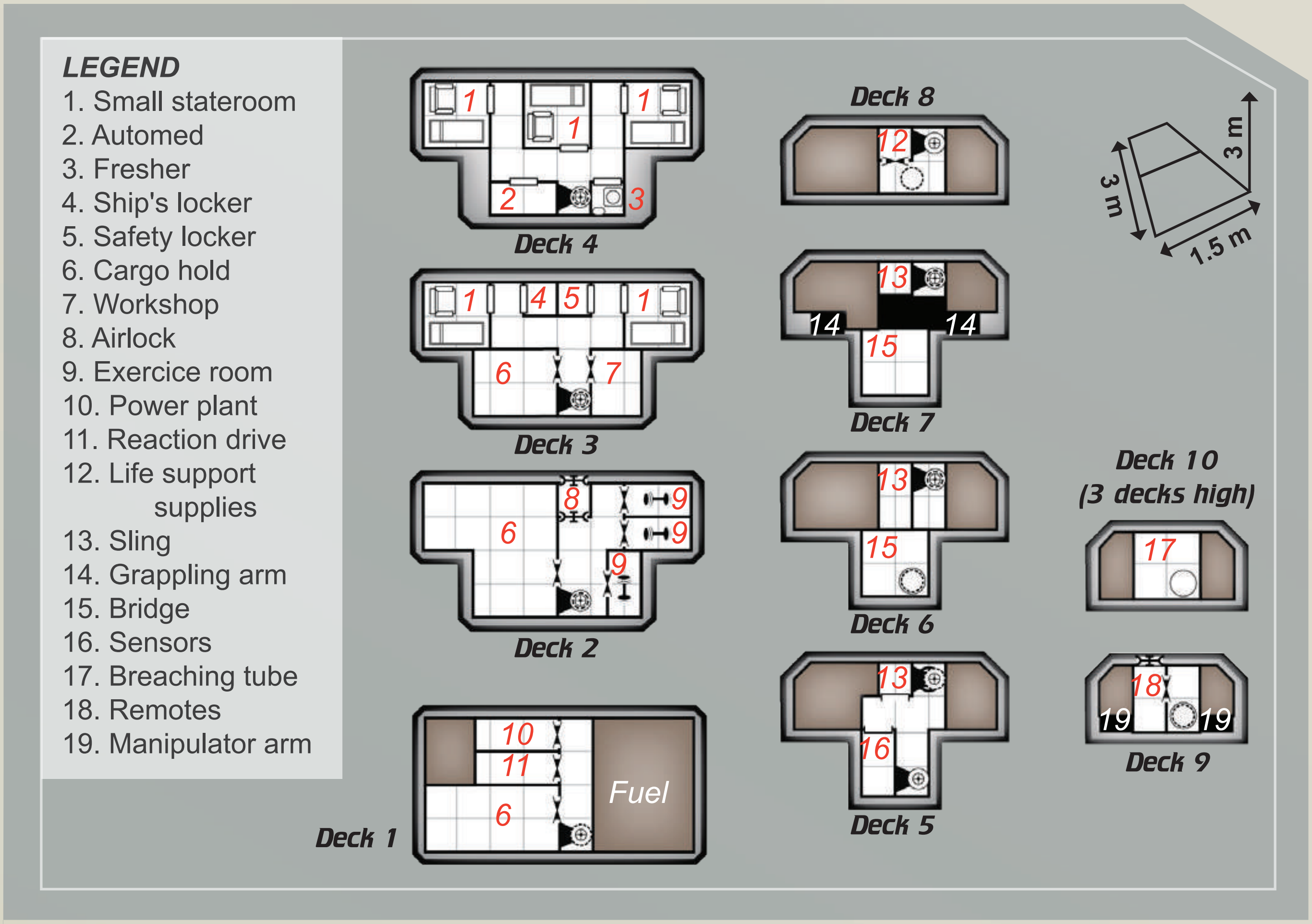
Running Costs
Maintenance Cost: Lv916/month
Purchase Cost: MLv10.05

Power Requirements	Power
Basic Ship Systems	0.7
Sensors	2

TL10		Tons	Cost (MLv)
Hull	70-ton Aligned Crystal Steel Spaceframe	—	1.4
Hull Features	Radiation Shield, Advanced	3.5	1.75
Armour	4	3.5	0.28
Reaction Drive	OMS Rocket (advanced)	1.26	0.84
Power Plant	Fuel Cell (Power 3), Solar Panels (Power 5)	1.3	0.85
Fuel Tanks	OMS Rocket (6 Burns)	13.23	—
	Power Plant (4 weeks)	1.8	—
Radiators	Conventional, Capacity 5	0.5	0.025
Bridge	Small	3	0.35
Computer	Primary: Computer/10 Secondary: Computer/5	—	0.095
Sensors	Basic Nav Array	1	0.1
Systems	Automed, Exercise Equipment x3, Library, Safety Locker, Ship's Locker, Simple Fresher, Workshop	8	1.655
	Sling (50 tons), Breaching Tube, Grappling Arms x2, Manipulator Arms x2	13.5	3.05
	Inspection Remotes x3	0.825	0.2325
Airlocks	Standard Airlock	—	—
Accommodations	Zero-G: Small Staterooms x5	10	0.5
Software	Archive, Intellect, Manoeuvre	—	1
Life Support Consumables	60 days for 5 people	0.6	—
Cargo		11.49	—
Total: MLv10.05			

Crew	Passengers	Hull Points	Signature: 1
Captain/Pilot, Astrogator/Sensors, Engineer, Technicians/Mechanics x2 **Comfort Rating**: -2	—	7	Base Reflected: 1 Base Radiated: 1





JUMPERS

Before interstellar colonisation began in earnest, the first Jumper ships left the solar system, bound for distant stars. The Jumpers were made up of groups fleeing the growing homogenisation of human culture on Earth, including fringe religious groups and ethnic communities. They received financial aid and support from a number of anonymous sources and using only Generation I stutterwarp drives, set out to colonise the stars while nations and corporations inched towards Alpha Centauri.

The Jumpers were never heard from again. In all, at least 20 groups left Earth between 2130 and 2170. One ship, the *Delgado,* was found in orbit among the rings of Cocito in the Nyotekundu system, in the year 2263. Their stutterwarp drive was destroyed and engineering spaces thoroughly irradiated and open to vacuum. The evidence is consistent with a drive inversion event; Generation I drives were slightly more prone to them than current drives. The ship was long-abandoned, all logs wiped, computer cores removed and cleaned thoroughly to reveal no trace of those who once flew in it. From what little is known of the *Delgado*, it was supposed to be carrying members of a fringe Christian sect from the South-eastern United States, the Followers of the Revelation.

Several colony worlds have ruins that appear to be of human origin but long-derelict. Some appear to have been abandoned at about the same time that the worlds were surveyed or shortly thereafter. This group came to be known as Pariahs, for their evident desire to avoid human contact. Others seemed to have simply failed, due to a lack of equipment, knowledge or resources. These former settlements and those who settled them, are often termed ‘Lost’ or, less kindly, ‘Losers’.

There are less than a dozen of these sites, scattered over the French and Manchurian Arms. Only one has been confirmed on the American Arm, on the waterworld of Avalon. This settlement appears to have died off. Notable in all of these settlements, however, is the complete lack of technology. Either these settlements did not use any, which would explain their failure or survivors cleaned up the sites before their discovery.

One site, at Paulo, does not follow either of these two patterns. Here, the shadows of the Monte Verde range, an unknown group settled for about 25 years. They

Jumper Sites

World	Arm	Discovered	Abandoned Date	Classification
Nous Voila	French	2286	~2220	Pariah
Heidelshiemat	Manchurian	2251	~2205	Pariah
Beta Canum	French	2276	~2200	Lost
Cold Mountain	Manchurian	2291	~2200	Lost
Dukou	Manchurian	2268	~2230	Pariah
Paulo	Manchurian	2274	~2235	Sooner
Crater	French	2235	~2200	Lost
Joi	French	2273	~2230	Pariah
Sans Souci	French	2293	~2265	Lost
Avalon	American	2299	~2280	Lost
Kanata	Manchurian	2292	~2260	Pariah

conducted some mining operations, built a well-planned village and then left, taking everything with them and leaving the village a hollowed-out shell. Their departure happened at least 20 years before the world was first surveyed in 2255. All evidence based on building layout, proportions and other factors indicate that the people at the site were human and likely western, from Europe or North America. Beyond that, nothing is known. Many Jumpers acted in secret, assisted by their unknown benefactors and there are few records. This settlement, and the people who lived here, have been dubbed 'Sooners' by the media, as 'they left Sooner rather than later' (unlike the Pariahs).

The fate of the Pariahs and Sooners is unknown. Romantics like to believe they have fled far beyond the edges of human space, settling worlds far removed from the society they abhorred. Others, perhaps more realistic, accept the reality that Jumpers were ill-prepared for what faced them and that if any survived at all it was a matter of luck. Eventually however, if you come to rely on luck it will run out and at the worst possible time. This is the probable fate of all Jumpers, sadly, largely forgotten by those they left behind.

THE DELGADO

NATION: United States
FIRST EXAMPLE LAID DOWN: 2165
MANUFACTURER: Unknown
PRODUCTION STATUS: Out of Production
CONSTRUCTION TIME: 306 Days
SERVICE STATUS: Out of Service
FLEETS OF SERVICE: Private
NUMBER IN SERVICE: 1
LENGTH: 72.75 m
WIDTH: 48.5 m
WINGSPAN: 0 m
TAKE-OFF MASS (FULLY FUELLED): 4,000 tons
POWER PLANT: 4.4 MW Fuel Cell, 8 MW Battery, 2 MW Solar Array
REACTION DRIVE: OMS Rocket, 4,000 tons thrust
STUTTERWARP 1.0 MW Gen I1 Jerome-effect Stutterwarp

The *Delgado* was transferred from the Nyotekundu system to Tirane in 2271 by the American government, as the Followers of the Revelation had been largely American. It sits in orbit as an exhibit with the multi-national Museum of Human Settlement. It describes the *Delgado* as an early example of a starship but does not mention that it was used by a probable Jumper group.

The *Delgado* was a typical ship of her time, equipped with the early Generation I stutterwarp drive and an OMS rocket system. Power was from banks of batteries charged by solar panels. The *Delgado* would have had to spend weeks in system to recharge.

Oddly, for a civilian starship of its time, the *Delgado* was armed. Remaining records from the time describe the ship well but there is no mention of a railgun being installed.

The crossing from Earth to Wolf 359 (now known as the Nyoptekundu system) was particularly hazardous to ships with older drives, as the crossing pushed the envelopment of the drive's range. This has been identified as the reason the ship's drive had an inversion event. That is not the mystery.

The mystery is who rescued, or perhaps salvaged, the ship and when?

TL9		Tons	Cost (MLv)
Hull	400-ton Aligned Crystal Steel Dispersed Structure	—	6
Reaction Drive	OMS Rocket (crude)	8.8	2.16
Stutterwarp	0.058 ly/day, Tac Speed: 0, System Speed: 0.04 AU/day	2.4	1.49
Power Plant	Fuel Cell (Power 48), Battery (Power 40), Solar Panels (Power 24)	9.6	10.8
Emergency Power	Power 4 (24 hours)	0.96	0.96
Fuel Tanks	OMS Rocket (4 Burns)	61.6	—
	Power Plant (10 weeks)	72	—
Radiators	Conventional, Capacity 125	12.5	0.625
Bridge	Small, Encrypted Comms	10	3
Computer	Primary: Computer/5 Secondary: Computer/5 Tertiary: Computer/5	1	0.09
Sensors	Basic Nav Array, Basic Nav Array, Basic Survey, Telescope	7	5.7
Weapons	Railgun Fixed Mount	10	8.3
Targeting	None (DM-4)	—	—
Tactical Action Centre	4 Personnel	—	—
Systems	Under Spin: Common Areas x20, Exercise Equipment x5, Safety Lockers x10, Ship's Locker, Freshers x3, Simple Freshers x3	27	3.895
	Sling (100 tons)	5	1
Airlocks	Standard Airlocks	—	—
Accommodations	Under Spin: Bunks x15, Cryo Berths x200, Small Staterooms x3	111	100.425
Artificial Gravity	Type: Spin Capsules (142.38 tons under spin)	15.66	7.83
	Radius: 30 m, 3 RPM, Gravity: 0.3 G, Spin Up/Down: 18 minutes		
Software	Archive, Manoeuvre, Stutterwarp Control	—	0.0232
Life Support Consumables	4 years for 17 people	4.38	—
Long Term Life Support	Basic for 17 people	8.5	0.85
Cargo		31.55	—
Total: MLv145.11			

Crew	Passengers	Hull Points	Signature: 3
Captain, Astrogator, Flight Engineer, Pilot, Sensor Tech, Reaction Drive Engineer, Stutterwarp Engineer, Power Engineer, Gunner, Electronics Tech, Specialists x4 **Comfort Rating**:+0	200	32	Base Reflected: 3 Base Radiated: 2

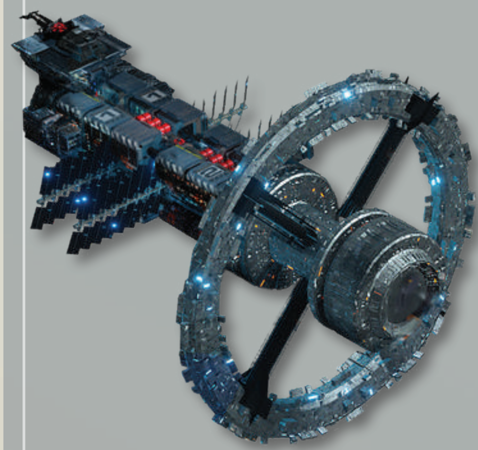
Running Costs
Maintenance Cost: Lv12093/month Purchase Cost: MLv145.11

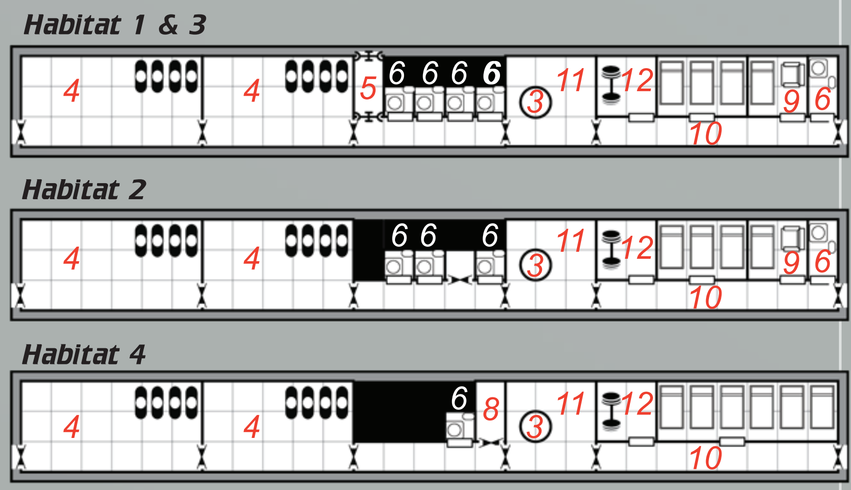
Power Requirements	Power
Basic Ship Systems	4
Long Term Life Support	8.5
Sensors	5
Stutterwarp	10
Weapons	8

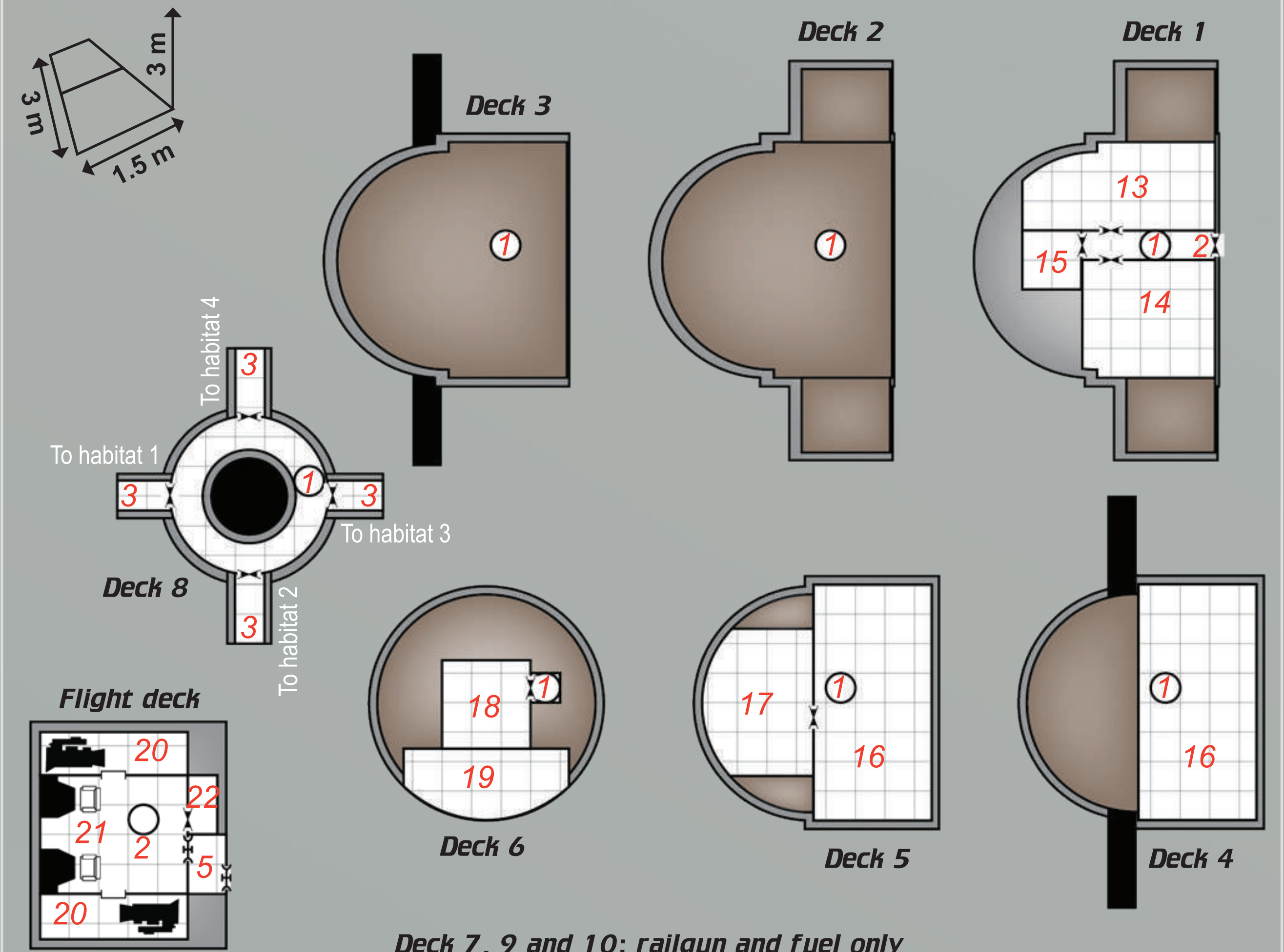
Weapon	TL	Range	Power	Damage	Tons	Cost	Traits
Delgado Railgun	9	Adjacent	80	3D-3	5	MLv2	AP 10, Slow

LEGEND

1. Access tube (through ship)
2. Flight deck access tube
3. Habitat access tube
4. Low berths
5. Airlock
6. Fresher
7. Safety locker
8. Ship's locker
9. Small stateroom
10. Bunks
11. Common area
12. Exercice room
13. Reaction drive
14. Power plant
15. Stutterwarp
16. Cargo hold
17. Long term life support
18. Life support supplies
19. Sling
20. Sensors
21. Bridge
22. Emergency power







Deck 7, 9 and 10: railgun and fuel only

Generation I Stutterwarp Drives

The first iteration of the stutterwarp was greatly inferior to the current generation. Larger, more power intensive and much slower, the early drives were also more prone to inversion events; a catastrophic release of energy from the drive as the tantalum spontaneously relaxed to hafnium, releasing a torrent of heat and gamma radiation.

Generation I drives are only available at TL9 and require twice the power and space of an equivalent Generation II drive. Divide all drive speeds by 10 to determine Stutterwarp Efficiency for these older systems.

There are no known examples of this generation of stutterwarp still in service.

TRANS- AND POSTHUMAN ENCLAVES

The definitions of transhuman and posthuman are somewhat murky. Recipients of DNA modifications would seem to fit at least the transhuman category but lack the social break, the psychological evolution that would put them in a different category than other, non-modified humans. For the most part, they are just 'different'. The Ultras from King and the Tritons are the only DNAM groups that appear to be moving towards a changed society but that is as much a matter of their hostile environments as their enhancements. These two classes of modification are also the only ones that cannot interbreed with baseline humans with medical intervention, which is likely another factor driving their cultural evolution.

The Autumn Collective, in Ross 128 on the French Arm, self-describes its members as 'posthuman'. The 57 members of the Collective are all very old and very heavily augmented. Little of their biological bodies remain and most of organic parts are buried under layers of metal and carbon fibre. They make use of Demarchist-style brain implants to communicate with each other and make decisions but hardly ever meet in person. They seldom deign to meet with outsiders either, save for trade. Even then, they prefer all communication to be by radio or telepresence. They tend to be very matter of fact and will not discuss anything other than the business at hand.

ProVolution once boarded their station in an effort to recruit the Collective or perhaps steal their secrets. French naval personnel discovered the starship the Provos had used, drifting in the outer reaches of Ross 128, its emergency beacon howling. Everyone on board was dead, killed brutally yet efficiently, somewhere other than on their ship. The Collective denied responsibility.

At the far end of the Manchurian Arm, at Kapetyn's star, is Farlook Station. Once a research facility, it was closed in 2276 due to lack of funding and subsequently abandoned. At the time, it was one of the most distant outposts in human space. Staff from the former outpost have often talked about how the loneliness and isolation felt at the station and for some the terror of looking away from Sol at a vast volume of space never visited by humanity.

Sometime in the early 2290s, individuals who self-identified as 'transhuman' took up residence at the outpost. They brought with them considerable resources and an open invitation to anyone else who identified as transhuman or posthuman to join them. The population of the outpost is unknown but is thought to be at least 30 people, with some estimates reaching as high as 100. Here, they are trying to build a new society, with its goal the transcendence of cultural norms and the creation of a true, free and equal society. Cynics do not give them high odds of success.

SPACE FORCES

Most nations maintain some sort of space military force and even some Tier 4 and Tier 5 nations have a space military presence, even if only in the form of 'coast guard' units, border patrol and orbital quarantine command. Roughly speaking, the size and capability of space forces depends on the national Tier. Tier 1 and 2 nations will have the largest, most advanced and most flexible forces. With units dedicated to performing a wide variety of tasks, they are best-suited to respond with appropriate units and numbers. Tier 3 nations have much smaller forces and their units tend to be multirole rather than specialised. While this provides them with some response capability, it is unlikely to be as effective as the response from a larger force.

As noted elsewhere, ranks and naming conventions in space militaries vary from nation-to-nation. The United States uses an air force-based scheme, with unit names based on mission rather than set class. Ranks likewise take from the air force. Most European nations base their organisations on a naval model, with classes based on size and capabilities. Ranks are likewise naval in origin, although often simplified.

The major human military space forces are scattered over the 50-light year radius sphere of human space. These ships are spread thin across the various Arms, while still ensuring a significant presence at home. This was the mistake France made in the wake of the Central Asian War. They scattered their fleet to bring order to their older, more fractious colonies and when the Hanoverians led the other disparate German nations in a drive for unity, forcibly adding French-allied Bavaria to the mix, the French fleet did not have enough vessels at Earth to offer a challenge to the massed German flotilla.

After the Kaefer invasion of Aurore in 2298 and the subsequent human counterattack in 2299, Aurore has increasingly become the focus of human military attention, even if the political leadership and media are downplaying the risk. The military and civilian leaders are well aware of the risk but see no benefit in provoking a panic amongst the billions in the Core.

Many major space naval forces have representation at Aurore and currently, aside from Earth, it may be the most heavily-fortified planet in human space.

TIER 1 AND TIER 2 SPACE FORCES

The militaries of the First and Second Tier have the largest, most complex and most powerful space forces. The compositions of five largest – Britain, France, Germany, Manchuria and the United States – are provided here.

American Space Force

Until the Central Asian War (CAR), the American Space Force was relatively small, a mix of patrol, defence and a few longer-ranged designs. In the build-up of tensions prior to the war, the General Staff realised that American interests were at risk from an inability to project force. While the American Arm is securely under American control, access to the Arm overlaps the route to the Manchurian Arm. It would be possible for a hostile force to interdict the American Arm from a few carefully chosen choke points. Aside from this, there is an identified risk from other powers, notably Tier 3 nations, which could encroach on the American Arm and current American-only worlds. There is nothing in the Melbourne Accords to prevent this and, indeed, the Accords guarantee this ability. So far, other nations on the Arm have been invited by the United States, including Australia and Nigeria, but there exists the possibility of hostile, or at best unallied, nations taking an interest. While undertaking design studies, the consultants working with the Space Force began analysing battles of the CAR, which was ongoing at the time. They came to the conclusion that speed and combat drones, not guns or armour, was the answer to America's combat requirements. The Kennedy-class was the first result of this design philosophy, with sister craft of the Columbia-class to finish trials in mid-2300. The Atlanta-class escort craft is set to follow from Newport Yards over Mars in early 2301. Aside from these newer vessels, the ASF is a somewhat motley collection of craft, including Chicago-class patrol craft, Cayuga-class heavy escorts and Hampton-class fast escorts. The Department of the Navy also runs a few starships, much to the chagrin of the Space Force. The navy craft are designed for stealth, with radar/lidar-absorbing hulls and heat sinks to foil passive sensors.

Ships of the American Space Force

While the American Space Force insists on using air force terminology, having arisen out of that service, in practice most other nations refer to the American Navy and often translate the somewhat obtuse class names to more familiar naval terms:

- 1 x Columbia System Control Craft (additional 2 under construction)
- 12 x Kennedy Missile Carrier (1 lost 2299)
- 9 x Cayuga Fast Escort (2 lost 2298)
- 6 x Hampton Heavy Escort
- 3 x Valley Forge Light Assault Carrier
- 14 x Knox Heavy Patrol Craft
- 12 x Chicago Fast Patrol Craft
- 6 x Atlanta Next Generation Patrol Craft (under construction)
- 2 x Racine Fleet Intelligence Craft
- 6 x Brubaker UNREP Craft
- 4 x Carlsbad Ice Mining and Refuelling Craft
- 8 x Pronghorn Courier
- 3 x Ford Mobile Repair Bay
- 4 x Madison Mobile Support Platforms
- 2 x Sacajawea Long Range Survey Ships (the Department of the Interior owns these vessels and insists on calling them ships, despite their ASF crews)

Fighters and Small Craft

- X-2296 Fighter
- FS-17 Fighter
- SB-22 Guncarrier
- SBH-55 Orbital Strike Bomber
- SA-10 Aerospace Fighter
- CIT-990 Combat Lander
- CIT-50 Heavy Combat Lander
- LC-20 Combat Lander (to be retired by 2305)

Combat Drones

- SIM-14
- SIM-10

American Department of the Navy Boats

The Department of the Navy refers to all spacecraft it operates as 'boats'. Notably, submarines are also referred to as boats and apparently these craft are operated much the same, with a mix of fast attack, intelligence-gathering, and deterrence. They are all very stealthy, with significant heat sink capacity to allow them to remain unseen for long periods of time:

- 6 x Alaska-class Deterrence Boats
- 6 x Starwolf-class Fast Attack Boats
- 4 x Island-class Stealth Reconnaissance Boats

Deterrence Ships

The United States, France, the United Kingdom and (allegedly) Manchuria all operate so-called 'deterrence' ships. These are stealthy ships, armed with system-range drone weapons, that lurk at the edge of a system for long periods of time. While their weapons are designed to deliver a massive attack on stationary ships and orbital infrastructure, there is little to stop them from being armed with nuclear or even prototype anti-matter weapons. No force has maintained or deployed ballistic missiles since Twilight and so the emergence of these ships is a worrying trend.

American Space Force Bases

America has support bases for the space force across their Arm of space but American ships can be found in some odd places.

THE CORE

The largest ASF base is located at the L-4 point trailing the Moon. There are a couple more stations orbiting Earth, along with bases groundside. Most ASF ground bases are co-located with US Air Force facilities and the two branches have a friendly rivalry. Reinforcing the friendliness is the scarcely contained hostility towards the Navy for operating their own ships independent of the ASF.

Along with Earth, there is an ASF base on Mars in the Sol system, protecting the Trilon and Newport shipyards. There is also a base at Tirane and, until 2289, a small base at Proxima Centauri for protected forces training, since closed and sold off.

AMERICAN ARM

The ASF has bases at Broward, King, New Melbourne, Vega Red Speck, Ellis and AC+2 2155-242. Only Ellis has a substantial base and is the headquarters for the ASF 2nd Space Group.

The Department of the Navy maintains a base at Barnard's Star and Mu Herculis, with another secret outpost somewhere on the Arm.

FRENCH ARM

America maintains an ASF presence at three worlds on the French Arm. There is an assault carrier with escorts providing support for the peacekeeping mission at Vogelheim, a small group patrols the complex Xi Ursa Majoris system, at the request of Trilon, and of course there are some ships at Aurore, including three Kennedy-class missile carriers, escorts and a Brubaker UNREP craft. There are also rumours that the Navy keeps some of its stealth ships lurking near Astraeus, the outer gas giant of the Eta Bootis system.

Ships of the Imperial French Space Navy

France maintains a large naval presence, concentrated at the Core and at Beta Canum. Colonial unrest and succession risk is a major issue for the nascent Imperial French government and the fleet is spread thin to maintain control. This resulted in the loss of the War of German Reunification, as the massed German fleet forced the French fleet to stand down before reinforcements could arrive from outsystem.

- 2 x Tallyrand Battleship (1 lost 2298)
- 7 x Suffren Battlecruiser (2 lost 2298)
- 6 x George Fochs Assault Carrier
- 6 x Aquitaine Cruiser (1 lost 2299)
- 11 x Cassard Destroyer (2 lost 2298)
- 1x Orage Frigate (training vessel, 6 released for export)
- 1 x Ypres-12 Frigate (training vessel, 4 released for export)
- 14 x Aconit Frigate (1 lost 2293, 7 lost 2298, 2 lost 2299, 16 released for export)
- 26 x Lafayette Patrol Corvette (3 lost 2298, 2 lost 2299)
- 2 x De Bettignies Fleet Signals Platform
- 7 x Baker Monitoring Vessel (1 lost 2298)
- 8 x Surcouf Deterrence Platform
- 6 x Ânesse Fleet Replenishment Ship
- 2 x Metal bloc II Fleet Support Ship
- 8 x Seine Tanker
- 3 x Pasteur Hospital Ships
- 3 x Renault Factory Ship
- 4 x Asturien Mobile Repair Dock

Fighters

- Bonaparte
- Bufer
- Martel
- Mistral
- Riche

Combat Drones

- Ritage-1
- Ritage-2
- DA-2290 (limited deployment, Core only)

Imperial French Naval Bases

France only maintains static bases at a few worlds, relying on mobile patrols for coverage. Due to ongoing colonial unrest across many of the longest-settled worlds, the French Admiralty avoids placing long-term bases when possible, in order to prevent crews from forming loyalties and attachments with local populations.

THE CORE

Imperial France maintains a number of bases across Earth and the solar system. Notable installations can be found in North Africa, Metropolitan France, Guyana and of course at Libreville in Gabon.

Gateway houses a naval presence, given French ownership of the Beanstalk and there is a flight of fighters on Luna. Additional French naval bases can be found at the L-5 habitat and Amalthea. France has a major base and a substantial portion of their fleet at Tirane, home to the largest French population in human space, even larger than metropolitan France.

THE FRENCH ARM

The bulk of French forces are concentrated on the Arm, with even their substantial numbers spread thin across so many worlds. The main fleet bases are at Bessieres, to protect the industrial facilities and at Beta Canum. There is, of course, a substantial fleet presence at Aurore, including the Tallyrand. France has already lost many ships to the Kaefers and they are looking for payback for the loss of Ste. Jeanne d'Arc.

Combat Losses

By the end of 2299, France had lost more combat spacecraft than most Tier 3 nations have in their entire space forces. The loss of 10 ships to the Kaefers over the past five years has angered the French admiralty and the public at large. While this anger is currently directed at the invaders, it would not take much to turn that anger inward to the still new Imperial throne. Nicholas Ruffin and his inner circle are very much aware of this risk and closely monitoring the situation.

MANCHURIAN ARM

Although Manchuria was a late signatory to the Melbourne Accords, it did eventually sign. A sticking point for Manchuria was the presence of several French outposts on what they claimed was 'their' Arm, a position the Accords did not support. They eventually agreed to sign, on the condition that France would limit the number and size of ships at the outposts. France agreed so readily that Manchuria suspected a trap. After ratifying, they found it; France was limited in the size and number of starships they could post at each station but not in the number of non-starships or, in other words, fighters. Both France and Manchuria have outposts in the Seruier, Broward, DM-26 12026, Davout and D'Artagnon systems, which have been the source of multiple diplomatic and military incidents since the start of the Central Asian War.

Ships of the Royal Space Navy

The British Royal Navy is perhaps the archetypal naval force, both on the seas and in space. Sometimes referred to as the Royal Space Navy, it is generally understood that any reference to 'Royal Navy' off Earth refers to the space force. Britain maintains a wide array of ship classes, preferring more specialised designs than the big French ships. With fewer colony worlds, the British Royal Navy is not spread as thin as the French. Their fleet is slightly larger, although overall with a far smaller tonnage. The County and K-class destroyers are barely larger than a frigate, while frigates are more on par with a corvette.

The Royal Navy has a bad reputation with Belters and Libertines, as it often acts in support of national and even corporate wishes outside of the rules of the Melbourne Accords. For their part, the Royal Navy maintains that the Accords only apply to nation states and the stateless Belters and Libertines have no rights or recourse under its terms.

- 2 x Invincible Fleet Carriers
- 2 x Dreadnought Battleship
- 2 x Trafalgar Battleship
- 11 x County Destroyers
- 7 x K-class Destroyers
- 22 x Daring Frigates
- 18 x Exeter System Defence Boats
- 1 x Newcombe Mobile Repair Dock
- 2 x Turing Signals Intelligence Vessels
- 5 x Planet UNREP vessels
- 12 x Ocean Fuel Processing and Transport (FPT) ships
- 1 x Gardner Planetary Survey Vessel
- 5 x Triumph Fleet Deterrence Platform

Fighters and Landers

- Wellington Gunship
- Space Harrier Gunship (Martel)
- Hurricane Light Fighter
- Typhoon Aerospace Fighter
- Type 17 Landing Craft Vehicle Personnel (LCVP)
- Type 55 Heavy LCVP
- Type 22 Landing Craft, Utility (LCU)
- Bison Cargo Landers

Combat Drones

- Ritage-1
- Ritage-2
- Space Sparrow

Royal Navy Bases

With the majority of their ships using MHD turbines for power, the Royal Navy maintains a system of refuelling depots along the French Arm. Some of these stations are little more than a workshack and tank floating in space, maintained by a small fleet of FPT ships that make the rounds to outposts across scattered systems. These stations are extremely unpopular postings, often viewed as punitive assignments.

In addition, every British colony world is supported and defended by a Royal Navy outpost. These outposts are outfitted with a number of lighter vessels and fighters, leaving a core of heavy vessels as a mobile strike force, rather than pinning them down defending static targets.

THE CORE

The primary Royal Navy base in the solar system is Queen Elizabeth II Station, a large double ring station supporting a number of maintenance and construction facilities. This is the headquarters of the Terran Reserve Fleet, an extremely powerful battlegroup. Royal Navy units from the Reserve Fleet patrol the outer system but there are no other permanent facilities in the Sol system.

The situation in the Alpha Centauri system is complex after the independence of the Wellon colony. There is a joint Wellon/Royal Navy base in orbit over Tirane, as well as a smaller base beholden to the Albion colony, that maintains sovereignty and security. Further out in the system is a training facility that the Royal Navy will be releasing to Wellon by 2304 once the latest, and last, class graduates.

THE FRENCH ARM

Thanks to its refuelling stations, the Royal Navy has an extensive presence all along the French Arm. There are refuelling stations at Nyotekundu, Bessieres, Augereau, Kimanjano, Beta Comae Berenices, DM+36 2293, DM+50 1832, DM+32 2219 and Hochbaden. There was a station in the Eta Bootis system but it was destroyed, along with so much else, in 2298.

All British colony worlds have naval bases, with the largest at Beowulf. Breca Station is home to the 3rd Reserve Fleet, the largest group of British warships outside the Core.

In addition to the colony bases and refuelling stations, Britain also maintains a permanent presence at Aurore during the current emergency. This squadron includes a pair of County-class destroyers and six Exeter system defence boats, in addition to a pair of FPT refuellers. As of January 2300, a Planet-class UNREP ship and four K-class destroyers were en route to reinforce the squadron.

AMERICAN ARM

DeVilbis Station, in the Clarkesstar system, is the only non-American/Australian naval post on the American Arm, although the system is right at the beginning of the Arm. A small Royal Navy detachment of two Exeters and one K-class operate from DeVilbis, which is otherwise noteworthy as an astronomy outpost operated by the AAEC (American-Australian Exploration Council).

Ships of the German Space Force

The Raumwaffe, or Space Force, of United Germany is a new organisation, although built on the core of Hanover's Space Self-Defence Force. Like most European forces, it follows naval nomenclature for class names and ranks. The Raumwaffe is fortunate to have acquired advanced French technology through absorption of the Bavarian Space Force, although a few ships of the BSF did defect to Heidelsheimat and Freihafen after the War of German Reunification. The industrial might of the united Germanies puts it on par with European France, although French possessions elsewhere on Earth dwarf German industry. The Raumwaffe is a mix of solid Hanoverian designs like the Sachsen-class and more advanced Bavarian designs like the Hamburg-class missile cruiser. The latest ship, the heavy Bismarck-class, is a mix of the two, combining a Hanoverian hull with Bavarian drives and electronics. France is known to be furious at the technology transfer from Bavaria to the united Germany but there is little they can do about it. There is currently no appetite on anyone's part to re-fight the War of German Reunification, not with the Kaefers baying at the door.

- 3 x Bismarck Battlecruiser
- 6 x Hamburg Missile Cruiser
- 3 x Krüger Assault Carrier
- 4 x Rommel Destroyers (1 lost 2299)
- 13 x Saschen Frigate (1 lost 2293, 1 lost 2298, 2 lost 2299)
- 15 x Gepard Corvette (2 lost 2299)
- 10 x Myrmidon System Defence Boats
- 4 x Mastodon Fleet Support Carrier (ex-Mammoth, 1 lost 2299)
- 3 x Packpferd UNREP Vessel (ex-Cargomax, to be retired 2301)
- 6 x Rhein Fleet Tanker
- 2 x Aister Signals Intelligence Ship

Fighters and Landers

- Gustav Fighter
- Udet Fighter
- Wespe Heavy Fighter
- Typhoon Aerospace Fighter
- Tiger Gunboats
- Plötze Utility Lander
- Type 620 Light Combat Landers
- Type 200 Heavy Combat Landers
- Type 100 Cargo Lander

Combat Drones

- Ritage-1
- Ritage-2
- Donnerwetter
- SR-9
- SR-10

Raumwaffe Bases

Hanover and the other German states outside of Bavaria had few space military bases. Of those predecessor states, only Hanover had an extrasolar colony, at Joi. With four other colonies on the planet, there were sufficient commercial resources in place that all Hanover needed was to invest in the colony, rather than outposts to support it. Bavaria, however, had an extensive network of outposts to support its six colonies over two different Arms of space. Even after the initial effort was complete, a few outposts were retained.

THE CORE

United Germany inherited most of the space infrastructure of Bavaria, save for two facilities that were joint with France. Most of the Bavarian facilities were civilian, with only a small orbital station and repair facility.

At Tirane, Bavaria had a more extensive military presence but Freihafen's declaration of independence in 2294 prevented the transfer of any Bavarian facilities to Germany.

THE FRENCH ARM

Neubayern was the industrial heart of Bavaria and it has embraced the concept of a united Germany. This was the real prize, with both civilian and military starship construction facilities. Germany maintains the large Marienburg fortress in the asteroid belt, home to the German (formerly Bavarian) 1st Colonial Fleet.

All colony worlds have some level of system defence, oftentimes the robust little Myrmidon system defence boats. Hochbaden, next in line after Eta Bootis, has the 2nd Colonial Fleet at its disposal to protect the orbital habitats and the domed surface facilities. With the flag carried by a Bismarck-class battleship, this is an extremely-powerful force. Raumsberg, an armed and armoured station, orbits near Star City, the largest habitat. While it can defend itself with laser arrays and combat drones, the main purpose of the station is to act as a target to draw fire away from the habitat to buy the civilians time.

Like most other nations with holdings on the French Arm, Germany maintains a presence at Aurore. However, given the proximity of Hochbaden, the bulk of German forces are there with only a few fast ships at Aurore to carry word to the 2nd fleet.

MANCHURIAN ARM

With a colony at Heidelsheimat, Bavaria was one of the few powers to have a permanent presence on two Arms. The colony was always a source of friction with Manchuria, which came to a head during the Central Asian War when Manchuria blockaded the system. Heidelshiemat as a colony of a Germany at odds with France is more to Manchuria's liking.

The 3rd Colonial Fleet is maintained at Heidelsheimat but despite its grandiose name, it is a shell of the fleet with only a few smaller system defence ships available, largely as a counter to Texas. It maintains the structure and organisation of a full fleet and could be rapidly brought to full strength if required.

Ships of the Manchurian Space Force

Manchuria has fewer large combatants and relies heavily on ships of the Chi'en Lung-class and variants. Classed as a heavy patrol craft, it is better known as

Aconit class frigate
Nation: *France*

CA-120 combat lander
Nation: *United States*

Geist
Nation: *Kaefers*

a raider to western forces. The Abahai-class system dominance vessel is the largest Manchurian craft in service. One of these ships is in service and another is under construction. The Bàquán-class planetary dominance vessel is the newest craft in the Manchurian arsenal, an assault carrier of unusual design. Manchuria officially discourages the use of naval nomenclature in describing their spacecraft.

- 1 x Abahai System Dominance Vessel
- 3 x Bàquán (Hegemony) Planetary Dominance Vessel
- 2 x Nanchen Aerospace Carrier
- 12 x Chi'en Lung Heavy Patrol Craft (3 lost 2286)
- 15 x Tunghu Light Patrol Craft
- 21 x Chengqing Colonial Patrol Craft
- 4 x Hyun Type 220 UNREP support vessels (ex-Hyun large cargo container vessel)
- 5 x Type 500 tankers

Fighters and Landers

- Jian Light Fighter
- Dadao Heavy Fighter
- Zhànzhēng Fēngzhēng (War Kite) Combat Spaceplane
- Tāntóu (Beachhead) Drop Fortress
- Qiang (spear) Dropship, Combat Walker (DSCW)
- Ge (dagger-axe) Dropship, Light Vehicle (DSLV)
- Yueji (axe-halberd) Dropship, Heavy Vehicle (DSHV)
- Pi (sword-staff) Dropship, Banner Infantry (DSBI)
- HL-150 Heavy Landers
- MC-200 Aerospace Cargo Plane

Combat Drones

- Fantan
- Glowworm
- Silkworm

Manchurian Naval Bases

Most Manchurian naval outposts are little more than refuelling stations. Unlike the British stations on the French Arm, these stations maintain their own fuel supplies from local resources. While normally closed to civilians, they provide fuel in emergency situations, but at exorbitant costs. Manchuria does not maintain standing fleets at any system in the Arm except for Syuhlam, as a counter to the Canton colony. There are local defence forces but these are ad hoc affairs organised by local governments. Customs are likewise the responsibility of locals but anti-smuggling operations are a significant part of the Manchurian fleet's duties. The other strategic goal is containing the Sung. Manchuria has let it be known that providing the Sung with stutterwarp technology will invite a full reprisal and they have no qualms about employing weapons of mass destruction to ensure the Sung are not able to escape their system.

THE CORE

Manchuria has several planetside bases on Earth, along with Empress Wu, the orbital station and construction yards for the Manchurian fleet. Aside from this large station, the Manchurians maintain no other bases in the Sol system.

The Tunghu colony on Tirane was never a priority for any faction of the Manchurian government. It is primarily a trade station, to keep Manchuria's hand in the events of the second most populous world in human space. It is also widely thought to be a centre for espionage. Manchuria has some aerospace defences there but little more.

THE MANCHURIAN ARM

As one of the most spread out and diverse Arms, Manchuria counts on the cooperation of the many Tier 3 powers that share the Arm. While bound by the conventions of the Melbourne Accords, Manchuria still tends to treat other colony-holding nations on the Arm as something like vassal states, able to retain holdings solely at the discretion of their hosts. Manchurian military power on the Arm simply overwhelms all other colonies put together.

As mentioned, Manchuria does not have naval stations so much as simple refuelling stations. As defence against raiders and smugglers, Manchurian ships are always on the go. The Imperial House does not want crews becoming sympathetic to local populations, so there are no permanent planetside postings. There are refuelling bases at Seruier, Broward, DM-26 12026, Davout and D'Artagnon, systems that Manchuria shares with France, to their annoyance. There are also refuelling stations at a every Manchurian colony world, along with stations in most other colonised systems.

The largest single posting of Manchurian Space Force ships can be found at DM+19 5116, the next system in from the Sung homeworld at DM+4 123. This supports the quarantine control fleet in the Sung system, constantly on watch for any sign the aliens have somehow acquired stutterwarp drives.

TIER 3 AND TIER 4 SPACE FORCES

Tier 3 nations represent the largest group of starfaring nations, although most have small fleets. Tier 4 nations do not, normally, have much in the way of interstellar capability but there are exceptions. All the Tier 3 and Tier 4 nations combined would not equal the numbers of even the smallest Tier 2 power. These fleets are usually patrol and colonial defence forces and often comprise obsolescent vessels purchased from major powers and refurbished.

Of the Tier 3 powers, Argentina and Brazil have the largest, and sadly most experienced, fleets. Much of that experience has been against each other over the course of three Rio Plata wars. Australia has the next largest, and most modern, fleet. Texas and Canada trail behind, with few modern large warships but plenty of system defence craft and fighters. Mexico has a modern navy but is small and kept close to home. They have often facilitated the purchase of obsolescent warships for allies, even if the selling country has embargoed them, as in four Aconit-class frigates transferred to Mexico via Indonesia and from there to Argentina.

Only the Incan Republic carries a notable deep space navy and even they have only a handful of outdated warships, all purchased from Mexico. The Incan Republic Space Defence Force is just barely effective and, as in so many cases, often relies on other colonies co-habiting their own colony worlds.

Appendix I: Vehicle Scale Weapons in Starships

Vehicle-scale weapons are designed to operate in planetside engagements, with little capability against spacecraft save at incredibly close ranges. However, such weapons can be of use, especially for combat interface transports, often called dropships, and for aerospace fighters expected to engage targets from the ground to low orbit.

Weapon Mounts

Like starship weapons, there is a limit to how many vehicular weapons a ship can mount. Instead of hardpoints, the term is mount points. Ships get one mount point per 50 tons and can also trade in one starship hardpoint for two mount points. Fixed weapons do not require mount points but a ship can only carry up to 10% of its tonnage in fixed weapons.

Weapons cannot be mounted alongside starship weapons. Most starship weapons, with their large focal arrays and beam emitters, cannot be deployed in atmosphere and take up the entire space of their mounts. Weapons are typically located in dedicated mounts, usually some sort of retractable turret, but fixed mounts and streamlined turrets are possible. A standard turret can also be used but not for vessels capable of interface travel.

The tonnage of the mount includes the weapons installed but the cost is separate. So, a 25 mm autocannon that consumes 1 Space in a vehicle would consume 0.1 tons in a fixed mount. The mount itself would cost MLv0.1, while the weapon is another MLv0.1. The mount includes one full magazine for the weapon in question.

Very light weapons, up to 1 Space, can be emplaced on a sling or pintle mount, usually concealed behind a hatch and used for covering fire when landing. Such light weapons do not need to be accounted for in the tonnage of the ship but should be limited to no more than one or two per vehicle door or ramp. Such weapons cannot be used when the vehicle is moving faster than 200 kilometres per hour.

Ordnance Bay

Bombs and missiles are typically carried in bays. A bay is treated as a fixed mount but, in the case of missiles, the launcher from the *2300AD* box set is not required.

External Mounts

Missiles and bombs can be mounted externally. However, they cannot survive re-entry or orbital insertion. An aerospace craft would have to land and have external ordnance loaded while on the ground. For that reason, external mounts on aerospace craft are rare. An airframe body can carry 1 Space of external ordnance per 10 tons, while a lifting body can carry 1 Space of external ordnance per 12 tons. Carrying external ordnance lowers speed by one Speed Band.

Ammunition

Mounts contain one magazine's worth of ammunition and additional ammunition must be accounted for internally within the vessel. An ammunition feed system is automatically included in the vessel if applicable.

Fire Control

Like vehicles, computer-assisted fire control is also available for weapons mounted on a spacecraft. Some level of basic fire control is assumed to be fitted, to allow the vessel to fire its weapons when on the move

Weapon Mounts

Mount	Tons	Cost
Fixed	Weapon Spaces/10	MLv1 per ton
Retractable	Weapon Spaces /5	MLv2 per ton
Streamlined	Weapon Spaces /7	MLv2 per ton
Standard Turret	Weapon Spaces /7	MLv1.5 per ton

Machineguns

Weapon	TL	Range	Damage	Spaces	Cost	Magazine	Magazine Cost	Traits
9mm Rotary Gun	11	1	4D	0.25	Lv5000	1000	Lv500	AP 2, Auto 20
Heavy Machinegun	6	2	6D	0.5	Lv80000	500	Lv400	Auto 5
Light Gauss Machinegun	12	0.8	4D	0.25	Lv10000	2000	Lv1000	AP 3, Auto 15
Light Machinegun	8	0.2	3D	0.25	Lv500	1000	Lv250	Auto 10
Medium Machinegun	7	0.5	4D	0.25	Lv800	500	Lv125	Auto 10

Automatic Grenade Launcher

Weapon	TL	Range	Damage	Spaces	Cost	Magazine	Mag Cost	Traits
Automatic Grenade Launcher	7	2	Varies	0.5	Lv5000	50	Lv2000	Auto 3

without penalty. Upgraded fire control can be added; DM+1 is available at TL10 for Lv10000, DM+2 at TL11 for Lv20000 and DM+3 at TL12 for Lv30000.

TYPICAL WEAPONS

The list presented here has some vehicle weapons that are often fitted as secondary weapons on spacecraft or interface vessels.

SMALL CALIBRE WEAPONS

These are vehicle-mounted versions of common portable projectile weapons.

MACHINEGUN

Machineguns are light automatic weapons that typically fire small arms ammunition. The heavy machinegun is an exception, somewhere between the lighter machineguns and autocannon in firepower.

AUTOMATIC GRENADE LAUNCHER

The 30mm automatic grenade launcher uses the same grenades as those launched from lighter weapons.

AUTOCANNON

These rapid-fire projectile weapons are common support weapons for combat landers and orbital assault craft.

TOHU TYPE-15 25MM AUTOCANNON

This is a light, single-barrelled fully-automatic 25mm chaingun. Unlike the similar, although recoil-operated Type-12, the Type-15 is powered by a chain from an external motor, giving it a much higher rate of fire than its ground-bound cousin.

RHEINMETALL BKR-25 25MM ROTARY AUTOCANNON

Utilising the same 25 x 161mm ammunition as the Type-12 and the Type-15, the BKR-25 features much greater firepower due it is extremely high rate of fire. It is often found in fighter aircraft and drones. Like the Type-15, it is powered by the vehicle.

DUNARMCO M8 'BOOMER' 75MM AUTOCANNON

The 75mm autocannon fires the heaviest chemically-propelled round in common use. The high rate of fire and destructive potential of the 75mm round sees it widely used by Tier 3 and lower militaries as a light tank weapon.

Autocannons

Weapon	TL	Range	Damage	Spaces	Cost	Magazine	Magazine Cost	Traits
Type-15	6	1	6D	1	Lv100000	500	Lv500	AP 10, Auto 10
BKR-25	8	1	6D	2	Lv250000	2000	Lv2000	AP 10, Auto 20
Boomer	7	3	8D	4	Lv500000	100	Lv400	AP 15, Auto 3, Blast 3

Mass Driver Cannons

Weapon	TL	Range	Damage	Spaces	Cost	Magazine	Magazine Cost	Traits
CMK-75	11	3	3DD	10	MLv10	40	Lv4000	AP 25, Auto 2
AMD-50	12	3	1DD	6	MLv8	50	Lv5000	AP 25, Auto 3
LGS-85	10	3	2DD	12	MLv8	30	Lv3000	AP 20, Auto 2
EMK-65	12	4	3DD	8	MLv12	60	Lv6000	AP 30, Auto 2

MASS DRIVER CANNONS

Mass driver cannons store enough power in their capacitors to fire 20 shots and typically recharge the capacitors at a rate of one shot per combat round. Additional capacitors can be added, with half a Space holding enough power for an additional five shots and costing MLv0.5.

CMK-75 (CONDUCTEUR DE MASSE HYPERKINÉTIQUE 75MM)

The CMK-75 is a last-generation weapon in common use in the hovertanks of France and many allied nations. Many older vehicles have been upgraded over the years to use this system. It was the first of the true hyperkinetic mass drivers, relying solely on a hypervelocity penetrator for effectiveness.

DUNARMCO AMD-50 (ADVANCED MASS DRIVER 50MM)

The AMD-50 is a next-generation coilgun design with improved cooling and a higher rate of fire than older designs. Like most mass drivers, it uses a hyperkinetic round without payload.

HYDE DYNAMICS LGS-85 (LINEAR GUN SYSTEM 85MM)

While the LGS-85 is capable of firing hyperkinetic rounds, it must use a discarding sabot to do so. It is otherwise capable of firing a multitude of rounds not commonly available to smaller calibre mass drivers, even lobbing shells in an indirect fire arc, something no other current mass driver can do. It is this flexibility that has kept the weapon in American inventories long after other nations moved to dedicated hyperkinetic platforms.

RHEINMETALL EMK-65 (ELEKTROMAGNETISCHES KANONE 65MM)

The EMK-65 premiered on the LkPz-IX hovertank and was subsequently used in the Raumwaffe's new Werwolf heavy combat lander. It is a compact and powerful weapon, firing hyperkinetic rounds typical of small-calibre mass drivers.

LASER WEAPONS

Laser weapons designed for vehicles do not resemble the large focal arrays required for space-based systems. These smaller weapons are enclosed within the hull and use mirrors and optical guides to redirect and aim the weapon. The internal capacitors on laser cannons hold enough power to fire 10 shots and recharge at the rate of one shot per combat round. As with mass drivers, additional capacitors can be added.

DARLAN LL-300 GATLING LASER

Gatling lasers cycle rapidly through multiple emitters to improve cooling, reliability and rate of fire. They do not actually spin, unlike their projectile-based equivalents.

HYDE DYNAMICS NLC/SEQ-17 HEAVY LASER CANNON

This high-powered laser cannon is an effective anti-armour and anti-aircraft weapon; it can even be used to attack spacecraft on re-entry. Its heavy weight and high power requirements restrict its use to large spacecraft with the energy (Power 5) required to fire this weapon.

Laser Weapons

Weapon	TL	Range	Damage	Spaces	Cost	Magazine	Magazine Cost	Traits
LL-300	10	3	6D	7	MLv1.25	200	—	AP 20, Auto 4
NLC/Seq-17	11	3	2DD	28	MLv10	40	—	AP 25, Auto 2
J-90	12	4	1DD	8	MLv12	60	—	AP 30

Canon Leger Pyrotechnique-1A

MAGSTAR J-90 LASER CANNON

Although slightly behind other nations, Manchuria's powerful J-90 laser cannon is used in their interface fighter craft. These weapons have a slower rate of fire than gatling lasers but compensate by channelling considerably more power into their shots.

PLASMA WEAPONS

There are a variety of plasma guns used as secondary, or even primary, weapons on military vehicles. All use the same plaser-cell technology as portable varieties.

QUINN-DARLAN PGVM (PLASMA GUN, VEHICLE-MOUNTED)

The PGVM is the Mk2A2 PGHP converted for use in a vehicular mount and provided with more effective cooling to increase rate of fire.

CLP-1A (CANON LEGER PYROTECHNIQUE-1A)

The CLP-1A is one of the heaviest plasma guns produced but is long out of production. Originally designed as a field gun, engineers later modified it for use in vehicles. There are rumours that the Tanstaafl colony has started unauthorised production of the weapon and its ammunition.

MISSILES

There are a number of missile systems available for use on ships, typically for use against ground targets, armoured vehicles or light aircraft. They can be effective against other spacecraft, however.

GISCARD AERO-12

The Aero-12 is an advanced silhouette-seeking missile that homes in on vehicle profiles. The heavy HEAP warhead is capable of punching most modern armour.

GISCARD AERO-27

The Aero-27 is a fast anti-aircraft interceptor missile, using a conventional explosive warhead.

GISCARD MANTA-1

The Manta-1 was one of the first generation of hyperkinetic anti-tank missiles, using a solid-fuel, air-breathing motor to achieve Mach 5 quickly after launch.

LUCHS

The Luchs is a hyperkinetic missile that launches at Mach 7 and damages its target solely through kinetic energy.

Plasma Weapons

Weapon	TL	Range	Damage	Spaces	Cost	Magazine	Magazine Cost	Traits
PGVM	12	0.25	5D	0.5	Lv25000	32	Lv175	AP 10, Auto 4
CLP-1A	11	1	1DD	4	MLv1.2	10	Lv1500	AP 10, Blast 10

Missiles

Weapon	TL	Range	Damage	Spaces	Cost	Magazine	Magazine Cost	Traits
Aero-12	12	4	8D	0.5	Lv14600	1	—	AP 16, One Use, Smart
Aero-27	11	20	3D	1	Lv50000	1	—	One Use, Smart
Manta-1	11	2	8D	0.5	Lv12000	1	—	AP 20, One Use, Smart
Luchs	12	4	8D	0.5	Lv10000	1	—	AP 20, One Use, Smart
Ohu	12	40	4D	1	Lv40000	1	—	One Use, Smart

OHU

The Ohu is a large, vehicle-mounted missile. The heavy warhead consists of three hyperkinetic submunitions that separate from the main body of the weapon when within one kilometre of the target, suddenly creating three targets for any anti-missile system.

BOMBS

Aside from the basic high-explosive bomb, there are a number of warheads available for 200 and 400 kilograms bombs.

200 KG HIGH-EXPLOSIVE BOMB

This is a typical high-explosive bomb, designed to cause concussion and fragmentation damage to its targets.

200 KG INCENDIARY BOMB

The incendiary bomb is loaded with jellied petrochemical fuel that sticks to anything its hits, burning intensely.

200 KG WASP (WIDE-ANGLE SCATTERABLE PROJECTILES)

The WASP is an area-denial cluster bomb, throwing out large numbers of bomblets over its area of effect. The Blast trait is for the warhead as a whole; each individual bomblet has the Blast 2 trait.

400 KG FAE BOMB

The fuel-area, or thermobaric, explosive, is the most powerful non-nuclear warhead available. It releases gaseous fuel over a large area and then ignites to produce an exceptionally powerful explosion with a massive shockwave.

400 KG WASP

A larger variant of the standard 200 kilogram model, with a larger area of effect. Each bomblet has the Blast 2 trait.

ROCKETS

RGU-70-8 ROCKET POD

A small pod containing eight small rockets with high-explosive warheads. They can be fired singly or 'ripple-fired' all at once. This is an uncommon weapon for spacecraft, as it cannot be used properly in a typical missile bay. The rockets can have basic guidance (Smart) for Lv100 per rocket.

M70 ROLAND ARTILLERY MISSILES

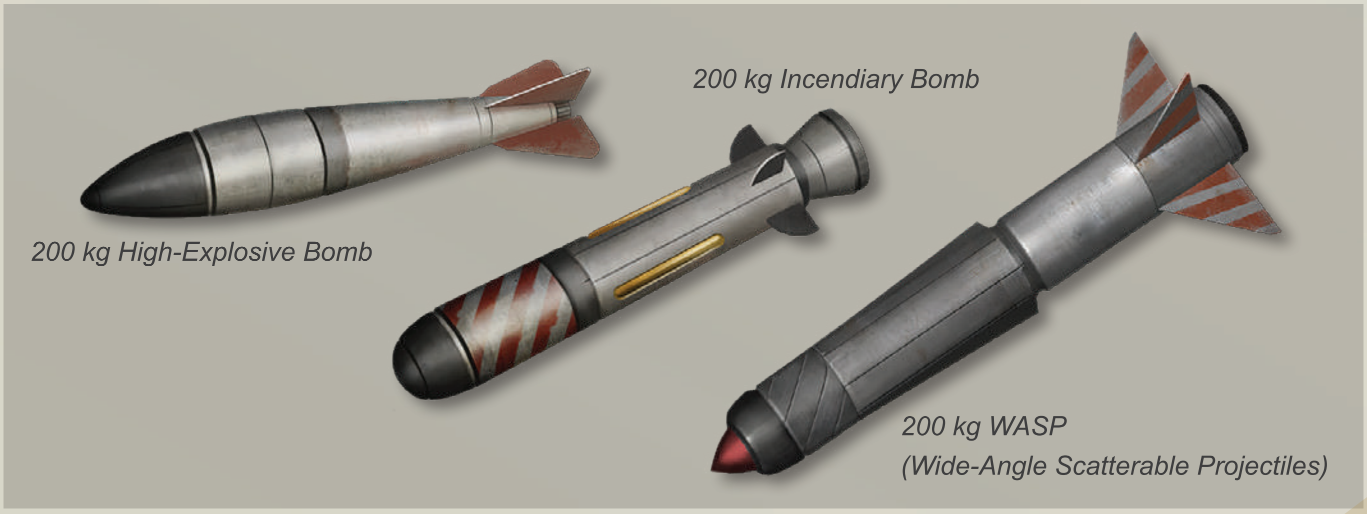
Artillery missiles are long-range missiles usually intended for static targets, although they do have some ability to strike a large, slow target like a surface ship or land ship. As the design advances, these weapons become smaller, faster and more accurate.

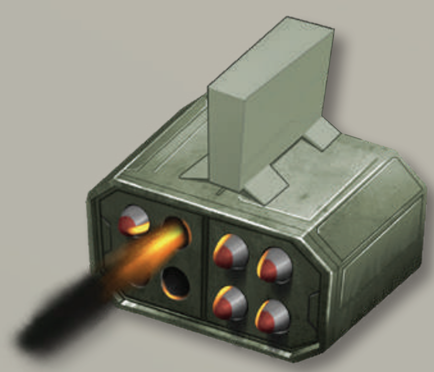
M27 MLRS-12 ARTILLERY ROCKET POD

This pod contains 12 large rockets with high-explosive warheads. Alternative warheads are sometimes used, including incendiaries and chemical weapons. Rockets can be fired one at a time or 'rippled' in a rolling salvo. This is another weapon not often found in spacecraft.

SONIC CANNON

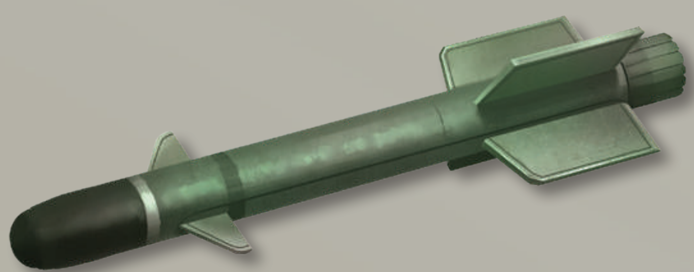
A large-barrelled stunner weapon designed for crowd control, it is also an effective military weapon against unprotected opponents. Use of this weapon at close range can result in permanent hearing loss and potential internal organ disruption.





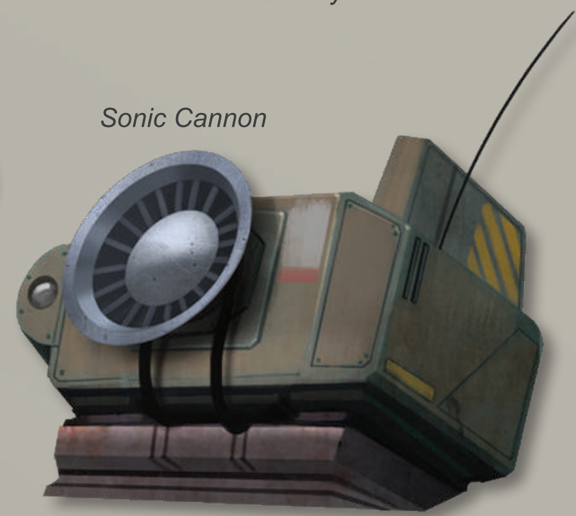
RGU-70-8 Rocket Pod

M27 MLRS-12 Artillery Rocket Pod



M70 Roland Artillery Missile

Sonic Cannon



Rockets

Weapon	TL	Range	Damage	Spaces	Cost	Magazine	Magazine Cost	Traits
Rocket Pod	8	1.5	4D	1	Lv50000	8	Lv1600	Auto 3, Blast 5
Artillery Missile Launcher	8	20	10D	3	Lv500000	1	Lv100000	Blast 20, Smart
Artillery Rocket Pod	6	8	5D	8	Lv300000	12	Lv24000	Auto 3, Blast 15
Sonic Cannon	11	0.2	5D	2	Lv125000	—	—	Auto 5, Blast 5, Stun

Bombs

Weapon	TL	Range	Damage	Spaces	Cost	Magazine	Magazine Cost	Traits
200 kg HE Bomb	10	2	1DD	0.5	Lv1500	1	—	Blast 10
200 kg Incendiary Bomb	10	2	8D	0.5	Lv2000	1	—	Blast 30, Fire
200 kg WASP	10	2	4D	0.5	Lv2500	1	—	Blast 30
400 kg FAE Bomb	10	4	2DD	0.5	Lv10000	1	—	Blast 50
400 kg WASP	10	4	4D	1	Lv10000	1	—	Blast 50

APPENDIX II: DRONES AND SUBMUNITION DESIGN

Drones are an important facet of space travel. These miniature, remote-piloted spacecraft are equipped with stutterwarp drives much like their larger counterparts, along with the computers and communications equipment to operate them.

Combat Drones

Human intuition plays a role in space combat that cannot yet be duplicated by computer systems. The targeting solution for starship weapons is a cone of probability and weapons are designed to saturate this cone in the hopes of catching the targeted vessel. The entire probability cone of a starship cannot be covered, however, due to the speed and unpredictability of stutterwarp ships. While there are self-guided combat drones, they are rare and largely ineffective.

Recon and Survey Drones

Recon drones are military intelligence-gathering platforms. Some operate under stealth with full heat sinks to passively observe opposing forces. Survey drones are designed to remotely observe planets and other astronomical objects. They are civilian designs and stealth is not a factor. They are similar to recon drones only in that they are remote sensor platforms.

DRONE AND SUBMUNITIONS DESIGN

Drones use many of the same design rules as ships, including power plants and drives. However, they also have some features that differ significantly from the ship design. Hull, sensors, communicators and weaponry, including warheads, are all features of drones that differ from spacecraft.

The design sequence for drones is a subset of the ship design system and uses many of the same concepts and rules. Any additions or deviations from those rules are detailed in this chapter.

Design Sequence for Drones

1. Choose Drone Body
2. Install Drone Controls
3. Install Sensors
4. Install Stutterwarp
5. Install Reaction Drive
6. Install Power Plant
7. Install Weapons
8. Choose Accessories
9. Finalise Design

Drone Body

When designing a drone, it is useful to determine what is needed and choose the minimum possible size of hull. This may require some tinkering back and forth until the most efficient size is achieved.

Cost for a drone hull is MLv0.01 per ton and includes the required control transceiver. Material modifiers from page 7 can be applied, as can hull traits from page 12. All drones are designed as spaceframes and most combat drones have the Disposable trait.

Drone Controls

Drones are fitted with remote-control systems, operated by a human pilot on a carrier. Some drones can be fitted with more sophisticated automated systems, requiring the installation of a more advanced computer. This computer consumes 0.05 tons and is double the cost of the computers listed on page 26. An autonomous drone requires Robotic Control software (page 29) in conjunction with a suitable computer. Unlike in a ship, the drone's computer just runs Robotic Control, not Manoeuvre, Stutterwarp Control or Intellect.

Sensors

While drones can make use of full-scale starship sensors, they more often use sensors tailored for the smaller size and lower power available to a drone. These systems have a lower range and are often less capable than their larger counterparts.

COMBAT SENSORS

Combat drones require specialised sensors for terminal guidance and targeting. Most targeting information is relayed to the drone by the carrier or another ship.

TL	Power	Tons	Cost	Attack Roll
10	0.1	0.1	MLv0.15	DM-1
11	0.15	0.05	MLv0.2	DM+0
12	0.2	0.025	MLv0.25	DM+1

MILITARY SENSORS

In addition to the basic targeting systems often used on combat drones, sensor suites like those found in ships can also be installed. While this is rare for a combat drone, military forces sometimes employ fast, specialised sensor drones to serve as the forward eyes of a ship or fleet.

Military sensors are much more capable than basic combat sensors, with ranges and capabilities in line with those installed in starships. The antennae for these sensors are often too large to be contained within a drone and must use extendable arrays, deployed after launch. These folding arrays have their extra cost and tonnage already factored in.

These sensor systems are equivalent in capability to standard ship systems. When the folding array is deployed, it adds +1 to the drone's Signature.

SURVEY SENSORS

Drones are often used to supplement the capabilities of exploratory and survey starships, and used to investigate targets of interest and identify whether more comprehensive investigation is warranted. More advanced versions can be left behind in a target system while the carrier moves on. These systems are more compact and require less power than standard drone sensors and are therefore more expensive. While not quite as capable as ship sensors, they represent a reasonable trade-off. Large drones can be built that will accommodate standard sensors but this is rare.

Stutterwarp

Use the rules on page 17 to design the stutterwarp drive for drones.

Reaction Drive

If a drone is designed to be used below the Wall, it requires a reaction drive, typically a rocket. Drones use the rules on page 14 for reaction drives. Adding a reaction drive to a combat drone can often make it unduly large, which affects stutterwarp performance. As such, boosters are often used to launch combat drones to enable them to reach the Wall.

Power Plant

Drones typically use fuel cells for power, although a larger model may use an MHD turbine instead. Long endurance drones, like system survey models, use solar panels and/or a radio-thermal generator. Fission and fusion reactors are not available for drones but all other power plant types are available.

Military Sensors

System	TL	DM	Comm Range	Includes	Power	Tons	Cost	Folding Array
Basic Military	11	+0	1 AU	Radar/Lidar, Passive EM, Visual, Jammers	5	2	MLv4	No
Advanced Military	12	+1	2 AU	Radar/Lidar, Passive EM, Visual, Jammers	10	3	MLv2	Yes
Very Advanced Military	13	+2	3 AU	Radar/Lidar, Passive EM, Visual	15	5	MLv4	Yes

Survey Sensors

System	TL	Power	Tons	Cost	Folding Array	DM
Basic Survey	10	1	3	MLv0.5	Yes	-2
Telescope	10	0	2	MLv5	Yes	—
Standard Survey	11	2	5	MLv1	Yes	-1
Advanced Survey	12	5	10	MLv2	Yes	+0

POWER STORAGE

Drone fighters normally carry batteries to power their weapons, rather than a power plant. While this limits the number of shots, it allows drones to be more compact. Each shot from the weapon requires its listed Power to be supplied from a battery, with each shot draining the battery by that amount.

TL:	12
Power:	10
Tons:	0.01
Cost:	MLv0.01

SOLAR PANEL

Solar panels are often used for long-duration drones, in particular sensor buoys.

TL:	12
Power:	10
Tons:	1
Cost:	MLv1

Bomb-Pumped Lasers

Nuclear bomb-pumped laser warheads are available in a wide variety of sizes and power levels, and used in both combat drones and submunitions. These weapons use the energy of a nuclear blast to generate coherent x-rays in a cone-shaped zone in front of the weapon. They have a very short range and only effective at Close range or nearer. As nuclear weapons, their ownership and use is tightly controlled by national governments.

- Warheads have a Damage score and also the Blast and Radiation traits.
- The size of a warhead is equal to 0.075 x Damage x Blast, in tons.
- The cost of warhead is equal to its tonnage x 1.25, in MLv.

Yield in kilotons equals the number of Damage Dice x Blast score x 6. So, a 5D, Blast 6 warhead will have a yield of (5x6x6) 180 kilotons.

Weapons

Combat drones mount offensive warheads, either single-use bomb-pumped lasers or other systems, including compact lasers, particle beam weapons and point defence clusters.

LASER ARRAY

The focal array and emitter unfold from the drone after it is launched and retract when the drone is recovered. Laser arrays cannot be used on drones that also have folding sensor arrays. A laser array takes one round to deploy and adds +1 to a drone's Signature.

PARTICLE BEAM WEAPON

Similar to larger models found mounted on starships, the particle beam weapon trades offensive power for combat endurance. They require substantially more energy than a laser array.

PDC-17

This early iteration of the point defence cluster is also common on civilian vessels that travel through contested space. On a drone, it allows a warship to attack combat drones and fighters while they are out of effective range of the ship. Similar to conventional laser arrays, point defence clusters have folding focal arrays and emitters.

PDC-29

The most recent military version of the point defence cluster is a British design widely copied by most western nations. Manchuria has a similar model that uses a different array configuration. The PDC-29 is more efficient and cycles more rapidly than the PDC-17.

Weapons

Weapons	TL	Power	Tons	Cost	Damage	Traits
Laser Array	11	10	1	MLv0.5	1D	Accurate
Particle Beam	11	20	2	MLv 2	3D	AP 2, EM, Slow
PDC-17	10	10	1	MLv1	1D	Accurate, Point Defence, Rapid Fire
PDC-29	12	15	1	MLv1.5	1D+1	Accurate, Point Defence, Rapid Fire

Accessories

There are numerous options available for drones, including decoys packages, communicators and electronic warfare suites.

COUNTERMEASURES SUITE

The maximum range of the countermeasures suite is Adjacent and it inflicts DM-2 to opposing Electronics (sensors) checks.

This compact countermeasures suite uses2 Power, requires two tons and costs MLv2.

Power:	2
Tons:	2
Cost:	MLv2

DECOY PACKAGE

Decoy packages are rated by the tonnage of the ship they are designed to emulate. A decoy is a large reflective balloon with an EM emitter and stutterwarp drive. To anything but a close range passive scan or a very skilled operator, it appears to be a ship. The actual stutterwarp signature cannot be emulated but it takes a skilled sensors operator and a GADS system to determine that.

Power:	1
Tons:	0.5% of tonnage of ship being copied
Cost:	MLv0.001 per ton of ship being copied

TIGHT BEAM RELAY

Tight beam transmissions follow straight, narrow paths and intercepting one is difficult, although not impossible. The only information required is the location of the transmitter and receiver. A tight beam relay changes that equation by rerouting the transmission, possibly even through multiple relays.

TL:	11
Power:	1
Tons:	1
Cost:	MLv1.5

Finalise the Design

Once all systems have been chosen and placed, adjust the size of the drone body to fit, if needed. This will likely require the stutterwarp efficiency to be recalculated.

Use the value of the power plant to determine Radiated Signature but do not include the value for the battery.

Power Rating	Radiated Signature
≤1	0
≤10	1
≤100	2

Most combat drones will have Reflected Signature 0, due to their small size. Those above 10 tons will have Reflected Signature 1.

Use the higher of Radiated Signature or Reflected Signature as the Base Signature. The modifiers in the Drone Signature table will apply to this. Note that a decoy drone will have two Signatures, for when the decoy system is deployed and when it is not. The Signature of the decoy will be identical to that of the ship it is imitating.

Drone Signature

System	Modifier
Sensor Array, Unfolded	+1
Laser Array, Unfolded	+1
PDC array, Unfolded	+1
Solar Panels Deployed	+1
RTG Power Supply	+1
Reaction Drive in Operation	+4

SUBMUNITIONS

A submunition is a bomb-pumped laser warhead, like a combat drone but without the drone body. It is dropped (or dispensed) by a ship, which relays targeting information to the warhead while it moves, clearing the blast radius in short order. The submunition orients itself in the direction of the target with an array of position-keeping thrusters and, on command from the carrier, detonates.

Submunitions can be designed to fill a variety of roles. A small, low-powered device might be useful against combat drones, for example, especially if it has a high Blast trait to strike multiple targets. Conversely, a powerful device with a lower Blast trait might be good against fighters or even starships.

There are two parts to the submunition system; the submunition itself and the dispenser to store and deploy it. The system also requires a targeting array, either a TTA, Light TTA, or UTES installed with the dispenser. This is not included in the cost of the dispenser and must be added separately.

Submunition Design

A submunition consists of a bomb-pumped x-ray laser warhead and the body. This body contains the communications equipment and positioning thrusters required to aim and fire the warhead. Unlike missiles and drones that are often reusable, submunitions are disposable.

The warhead design rules on page 135 are used to build the submunition warhead. Note that submunitions are usually smaller than the powerful warheads installed on combat drones. The tonnage of the submunition is equal to that of the warhead plus 0.05 tons for the fixed equipment. The total cost of the submunition is equal to the warhead cost + MLv0.01. All submunitions have Signature 0.

Dispenser Design

A dispenser contains the deployment system for the submunition, the weapon's magazine and a communicator to relay positional and targeting information. The dispenser uses a small linear motor to eject the round, arming the warhead as it does so. It is a simple and robust system, although the idea of carrying upwards of 20 small nuclear warheads is enough to give anyone pause.

The dispenser consumes 0.2 tons, plus the number of submunitions carried, multiplied by their size. The cost of the dispenser is MLv0.5 per ton.

The normal rate of fire on a submunition dispenser is up to 3 submunitions per round. A submunition dispenser can be designed to launch a large number of warheads at once, giving it the Auto trait. This uses a number of submunitions equal to the Auto trait multiplied by three. Adding Auto to the dispenser requires an increase in tonnage equal to the Auto score multiplied by the tonnage of the submunitions. Cost is MLv0.5 per Auto score (i.e., Auto 2 is an extra MLv1, while Auto 4 is an extra MLv2).

Submunition dispensers require Power 1, regardless of size, for their communicator and linear motor.

APPENDIX III: ALIEN SHIP DESIGN

Aside from humans, three other species have been contacted that design and build spacecraft. The Sung, with ion and plasma drive fast ships and stately solar-sail transports; the Pentapods with their organic, living starships and anomalous stutterwarp drives; and the Kaefers, with brutal, powerful warships packed to the brim with troops just waiting to ravage human worlds.

The ships for the non-human spacefaring species are created with the normal ship design system, for the most part. Each species also has special rules based on technological development, physical requirements and mental processes.

SUNG

When first contacted by humanity, the Sung were confined to their home system, travelling between planets using ion and variable plasma drives. The Sung are the only one of the three extant space-faring peoples that do not have stutterwarp drives. First contacted in 2248, Canada and Manchuria fought a brief space war against them in 2252, followed by landings and occupation of their offworld colonies. After two years of sporadic fighting, the Sung surrendered to the overwhelming technical superiority of human starships. Since then they have been requesting access to stutterwarp technology, a reasonable action under their cultural rules: a conqueror is responsible for lifting up the conquered to their level. This is a core concept of their culture, called Sos-Soon-Atkacharr and is the reason that the Sung homeworld is, despite a multitude of nations, uniform in technology, language and culture.

While they have consistently agitated for the technology transfer they felt entitled to under their laws and customs, they also realise that humans are not bound by their societal norms. It does engender a certain amount of hostility, however, and there have been attempts by some Sung nations to purchase stutterwarp drives illegally. Neither Canada nor Manchuria are keen to see Sung ships traipsing around the Manchurian Arm, potentially stirring up trouble and have been very careful to ensure that drives do not fall into Sung hands.

Sung Ship Design

Sung ships use most of the same components as human ships. Interior design features are different, however, as Sung are significantly shorter than humans and seating and other accommodations must take into account their wings. Humans find the interior of Sung vessels to be cramped and uncomfortable. In general, they only allocate half the space per person as human vessels.

With the exception of stutterwarp drives and some power generation methods, human and Sung technology is roughly comparable, with some areas slightly more advanced or slightly behind each other. Sung technology is more uniform between nations than human technology and is evaluated in this section as basic or advanced. Basic is roughly TL11, while advanced is TL12 or even TL13.

Most electronics are similar enough to use the same rules, although most Sung equipment is TL11 (basic) while military gear is TL12–13. Any changes between human and Sung designs are outlined below.

Hull Materials

Most Sung spacecraft use hulls made of synthetic material similar to human hulls but superior. Crystal steel is also available but the Sung version is not as effective as the human equivalent. Warships use ablative ice armour over the top of the synthetic hulls, rather than dedicated material armour. Most such warships also serve as transports and unless heavy armour is required for combat, these multi-purpose vessels can improve performance by travelling without.

Material	TL	Cost Multiplier	Max. Armour	Hull Traits
Aligned Crystal Steel	10	1.1	TL-4	Heavy
Synthetic	12	1.2	TL-2	Advanced, Reflected Signature -2

Hull Armour

Sung do not use Thermal Synthetic Ablative Armour (TSAA), only Fibre Reinforced Ice Armour (FRIA). Sung do not otherwise armour their ships, although if they had access to stutterwarp drives it is likely that they would.

As mentioned, Sung military spacecraft use ablative ice armour if conflict is expected. For long term travel, every five points of ablative armour adds 5% to a ship's travel time. If used on a stutterwarp ship, every five points reduces stutterwarp speed by 5% as well.

Hull Configuration

Sung do not use dispersed hulls or container ships. They do use modular vessels, along with spaceframes, lifting bodies and airframes.

Hull Traits

Sung ships do not use stealth technology.

Reaction Drives

Sung interface craft utilise liquid-fuelled rockets of a more advanced design than humans. They do not make use of magneto-plasmadynamic thrusters nor nuclear thrusters. Sung rockets are designed the same as human designs but require one less Burn for any given world Size and can still use the Advanced and Air-breathing traits. Sung-built interface craft are starting to appear on Manchurian colony worlds, although only in government service.

Power

Sung spacecraft primarily use solar power. As such, their solar power technology and power storage is more advanced than human designs.

Military craft also make use of fuel cells and MHD turbines in combat, when they fold vulnerable solar panels. Sung fuel cells and MHD turbines are effectively identical to human designs but they do not make use of nuclear power; they never developed fusion power and have a cultural fear of fission. There is a theory that the Sung suffered a nuclear war in the past, or perhaps nuclear power accidents. Another idea, almost a conspiracy theory, suggests that the ancient Ebers had contact with the Sung and in the course of the Eber's Last War, they also bombed the Sung back to the stone age.

Solar Panels

Only Sung military craft use extendable solar panels. All others use fixed panels, as these are the primary power source.

Solar panels are installed in banks of cells, with each cell producing Power 1 and having an area of 100 metres squared. Sung spacecraft cannot use more than one cell per 5 tons of vessel, due to the area of the fixed arrays. Extendable arrays are limited to one cell per 10 tons of vessel.

Solar Cell	Power per Ton	Cost per Ton
Basic	12	MLv0.25
Advanced	15	MLv0.5

Batteries

Sung batteries, like their solar panels, are more advanced than their human counterparts. Manchuria is actively trying to acquire and export the technology but the Sung are resisting, a form of push-back against the human failure to share stutterwarp technology.

Tonnage is per storage cell, which produces Power 1 per eight hours.

Battery	Tonnage	Cost per Ton
Basic	0.075	MLv0.25
Advanced	0.030	MLv0.5

Radiators

Sung make use of radiators for their ships but only the conventional variety. They otherwise use the same rules as human ships but do not use heat sinks.

Bridge

Sung ships use the same bridge, flight deck and cockpit types as human vessels, although sized for Sung. Humans attempting to use Sung controls suffer DM-4 to all checks. Sung use neural interface technology on their ships.

Computers

Sung computers are easily the equal of human varieties. Optical systems are standard for them, so they have the equivalent of /fib systems without paying an extra cost. Their software is also more optimised, resulting in a 25% reduction in required Bandwidth.

Sensors and Electronics

Sung have most of the same sensors capabilities as human ships aside from the GADS system, which requires a stutterwarp drive.

Weapons and Screens

Without stutterwarp, Sung weapons are relatively ineffective against human starships. This was a hard lesson from the Slaver War. Primary weapons on their ships are missiles, while secondary weapons include railguns with a few laser arrays and particle beam weapons. There is no equivalent of submunitions or detonation lasers.

STARHAMMER MISSILE

Sung missiles are housed in bays, similar to human drone weapons. The standard missile used by the Sung is the Starhammer, equipped with several different warheads, including a recon head. The missile itself is powered by a high-impulse rocket engine, with enough fuel for four rounds. Three Starhammer missiles consume one ton. In normal circumstances, a Sung missile will be unable to hit a ship in stutterwarp; it is effectively impossible, as the missiles are far too slow.

During the Slaver War, a pair of Sung mining boats managed to catch a Manchurian transport in orbit around Motherhome, the Xiang homeworld. Each boat fired six missiles at the ship, a mix of hyperkinetic fragmenting and standard explosive. The Manchurian crew barely had time to realise that they were under attack before five slammed home. The transport was crippled, although return fire from a pair of destroyers incinerated both Sung boats.

LIGHTNING SPEAR LASER ARRAY

The Lightning Spear is an effective laser weapon, with an array slightly larger than equivalent human designs, although not as power efficient. Most Sung ships do not use retractable arrays for the weapons; since they run on reaction drives, masking their signature is not an option.

FAST HAMMER RAILGUN BARBETTE

Human and Kaefer railguns are usually ortillery weapons, since they are not effective against stutterwarp ships. Sung, however, use them as the primary backup weapon to missiles in an anti-ship role. They are not effective against stutterwarp ships but can sometimes get lucky.

Drones, Probes and Remotes

Without stutterwarp, the type of drone used by human and Kaefer space forces does not exist. Sung do make use of remote objects like probes, repair remotes and satellites but nothing like human combat or recon drones.

Non-stutterwarp probes, remotes, and satellites are available for Sung spacecraft, at the same size and cost.

Small Craft

Sung vessels can have berths and hangars like human ships. However, most sub-craft are kept in external slings for flexibility and deployment speed. Sung ships otherwise use the same rules for housing sub-craft.

Crew

Sung ships use the same rules for determining crew numbers as human ships but the dimensions and shapes of Sung ships are significantly different than human ships. Ceilings are lower and rooms and

Starhammer Missile

Weapon	TL	Thrust	Damage	Tons	Cost	Traits
Ortillery	8	3	3DD	3	MLv1	Smart
Fragmenting	12	6	6D	3	MLv0.65	AP 10, Burst 8, Smart
Standard	7	6	8D	3	MLv0.15	Smart

Lightning Spear Laser Array

Weapon	TL	Range	Power	Damage	Tons	Cost	Traits
Lightning Spear	11	Close	20	1D	1	MLv0.50	Accurate

Fast Hammer Railgun Barbette

Weapon	TL	Range	Power	Damage	Tons	Cost	Traits
Fast Hammer	12	Adjacent	60	3D+3	4	MLv2	AP 10, Slow

corridors are wider. All internal spaces are scaled and sized for Sung and are very uncomfortable for humans. They do not use racks or bunks.

Accommodations

Sung ships use small staterooms as the equivalent of a full stateroom.

SLEEPER

Sung have a unique type of accommodation, the sleeper. A sleeper has enough space for one Sung and contains a pop-up fresher that retracts into the floor and wall when not in use.

Tons:	1
Cost:	Lv0.01

Artificial Gravity

Most Sung ships will have retractable spin habs to provide artificial gravity. They do not make use of spun hull or double hull designs, as their ships are too small.

Internal Fittings

All internal fittings are available; however, they only need to be half the size of human fittings due to the smaller size and lighter mass of the Sung. The cost remains the same.

FLIGHT SPACE

Flying is necessary for Sung psychological health. All ships have an open volume available for crew and passengers but most will have to take turns, as with exercise equipment.

Tons:	10 per Sung
Cost:	MLv0.1 per ton

External Fittings

All external fittings are available for Sung spacecraft.

Finalise Design

Sung ships are finalised the same way as human ships. They also use the same rules to determine Signature.

PENTAPODS

First encountered in 2251 in the DM+36 2219 system, Pentapods are masters of biotechnology. Their entire technical infrastructure, with a couple of exceptions, is built on manipulated and engineered life forms based on the Pentapods themselves. They appear to make little differentiation between themselves and their technology.

One of the areas in which the Pentapods appeared to have achieved accidental success is their stutterwarp drive. They lack much of the technical legacy that provided stepping-stones for humans to develop the drive and there is no evidence they ever developed anything like the Generation I drives that fuelled human exploration in the mid- to late 22nd Century. On the contrary, they appear to have somehow stumbled upon Generation II drives. At the same time, some sociologists have speculated that non biotech or 'dead|tech' as Pentapods call it, might be a source of shame or prejudice in their society. As the vast majority of Pentapods appear to utterly ignore space travel, there may be some validity to this.

Pentapod starships are alive and self-aware, intelligent beings engineered into starships. The hulls are clearly organic in nature and once inside it is very much obvious that they are living beings. No human has ever got a close look at the internal structure of a Pentapod ship. At one point, when the French government offered to sell the Pentapods new drive technology, they refused. They appear to have no desire to change their drive technology.

Pentapod Ship Design

Pentapod ships show the greatest divergence from typical human ships, not just in shape but in materials as well. They are relentlessly biological.

Hull

Pentapods use two different hull materials. Exoskeletal chitinous hulls are used in interface and paramilitary craft. The more common viscous hulls are used in the majority of starships, which resemble gargantuan jellyfish.

Material	TL	Cost Multiplier	Max. Armour	Hull Traits
Chitinous	12	x2	TL-3	Lightweight, Reflected Signature -2
Viscous	12	0.25	N/A	—

A Note on Cost

Alien ships are rarely, if ever, available for purchase. 'Cost' is calculated for comparison and maintenance purposes, not with the intent that the ships could be purchased by rich Travellers.

Armour

Only the chitinous hull can be armoured, with a combination of reinforcement and additional hull material.

Armour	TL	Tons	Cost	Max. Armour
Chitinous	12	7%	2%	TL-3

Hull Configuration

Pentapod ships are designed with a variety of hull configurations. Viscous ships can only use spherical or amorphous hull configurations, while chitinous hulls must use lifting body hulls, darts or spiders.

SPIDER HULLS

Spider hulls look like giant, multi-legged insectoid craft. They are the most common of the chitinous hulls but are rarely seen in human space. The legs of the craft act as manipulators and tools, and can support the ship's weight in conditions of up to 0.1G. Some versions of these hulls are dubbed 'skorpions', for a large tail-like structure that contains a heavy manipulator or other biological device.

DART HULL

Dart hulls are similar to ballistic hulls but tend to be longer and more slender. They are the most common configuration for Pentapod interface craft.

LIFTING BODY

Pentapod lifting bodies bear a distinct resemblance to thick-bodied Terran mantas or rays, although they lack tails. The most iconic Pentapod starship in the popular imagination is the sinister-looking Type III Defensive, the VoidShark, which is built in this configuration.

Chitinous Hull	Hull Points	Cost	Notes
Spider	+10%	+10%	Unstreamlined
Dart	—	+10%	as Ballistic Hull
Lifting Body	-10%	+20%	—

Viscous Hull Configurations

Viscous hulls are designed solely for use in space and the common configurations reflect that. The exterior of viscous ships is covered by a thick layer of gel, which protects the hull from spaceborne dust and debris. The outer layer of this gel is a long-chain organic polymer that is vacuum-resistant and includes unusually strong intra-molecular bonds, which protects the inner layers from outgassing and non-ionising radiation. In the event of hard ionising radiation, the chains of the polymer break and go opaque to short wavelength energy, protecting the ship but leading to vacuum damage in prolonged exposure. Once the event is past, the hull sloughs off the damaged area and begins to regrow the outer layer.

AMORPHOUS HULL

The amorphous hull has the appearance of a jellyfish and slowly pulses and undulates as it moves. The shape is constantly changing in response to stimuli to the ship-brain controlling the vessel.

SPHERICAL HULL

The spherical hull is somewhat more rigid than the amorphous hull and while it too exhibits some movement, pulses and shudders in the outer hull, it does not shift shape the way the amorphous hull does. It otherwise keeps to a spherical or oblong shape.

Viscous Hull	Hull Points	Cost
Amorphous	-50%	-50%
Sphere	—	—

Vascular Network

The vascular network on a Pentapod starship is an internal system of muscular tunnels through a ship, used as part of the life support system for the ship to manage fluids, convey nutrients and route electrical power from the accumulator. It can also be used to transport larger items, like a Bishop or one of the smaller diplomats, to anywhere in a ship within 30 seconds or less.

Tons:	10% of ship tonnage
Cost:	MLv0.1 per ton

Stutterwarp Drives

Pentapods have access to only two specific stutterwarp drives. Human scientists and engineers have often questioned why Pentapods appear to have only these drives and do not create other designs. Pentapods do not appear to understand the question.

CLASS I DRIVE

The smaller of the two drive systems available to Pentapods, scarcely more powerful than a human-made drone drive.

TL:	12
Power:	2
Tons:	0.75
Cost:	MLv1

CLASS II DRIVE

In contrast, the Class II drive often seems over-powered for many of the applications that Pentapods use it for. This drive is used in small Starpigeon and the Voidshark to give them their formidable speed.

TL:	12
Power:	70
Tons:	4.5
Cost:	MLv6.0

Reaction Drives

Pentapod ships use organic rockets, or bio-rockets, to achieve low orbit. They consume more fuel than human designs, so ships that can make the Wall have limited capacity. At Pentapod worlds, there are booster systems in low orbit that lift ships to the Wall.

ORGANIC ROCKET

Pentapod bio-rockets are self-contained and are designed much the same as human thrusters.

Bio-rockets are rated according to the Size code of the world they are designed for. These organic drive systems consume 0.75% of a craft's tonnage per Size code but do not require external power. They cost MLv0.5 per ton.

Fuel for organic rockets consumes 5% of the hull per Burn Point. Pentapod craft do not have boosters or external fuel tanks available. They can use the Advanced, Low Orbit and Air-Breathing traits but not Crude or Disposable.

LIFT ENVELOPE

Pentapod ships can be fitted with a hydrogen lift envelope, allowing them to drift in an atmosphere without consuming propellant. It can also be used to lift a ship to the edge of the stratosphere, where the organic rocket can engage. This lowers the effective world Size by -1 for interface travel time and fuel requirements. To perform this, however, the lift envelope must be jettisoned and the manoeuvre cannot be repeated until the lift envelope is regrown. When inflated, the lift envelope is three times the size of the ship.

The voyage to the edge of the stratosphere takes a number of hours equal to the world's Size code. Regrowing the lift envelope requires a number of days equal to the tonnage of the lift envelope, assuming a sufficient quantity of biomass is available.

Tons:	5% of ship tonnage
Cost:	MLv0.5 per ton

Power

The common methods used by other species are not available to Pentapods. Instead they use biological processes to generate and store power required by the stutterwarp and any human technology. Pentapod ships do not require power for life support and basic ship operations.

THERMODYNAMIC ACCUMULATOR

The power required to charge up and power a starship's stutterwarp drive comes from a thermodynamic accumulator. The system generates and stores electrical power, using the difference in temperature between the dayside and nightside of a ship in vacuum in direct sunlight. Unless a ship mounts human-made weapons or electronics, no further energy is required. The remainder of the ship's requirements are met by its biological processes.

Accumulators require both the thermal panels on the exterior of the craft, plus organic batteries to store Power to operate the stutterwarp when the ship is in darkness between stars. Lifting body hulls only generate half the Power.

Ships equipped with the thermodynamic accumulator have Radiated Signature 0 unless rockets, the tether system or human-made electronics are in use.

TL:	12
Power Generated:	1 per ton per hour
Tons:	0.1 per Power
Cost:	MLv0.75 per ton

Radiators

Pentapod ships do not require radiators unless they mount human-made sensors or weapons, then they must be equipped with radiators equal to the Power required by the weapons or sensors.

Bridge

Pentapod ships do not require a bridge or a computer. Instead, they have a portion of the ship set aside for the controlling intelligence and its biological requirements. The Pentapod term for this roughly translates as 'prime node|controller'. Like most Pentapod constructs, it is self-aware.

Sensors and Electronics

Compared to human vessels, the sensory capabilities of Pentapod craft are decidedly limited. Although they had developed radio by the time of first contact, they were only just beginning the development of radar. Human contact helped them achieve that milestone. They also have some unusual optical systems, including some sensitivity down to the high frequency microwave/radio range and up to extreme ultraviolet/ soft x-ray. The latter systems tend to be short-lived, destroyed by ionising radiation.

Prime Node|Controller

STR —	DEX 12	END —
INT 10	EDU 9	SOC 8

Pilot (small craft or spacecraft) 2, Engineer (Pentapod systems) 2, Recon 1 and other appropriate skills at level 0–1

Tons:	10% of ship tonnage
Cost:	MLv1 per ton

Pentapod Optical Systems

To be clear, although the term 'optical system' is used, what is really being talked about are eyes, in a variety of configurations and sizes. Some are disturbingly large and can only be installed (grown?) in viscous hulled ships.

PENTAPOD RADIO

Even with superior human 'dead tech' available, Pentapods prefer to use their own developments whenever possible. Unlike in human vessels, the communications system is not included as part of the bridge.

Power:	1
Tons:	0.1
Cost:	MLv1

NAV RADAR

With human help, Pentapods were able to develop navigational radar. It uses a 'dead tech' antenna to broadcast radio waves but a Pentapod optical system to see and interpret reflected signals. Most of the size of the unit is the large optic.

Electronics (sensors) DM:	-1
Power:	1
Tons:	4
Cost:	MLv2

Optical/EM Sensors

There are four categories of optical sensor available for Pentapod starships and each category is available in two formats: standard and high resolution. In general, high resolution optics are simply much larger.
All of these systems are passive and require no power.

High resolution optics grant DM+2 on Electronics (sensor) checks.

HF RADIO OPTICS

A simplified version of this optical system is included with the nav radar system. This version is similar to human-made radio telescopes, especially the high-resolution format.

TL:	12		
Tons:	0.5	**High Resolution:**	10
Cost:	MLv1	**High Resolution:**	MLv10

MICROWAVE OPTICS

These systems are sensitive to microwave/radio and used for most communications, as well as monitoring low-intensity heat sources. The high-resolution version is good at detecting subtle variations in background heat and emissions in space, including ships using heat sinks and stealth to avoid detection.

TL:	12		
Tons:	0.1	**High Resolution:**	5
Cost:	MLv1	**High Resolution:**	MLv5

NEAR-INFRARED/NEAR ULTRAVIOLET

Most ships will have this system and interface craft require it. It is capable of fine range finding and depth perception. The high-resolution format is often employed for astronomical observations or to survey planets from space.

TL:	12		
Tons:	0.01	**High Resolution:**	1
Cost:	MLv0.1	**High Resolution:**	MLv1

EXTREME ULTRAVIOLET/SOFT X-RAYS

This system is rare, as exposing biological optical systems to ionising radiation rapidly destroys them. Nor does it seem to have a clear purpose, aside from the sort of astronomical observations that the Pentapods do not seem to be interested in.

TL:	12		
Tons:	0.05	**High Resolution:**	2
Cost:	MLv5	**High Resolution:**	MLv20

HUMAN-MADE SENSORS

Human-made sensors can be added to Pentapod starships. These require 50% more space and are double the cost. Sufficient Power must be available and radiators are required equal to the Power requirement of the sensors.

Weapons and Screens

There are a few specialised weapons available for Pentapod starships but they are all intended as close range devices, usually within an atmosphere or at least almost touching. Ship-to-ship weapons were almost unknown before contact with humans.

Any of the biotech weapons from the *Vehicle Handbook* can be added to Pentapod ships. In addition, the following are also available.

BIOLASER

Along with the pheromone missile (see page 146), the biolaser is the only weapon useful at starship combat ranges. While this weapon requires Power, unlike human weapons installed in Pentapod ships it does not require radiators. In comparison to human designs, it is not very effective, however. It inflicts DM-2 to each segment of the targeting solution.

HUMAN-MADE WEAPONS

Human-made weapons can be added to Pentapod starships. Like sensors, sufficient Power must be available and radiators have to be added equal to the Power requirement of the weapon. A TTA or light TTA must be added as well, with the same requirements. Weapons and targeting arrays require 50% more tonnage and cost double the normal amount.

SCREENS

Pentapods do not have an equivalent of screens, although they can make use of human designs. Again, like other human technology, sufficient Power must be available and radiators must be installed to handle the Power load. These systems require 50% more tonnage and cost double the normal amount.

Biolaser

Weapon	TL	Range	Power	Damage	Tons	Cost	Traits
Biolaser	12	Adjacent	20	1D	2	MLv1	Slow

Drones

Pentapods have a variety of drones available, one of which was the only space-capable weapon in use before contact with humans. Like most such technology, these drones are self-aware. At the same time, these drones are considered disposable and even the drones themselves readily accept this fate. This often makes humans uncomfortable. Analogues to human-made repair and inspection remotes can be created by most ships on an as-needed basis. These biological devices are not self-aware, unlike most Pentapod constructs.

PROBE DRONE

Probe drones are used to remote examine distant objects and communicate data back to the main craft. They make use of the Pentapod biological radio for communications and may mount specialised optical systems. The version here is equipped with both the microwave optical system and near-infrared/near ultraviolet system.

In addition, the drone is also fitted with a cluster of five tentacles for manipulating objects and is able to grow a single use heat shield, if necessary, in order to make planetfall. It is not equipped to return to orbit.

Name: Hunter|Searcher
Country: Pentapods
Year: Unknown
In Service: Unknown
Sensors: High Resolution Near Infrared/Near Ultraviolet, Microwave Optical

PHEROMONE MISSILE

Until the biolaser was developed, this was the only offensive armament carried by Pentapod craft before contact with humans. It is specifically designed for use against other Pentapod craft and must make contact with the target. Needless to say, this is extremely difficult in the context of stutterwarp drives.

Like all Pentapod constructs, the pheromone missile is sentient, if not necessarily fully self-aware. While Pentapods see no ethical issue, most humans are less sanguine. Rumours that some of these missiles have been modified to carry human-made detonation lasers makes the ethics even more questionable, at least from a human perspective.

Once the missile closes to within a few kilometres of its target, it fires dozens of small darts in a wide cone. Even if only one of these darts strikes the target, it will inject the tailored microbial constructs that manufacture loyalty hormones and pheromones, converting the prime node and all other secondary nodes in the target to the side of their former opponent. Independent constructs on the ship would not be affected initially but within 10 hours all would be converted as they integrate with the ship to receive nutrients and programming.

Name: Unknown ('Pheromone Missile')
Country: Pentapods
Year: Unknown
In Service: Unknown
Sensors: Near Infrared/Near Ultraviolet

Small Craft Berths

Any biotech small craft or vehicle only requires a niche an opening in the material of the hull just big enough to fit it. In a niche, a vehicle requires no more than its tonnage for stowage and a niche can conform to larger or smaller vehicles as long as internal space is still available. There is no cost for a niche, and the vehicle can be accessed from the ship via sphincter.

Human vehicles can likewise be carried, although they require tonnage of a minimum 10% over and above their size. There is no cost to this, the ship must simply have internal space available.

Crew

A Pentapod ship does not require crew. Instead, it uses secondary nodes. Two nodes are required for each bridge position to ensure redundancy and stability. These nodes are scattered throughout the ship, as there is no definable bridge on a Pentapod ship. A node is also required for each weapon fitted, each additional sensor and one if any manipulators are installed. Nodes can also be grown to function as combination laboratories and researchers, or studios

Drones

Drone	TL	Weapon	Endurance	Tac Speed	Hull	Tons	Cost	Traits
Probe	12	None	Unlimited	5	1	2.7	MLv8.9	–
Pheromone Missile	12	Pheromone Load	Unlimited	9	1	1	MLv6.53	–

and professionals, although each node is specialised to one task only (choose a Science or Profession skill at level 3). Nodes not initially installed require a Maker, which only the largest, most secure ships would carry. Each Node requires one ton and costs MLv2.

Tons:	1
Cost:	MLv2

Accommodations

A Pentapod ship only requires accommodations if it is carrying passengers.

CYST

A cyst is a life support chamber within the hull of the ship. It is connected to the vascular network, so the occupant of the cyst can be delivered anywhere on the ship within 1D rounds. They are similar in purpose to human cryoberths, although any construct occupant can be instantly awakened and alert.

Cysts are not suitable for humans. A human in a cyst will be immobile and suffer one point of damage per hour until released from the cyst. It is possible to create a cyst that can support a human, at least for a while, but it could not support a Pentapod.

The most common occupant of cysts are Pentapod diplomats and agents, often with several of the same cohort onboard. Neural connections in the cyst allow the transfer of memories between all Pentapods of the same type carried in the cysts or to the ship. Another common occupant is a Bishop, a combat-form construct able to move with disturbing speed and armed with weapons ranging from sword-like blades to a biolaser.

A cyst can hold one Pentapod up to 200 kilograms in size. There is no cost for a cyst; as long as space is available, a ship can form a cyst at will.

Tons:	0.1
Cost:	None

ALCOVE

For Pentapods and other constructs on a ship that need to be free to move about, the alcove is an indent off the main chamber of the ship, giving a place to rest and possibly perform individualised work. There is no privacy to an alcove, it is literally just a hole in the wall. As long as space is available, a ship can form an alcove at will.

Tons:	1
Cost:	None

CHAMBER

A chamber is separated from other areas of the ship and can only be accessed through a door-sphincter or via the ship's vascular network. A chamber consumes any amount of space available, at no cost. As long as space is available, a ship can form a chamber at will.

FURNISHINGS

Provided the ship understands what is wanted, functional furniture and amenities can be provided at will, including fresher facilities. The ship will not make any attempt to conceal the true nature of the furnishings, which are obviously organic in form if not function.

HUMAN ACCOMMODATIONS

Pentapod ships can have rooms and even sections adapted for human comfort. These areas are either grown to specification or else prefabricated by human shipyards and installed by the Pentapods (the installation process is somewhat disturbing and not recommended for those with weak stomachs).

These accommodations require the same tonnage as the standard human version but are double the cost.

Fittings

Most options are available for Pentapod hulls, although in biological form. For example, manipulators might be tentacles, while an airlock is a chamber with sphincter valves leading into the ship. These fittings will have the same requirements (Power, tonnage, cost) as human versions.

Some fittings are not available or are changed. A lab or a studio can be installed but more often a ship will grow another node to perform that function.

Spin gravity facilities are not available on Pentapod ships, while something like a fresher would only be installed to facilitate human comfort.

Medical facilities are uncommon; if a Pentapod or construct gets injured, it either heals on its own or dies. As long as its experiences are backed up to the ship, its fate is irrelevant, at least to other Pentapods. If a construct or Pentapod form is injured and makes it back to the ship, the most likely occurrence is for the ship to fold them into a cyst, transfer their memories out and then render them for biomass.

Life Support

Pentapod starships are self-contained and do not need anything from the outside environment under normal operations. There are some things they require, biomass and fuel being foremost.

BIOMASS REQUIREMENTS

Biological starships require sustenance for energy and to build and heal the ship. While a ship can survive on its internal resources for a long time, eventually a lack will start to affect performance. If things get desperate, it is possible, even likely, that a ship would consume any passengers or constructs onboard. Organic material used to feed the ship and as raw material for construction and healing is known as biomass. Ships are not overly fussy about what they eat but require biomass to be processed to a slurry so it can be properly utilised. For frontier consumption, it can create a processor, which consumes 5% of the ship's tonnage, to process biomass into a form the ship can use. It will then reabsorb the processor.

STORAGE AND CONSTRUCT CREATION

A ship can use its stored biomass to create other constructs, from diplomats to Bishops to resource harvesters. If it has used all its biomass storage to remain alive, then it loses the ability to create constructs. The amount of biomass required to create a construct depends on size but usually works out to one and a half tons of biomass for every ton of construct. The time required to grow a construct is three days per ton. Note that components like radio antennas and stutterwarp drives cannot be made by a ship.

A ship requires 10% of its hull tonnage in biomass every 100 Pentapod days (about 75 terrestrial days). If it does not get this biomass, there will be no discernible impact for the first week. After that, the ship will start losing 1 Hull point a week. While in this state, the ship cannot heal, grow or replace nodes, create cysts, alcoves or chambers, and cannot recharge any bioweapons. It will also be unable to regenerate a lift envelope. In addition, it will lose a point of Power production every week, which will start to have an effect on the stutterwarp drive.

Healing

A healthy ship can heal one point of Hull damage per day, along with regenerating a node or any critical hits. If it has access to biomass, it can repair all damage in short order, at a cost of five tons of biomass per point of hull, node or critical hit. As long as biomass is available, this rapid repair will take a day.

Signature

Pentapod spacecraft do not require heat management. Their thermal generation panels effectively absorb much of a ship's waste heat, if the ship is in vacuum, while their hulls act to efficiently dispose of much of the remainder.

A Pentapod ship equipped with a thermodynamic accumulator has a much-reduced Radiated Signature and unless a rocket is in operation, Radiated Signature is 0.

Viscous hulls are low-density biological material and present a very small cross-section to active sensors, despite their size. These hulls effectively have the Stealth trait at no cost. Chitinous hulls have a lower Reflected Signature than a human-built synthetic or composite hull and can be grown with the equivalent of the Stealth trait for double normal cost. Even without the Stealth trait, chitinous hulls gain -2 to Reflected Signature.

Pentapod Stutterwarp

Human engineers and scientists are intensely curious about Pentapod stutterwarp drives and the line of thought and experimentation that led to their construction. For their part, the Pentapods refuse to let humans see their drives and are reticent to discuss their 'dead-tech' programmes. Some sociologists hypothesise that there may be a cultural taboo against talking about it, that it is somehow 'dirty'.

Pentapod Shipboard Constructs

Pentapods ships carry a variety of semi-independent constructs on their ships to perform independent tasks. Including maintenance, resource harvesting and defence. Of these, the defensive construct known as a Bishop is by far the most dangerous.

ARTWO MAINTENANCE CONSTRUCT

The so-called 'Artwo' is a squat five-limbed construct, engineered to withstand heat, radiation and vacuum for extended, although not indefinite, periods of time.

While a Pentapod ship can heal damage over time, sometimes damage needs to be repaired immediately. The 'mechanical displacement organ' cannot be simply healed, much to the consternation of Pentapod ships, and often require maintenance. Pentapod drives are somewhat temperamental devices and each one is apparently 'hand' built, so they require almost continual maintenance.

The Artwo constructs have incredible dexterity and share with their diplomatic counterparts' keen observational skills and problem solving, although in a narrowly-defined field. Like many other constructs, they are incapable of feeding themselves and rely on a ship or structure to provide nutrients via a cyst.

Artwo

STR 5	DEX 14	END 8
INT 11	EDU 4	

Athletics (dexterity) 1, Engineer (stutterwarp) 1, Investigation 4, Medic 2, Recon 2

Armour: Tough Outer Integument (+4)
Traits: Heightened Senses (+2), IR/UV Vision

THE BISHOP

Bishops are humanoid shapes in chitinous black armour, with three upper limbs and two lower, although one of the upper limbs is kept retracted into its chest. They have no visible eyes or sensory organs but can absolutely detect anyone, even if they are concealed by thermal-visual camouflage.

Bishops are armed with carbon monofilament blades that slide out of two of their arms, along with a powerful biolaser in their third arm, which folds out of the chest to fire. Their movements are very quick, but jerky, and their joints move in unexpected ways. People who have encountered a Bishop say they are profoundly disturbing.

They can withstand complete vacuum and extremes of heat and cold that would kill a human. They depend on a ship/host for their food supply, although are capable of feeding off whatever they kill. They do this by absorbing nutrients through the bases of the two arm blades, where they have a sucker-mouth protected by armour.

Among the smartest of Pentapod constructs, Bishops are chemically-imprinted to protect a certain structure, vehicle or construct. They have limited free will and really exist only to fight. In a structure or ship, they will bide their time in cysts, waiting to act. They can travel quickly throughout thanks to the vascular network, able to exit the network anywhere.

Bishops are best treated as characters rather than animals. They have no internal hierarchy, answerable only to those they are imprinted with and any Maker.

All Bishops encountered will have the same characteristics.

Bishop

STR 8	DEX 11	END 9
INT 7	EDU 4	

Athletics (dexterity) 2, Gun Combat (energy) 2, Melee (blade) 2, Recon 2, Stealth 4

Weapons: Carboglass Arm Blades (3D, AP 10), Biolaser (4D, 10 m)
Armour: Chitinous Exoskeleton (+10)
Traits: Camouflaged, Fast Metabolism (+3), Heightened Senses (+2), IR/UV Vision

KAEFERS

At the frontier of human space, the Kaefers made their presence known in 2295, entering the Arcturus system and approaching the outer system dwarf planet that serves as a discharge point. During that time, Station Arcture, studying the red giant, received signals from the visitor. Station personnel responded according to protocols that had been established after first contact with the Pentapods but there was no common ground to provide a starting point. After approximately 40 hours, the alien vessel, drive discharge complete, returned to wherever it had originated.

Two years later, the Kaefers invaded. First they captured Station Arcture, then invaded the distant colony world of Aurore. After handily destroying the human ships defending the colony, the aliens bombed everything that resembled an industrial site, fuel depot, airport or spaceport. Only then did the warship in orbit land legions of troops, which then proceeded to kill everything in their path. Their genocidal campaign against humans exceeded even the most horrific atrocities of humanity's long, dark past.

When human fleets returned in 2299, the remaining Kaefers fought hard. Even with numerical odds against them, Kaefer ships and crews proved superior, although they did lose in the end.

Kaefer Ship Design

Kaefer spacecraft tend to be large and blocky, similar to human spaceframes but with a far different design aesthetic, resulting in odd angles and hull protrusions with an unknown purpose. Kaefer technology is roughly equal to human equipment, although often more robust and consequently heavier. Computers tend to be much bulkier and unlike human spacecraft with distributed computer systems, Kaefers isolate computers in vault-like rooms near the centre of the ship, next to the buried command and control centres.

As a result of this increased robustness, Kaefer electronics consume 50% more tonnage than human designs. This includes stutterwarp drives but not reaction drives. Kaefer stutterwarp drives can be manufactured at up to TL13 but this is not common. Most military craft have TL12 drives.

Hull

Most Kaefer spaceframe hulls are made from aligned crystal steel, usually heavily-armoured, while interface craft use a composite material. A few advanced spaceframes appear to make use of armoured composite hulls, but these are the minority.

Stutterwarp Drives

Kaefer stutterwarp drives are bulkier than human models but very effective, with drives available at TL12 and TL13. The initial design is the same process but the formula for size is different.

Stutterwarp drives consumed space based on the Power requirement of the drive and Tech Level. The Tech Level of the drive does not have to match the Tech Level of either the hull or power plant. The size in tons is equal to three, multiplied by the square root of the Power divided by the Tech Level Modifier of the drive:

$$3 \times \left(\sqrt{\frac{P}{TSM}}\right) = \textit{Drive Tonnage}$$

P = Power Dedicated to Drive
TSM = Tech Level Size Modifier (TLM + 4)

Cost is equal to six x the tonnage of the drive.

Reaction Drives

Kaefers use both rockets and thrusters for interface travel, although thrusters are far more commonly used. Their starships use thrusters or nuclear thrusters for orbital operations and transit to and from the Wall. Kaefer thrusters are more advanced than human designs but rockets are virtually identical.

THRUSTERS

Kaefer thrusters are somewhat more efficient than human designs, whether in interface craft or OMS drives. A thruster is a recombustion chamber attached to an MHD turbine as a sort of afterburner, requiring an input of power and fuel.

Thrusters require an MHD power plant. Thrusters can use the Advanced, Air-breathing and Crude traits but cannot be Disposable. The thruster is part of the MHD turbine and cannot be discarded.

Power:	Hull tonnage / 10
Tons:	0.5% of hull tonnage per world Size
Burns:	2.25% of hull tonnage per Burn
Cost:	MLv0.5 per ton

NUCLEAR THRUSTERS

Thrusters can be powered by a nuclear reactor, either fission or fusion. Fission reactors can be used in interface craft but fusion plants are too massive. Both nuclear reactor types are in common use on starships, however, where they can power a thruster for use below the Wall.

Nuclear thrusters require a nuclear power plant. Nuclear Thrusters can use the Advanced, Air-Breathing and Crude traits but cannot be Disposable. Like a conventional thruster, the nuclear thruster is an integral part of the reactor system.

Power:	Hull tonnage / 10
Tons:	0.75% of hull tonnage per world Size
Burns:	1.35% of hull tonnage per Burn
Cost:	MLv1 per ton

OMS THRUSTER

OMS thrusters require an input of power from an MHD turbine. They can use the Advanced and Crude traits but not together. They cannot have the Air-Breathing or Disposable traits.

Power:	Hull tonnage / 10
Tons:	3% of hull tonnage per world Size
Burns:	2.7% of hull tonnage per Burn
Cost:	MLv0.03 per ton

NUCLEAR OMS THRUSTER

Nuclear OMS thrusters can use either fission or fusion power plants. Thrusters costs are on top of reactor cost. Orbital nuclear thrusters can use the Advanced and Crude traits but not together. They cannot use the Air-Breathing or Disposable traits.

Power:	Hull tonnage / 10
Tons:	2% of the hull tonnage
Burns:	0.0675% of hull tonnage per Burn
Cost:	MLv1 per ton

Power

Kaefers make use of something much like an MHD turbine, although more efficient, along with fusion and fission power plants of similar design to humans. Like much of Kaefer technology, their power plants are overbuilt and ignore the first critical hit made against them.

FISSION REACTOR

Fission reactors are not common on Kaefer starships. They are, however, in common use on heavy landers and other interface craft. The additional radiation risk seems to be ignored and some xenobiologists speculate that the Kafer homeworld may have a higher level of background radiation, to which the Kaefers have some adaptation. Or perhaps they are aware of the risk and simply do not care.

Type	TL	Power per Ton	Cost Per Ton	Minimum Size
Advanced Fission	12	10	MLv0.6	40 tons

FUSION REACTOR

Kaefer Fusion reactors are bulkier than their human counterparts but also correspondingly more robust. The key difference is that Kaefer systems have a far lower minimum power output, allowing the use of fusion plants in smaller vessels.

Type	TL	Power per Ton	Cost per Ton	Minimum Size
Kaefer Fusion	13	5	MLv0.25	20 tons

MHD TURBINE

The standard Kaefer design of something resembling a human-made MHD turbine employs different principles and is significantly more efficient. As the same general technology is used in thrusters, Kaefer reaction drives are also more efficient than their human counterparts.

Type	TL	Power per Ton	Cost per Ton	Maximum Output
Basic	12	15	MLv0.2	1000
Advanced	13	18	MLv0.4	1250

MHD Fuel Consumption

Power Plant	Short Term (tons per hour per Power)	Long Term (tons per week per Power)
Kaefer MHD Turbine	0.001	0.20

Bridge

Kaefer bridges use the same rules as human ships. They do not use dual cockpits or flight decks, instead installing a single cockpit for each crew member as required.

Tactical Action Centre

Kaefer Tactical Action Centres require double the number of officers and sensor technicians as a human TAC. The gunner and remote operators are the same, however.

Radiators and Heat

Kaefer ships use ADHR-type radiators, which are functionally identical to human designs. Some Kaefer vessels, notably the scout and raider, use extensive stealth and heat sinks, but they are uncommon among their vessels

Computers

Computers are one field that Kaefers lag significantly behind humans. This can be seen in the size and computing power available, along with limited software availability. They often use dedicated computers simply for stutterwarp control. Such computers can only be used for stutterwarp control and no other function, adding five to their Processing score and costing double the normal amount.

Processing	TL	Tons	Cost
Computer/5	12	1	Lv300000
Computer/10	12	1.5	MLv1.6
Computer/15	12	2.0	MLv10

Software

The following software packages are in common use on Kaefer starships. The software is identical in function to human software but with a higher Bandwidth requirement and a much higher cost (reflecting the complexity of Kaefer ships).

Software	TL	Bandwidth	Cost (MLv)
Fire Control/1	12	5	4
Fire Control/2	13	10	8
Manoeuvre	10	5	Included
Stutterwarp Control	12	2.5 x stutterwarp rating	1 x bandwidth

FIRE CONTROL

Fire Control allows the computer to assist targeting, adding DM+1 for each level of Fire Control.

MANOEUVRE

The Manoeuvre software is the fundamental control system of a spacecraft and all ships must have it. This software monitors all ship systems and assists with reaction drive control and orbital operations.

STUTTERWARP CONTROL

Stutterwarp Control software monitors and adjusts the output of a stutterwarp drive, determining pseudo-velocity and pulse rate. This software is required for all operations of a stutterwarp drive.

Electronics

Kaefer electronics require double the Power and tonnage of human electronic systems but are otherwise equal in cost and performance.

Weapons and Screens

Kaefer ships make heavy use of screens in addition to heavy armour. In addition, they also carry a significant array of high-powered weapons.

Kaefer ships use any of the mounts available to human ships, along with gun towers.

GUN TOWERS

Gun towers are added to turrets and barbettes to place them clear of the hull, giving them a greater arc of fire. This grants DM+2 to attack rolls.

TL:	10
Tons:	1 for turret, 2 for barbette
Cost:	MLv1

GRUMBLER HIGH POWER LASER ARRAY

Codenamed 'Grumbler', this laser array packs the punch of a pulse laser with extended range capabilities. No intact example of this weapon has ever been examined, despite companies like Darlan, Quinn and Hyde Dynamics posting large bounties for one.

GRAZER PARTICLE BEAM WEAPON

With the codename 'Grazer', this high-power turreted particle beam weapon is one of the more common weapons on Kaefer vessels, balancing firepower and energy consumption. It has a higher rate of fire than human weapons, making them more suitable for space combat.

Sensor System Codes

Due to the lack of knowledge of Kaefer sensor systems, the systems as a whole are assigned code names by intelligence services. These code names are more for flavour rather actual utility but Travellers will not necessarily know the true capabilities of Kaefer systems.

- Basic Military with DSS: 'Sea Gull'.
- Basic Military with DSS and GADS: 'Spoon Rest'
- Advanced Military with Basic Survey: 'Steel Yard'
- Advanced Military with DSS and GADS: 'Sky Watch'

GORGON

Codenamed 'Gorgon', this heavy laser barbette is often mounted on towers. The focal array is more compact and robust than equivalent human designs.

GOLGOTHA

The single most powerful weapon encountered on a starship, the Golgotha particle beam weapon causes an incredible amount of damage. It is only found on the Beta cruiser; it is unknown why no other class carries this devastating weapon.

GRINDER

This ortillery railgun weapon is found on Beta cruisers and Epsilon assault transports. It is used to support troop landings, as well as attacking orbital hard targets.

Weapons and Screens

Weapon	TL	Range	Power	Damage	Tons	Cost	Traits
Grumbler	12	Short	20	2D+2	1	MLv1	—
Grazer	12	Short	40	3D+3	2	MLv2	AP 5, EM, Hardened
Gorgon	12	Short	90	4D	4	MLv2.5	Hardened
Golgotha	13	Short	120	5D+5	8	MLv8	AP 10, EM, Hardened
Grinder	12	Adjacent	90	3D-3	8	MLv6	AP 15, Ortillery, Slow

Targeting Systems

All Kaefer weapons use an integrated targeting system in each weapon mount, similar to the French-made UTES. This system has been named 'KUTS' (Kaefer Unified Targeting System) and like all Kaefer systems is double the cost and power requirement of the human system.

Screens

Kaefer screens have more advanced construction than human designs. They use the same concept of electromagnetically-suspended reflective, ablative strips, just more efficiently.

Rating	Tons	Power	Cost
1	1.5	2	MLv2
2	3	5	MLv3.5
3	4	15	MLv6
4	6	30	MLv8
5	8	60	MLv12
6	10	12	MLv15
7	12	240	MLv18
8	14	480	MLv25

Drones

Kaefers make extensive use of combat drones and every example found so far has been based on detonation laser warheads. They do not carry extensive drone loads, although they are capable of firing and controlling a large number of weapons at once.

Kaefers do not seem to make use of probes or remotes.

WHISKEY COMBAT DRONE

The Whiskey combat drone is a short-range, low-endurance weapon. It appears to be more common in Kaefer inventories than other drones.

Whiskey Combat Drone

Name: Whiskey
Country: Kaefer
Year: Unknown
In Service: Unknown
Yield: 95 kt
Sensors: Terminal Guidance Only

X-RAY COMBAT DRONE

Far more potent than the Whiskey, the X-Ray combat drone is slower but more lethal.

Name: X-Ray
Country: Kaefer
Year: Unknown
In Service: Unknown
Yield: 180 kt
Sensors: Terminal Guidance Only

Drones

Drone	TL	Damage	Endurance	Tac Speed	Hull	Tons	Cost	Traits
Whiskey	12	4D	4 hours	5	1	1.9	MLv2.96	Blast 4, Radiation
X-Ray	12	5D	4 hours	3	1	2.9	MLv4.27	Blast 6, Radiation

Small Craft

Kaefer ships use the same small craft systems as human ships and often attach slings to the outside of hulls to carry additional sub-craft.

Crew

Kaefer ships are crewed as commercial rather than military vessels. They do not have stewards but require one security per 20 crew, or one per 10 embarked troops. They are otherwise crewed as human vessels.

Accommodations

Kaefers do not appear to need individual berths. The crew quarters of the scout visited by the Elysian Rangers was a nesting series of round rooms, padded all around and with bedding scattered about.

The nomenclature used for these spaces is human in origin; Kaefer names are unknown. The most common accommodation for Kaefers is the nest.

BURROW

Some Kaefers have individual quarters, about the size of a small stateroom. However, these rooms are round and have low ceilings. The only lighting is a single blue-white light that extends into the near ultraviolet range.

Tons:	4
Cost:	MLv0.01

NEST

A Nest is an open space, usually no more than 10 tons. It does not include any amenities like a fresher. Kaefers do not seem to share the human need for privacy or even personal space, as it appears that crew and troops all huddle together in these nests.

Tons:	1 per 4 Kaefers
Cost:	MLv0.01 per ton

PIT

This did not appear in the scout visited by Elysian Rangers but was discovered in a fragment of a warship discovered in 2299. The pit was found in close proximity to a burrow and contained scraps of cloth and some small bones. Unlike any other habitation space, it appears to be lockable but only from the outside. Analysis has hypothesised that pits are for some sort of pet or work animal. The pit was found in the 'floor', between decks in the vertically-oriented Kaefer ship.

Tons:	1
Cost:	MLv0.01

Artificial Gravity

Kaefer ships do not seem to take advantage of spin gravity in any form. It is unknown if they have a greater tolerance for zero gravity than humans.

Internal Fittings

Kaefer ships seem to lack much of the internal amenities available to human ships. They do require common areas, with a minimum of one ton per 10 crew or troops. Freshers do not seem to be used, although they have an approximation of simple freshers, usually found at a rate of one per 20 crew and troops.

The following fittings are available to Kaefer ships at the standard tonnage and cost:

- Armoury
- Common Space
- Exercise Facilities
- Simple Fresher
- Training Area
- Workshop

Shrine: The exact purpose of this fitting is unknown but one was found just outside the bridge of the scout ship and another outside what was thought to be the bridge of a destroyed warship.

Tons: 2
Cost: MLv0.1

External Fittings

All external fittings are available to Kaefer ships. Most do not seem to be used much but their assault carriers often carry heavy landers in slings.

Signature

Kaefer ships do not seem to use spin habitats at all and their ships are designed to minimise the frontal aspect. Kaefer ships determine Signature as normal.

APPENDIX IV: DESIGN DETAILS

Starship Manufacturers

Nation	Corporation
Australia	Fremantle Engineering and Aerospace Group (FEAG)
Azania	Nyanga Aerospace Corporation
Canada	DeMarchand Aerospace Systems
Canton	Baakchoek Aerospace
France	Darlan Aerospatiale
France	General Service Transport
France	Giscard Aerospace Division
France	L’Étage Aerospace
France	L’Étage Heavy Space Systems
France	Sabourin Cargo Systems
Germany	Baustoffe Aerospace
Germany	BRW AG (Baverische Raumfahrzeug Werke)
Germany	Köenig Aerospace
Germany	Rheinmetall Aerospace Division
Indonesia	Sumatro-Fabrique Spaceframes
Japan	Momotaro Aerospace Group
Korea	Syundai Space Industrial Systems
Manchuria	Manchurian Aerospace Science and Industry Corporation (MASIC)
Manchuria	Manchurian Consolidated Space Systems
Russia	Korolev Space Industries
United Kingdom	British Exospace
United Kingdom	Centurion Aerospace
United States	American Linear Reaction Products
United States	Hyde Dynamics
United States	Trilon Aerospace Division

There are a number of background details listed in the descriptions for each ship in the *2300AD* box set, *Ships of the Frontier* and this book. While these do not affect ship performance, and can be largely arbitrary, this appendix provides guidelines on how to determine them.

Construction Time

Construction time for starships is comparatively fast. Many components are 3D printed in place or in assembler arrays nearby. Depending on where a ship is constructed, it can take between two and four days per million Livre of value to construct.

Length

Length is easy to simply 'guesstimate' but all of the ships so far shown use a consistent process.
Multiply the ship's tonnage by 14 to get the volume in cubic metres. Find the diameter of a sphere with that volume, by dividing the volume by (3.14159) and then take the cube root of the result. Multiply that by two. This is the base length for the ship.

$$B = 2 \times \left(\sqrt[3]{V/\pi}\right)$$

B = Base Length
V = Volume in cubic metres

This number is then multiplied by a modifier based on the hull form to derive length, width, and wingspan, as applicable, as shown on the Hull Form Dimensions table. Multiply the base length by the value for the hull form to derive length, width, and wingspan.

Hull Form Dimensions

Hull Form	Length	Width	Wingspan
Airframe	1.75	0.25	1.5
Ballistic	2.00	0.75	0
Dispersed Structure	3.00	2.00	0
Lifting Body	1.50	0.50	0.9
Spaceframe	2.00	1.00	0

For example, a 100-ton airframe hull has a volume of 1,400 cubic metres. The diameter of a 1,400 cubic metre sphere 15.3 metres. The airframe hull has a length modifier of 1.75, giving a length of 26.73 metres. The width modifier is 0.25, giving a width of 3.82 metres. The wingspan modifier is 1.5. giving a wingspan of 22.91 metres.

Launch Mass/Take-off Mass

The design system does not use mass as part of the process or for determining performance. However, it can be approximated by multiplying a ship's tonnage by 10 to get the base mass, in tons. For composite hulls, multiply this by 0.9 to get the final mass and for synthetic hulls, multiply the base mass by 0.75. If the vessel is armoured, multiply the tonnage of the armour by 10, along with the material modifier and then add that to the total.

Power Plant Output

Divide power plant output by 10, to get the approximate output in megawatts (MW).

Reaction Drive Thrust

For any OMS drive, multiply the tonnage of the ship by 10 to get thrust, in tons. For conventional drives, multiply the ship's tonnage by 30. The result is in tons of thrust.

Atmospheric Flight Speed

Use the range of speeds for the ship's cruising Speed Band. Most of the ship's detailed here use the high end of the cruise value.

APPENDIX V:
SPACEBORNE CAREER

This career is an alternative to the Drifter from the *Traveller Core Rulebook*.

The spaceborne are the children of the stars, born in zero-gravity. Planets are not their friend and few will ever travel down the Well. With DNA modifications to keep them healthy, they view themselves as a people apart.

Qualification: Spacer Background. Automatic.

Assignments

Choose one of the following:
Belter: More than 'just' an asteroid miner, you are part of an emergent culture, leaving terrestrial society behind and embracing the challenges and opportunities of living in space.
Tinker: Roaming technicians and scavengers, Tinkers provide specialised skills and technology to people on the Frontier. While related to Libertines and Belters, Tinkers have a distinct society and set of skills.
Libertine: At first they laughed but now they fear your growing power and influence on the Frontier. It is you, your ships, your family, that provide the colonists what they need and ensure their products get a fair market value.

Career Progress

	Survival	Advancement
Belter	DEX 8+	END 6+
Tinker	END 7+	INT 7+
Libertine	DEX 7+	INT 7+

Mustering Out Benefits

1D	Cash	Benefits
1	None	Contact
2	None	Weapon
3	Lv1000	Ally
4	Lv2000	Weapon
5	Lv3000	EDU +1
6	Lv4000	Ship Share
7	Lv10000	Two Ship Shares

All Spaceborne also receive the 0-G DNAM.

1D	Personal Development	Service Skills	Advanced Education (Min Edu8)
1	STR +1	Athletics	Engineer
2	END +1	Melee (unarmed)	Astrogation
3	DEX +1	Recon	Science
4	Language	Streetwise	Profession
5	Profession	Survival	Admin
6	Jack-of-all-Trades	Vacc Suit	Advocate

1D	Libertine	Tinker	Belter
1	Pilot	Pilot	Pilot (small craft)
2	Vacc Suit	Profession	Mechanic
3	Persuasion	Mechanic	Astrogation
4	Mechanic	Streetwise	Vacc Suit
5	Engineer	Engineer	Profession
6	Electronics	Vacc Suit	Science

Ranks and Bonuses

Rank	Libertine	Skill or Bonus	Tinker	Skill or Bonus	Belter	Skill or Bonus
0	Shippie	—	—	—	—-	—-
1	—-	—	Fixit	Jack-of-all-Trades 1	Rook	Vacc Suit 1
2	Ship Third	Diplomat 1	—	—	—-	—-
3	Ship Second	—	Perfessor	Profession 1 or Mechanic 1	Rockjock	Profession (belter) 1 or Mechanic 1
4	—-	—	—	—	—-	—-
5	—-	—	—	—	—-	—-
6	Ship Boss	Persuasion	—-	—-	Boss	Leadership

MISHAPS TABLE

1D	Mishap
1	Severely injured (this is the same as a result of 2 on the Injury table). Alternatively, roll twice on the Injury table and take the lower result.
2	You are harassed and your life ruined by a corporation. Gain a corporate executive as an Enemy.
3	Hard times caused by a lack of interstellar trade costs you your job. Lose SOC -1.
4	Your family is investigated by the planetary authorities. Co-operate and the family faces charges but you gain DM+2 to the qualification roll for your next career as a reward for your aid. Refuse and gain an Ally.
5	A corporation challenges your family and disrupts operations, forcing you to leave the system. Roll Streetwise 8+. If you succeed, increase any skill you have by one level.
6	Injured. Roll on the Injury table.

EVENTS TABLE

2D	Event
2	Disaster! Roll on the Mishap table but you are not ejected from this career.
3	A patron offers you a chance at a job. If you accept, you gain DM+4 to your next qualification roll but you owe that patron a favour.
4	You pick up a few useful skills here and there. Gain one level of Jack-of-all-Trades, Survival, Streetwise or Melee.
5	You manage to scavenge something of use. Gain DM+1 to any one Benefit roll.
6	You encounter something unusual. Go to the Life Events table and have an Unusual Event.
7	Life Event. Roll on the Life Events table.
8	You are attacked by enemies. Gain an Enemy if you do not have one already and roll either Melee 8+, Gun Combat 8+ or Stealth 8+ to avoid a roll on the Injury table.
9	You are offered a chance to take part in a risky but rewarding adventure. If you accept, roll 1D: On a 1–2, you are injured or arrested; either roll on the Injury table or enter the Prisoner career in your next term. On 3–4, you survive but gain nothing. On a 5–6, you succeed. Gain DM+4 to one Benefit roll.
10	Life on the edge hones your abilities. Increase any skill you already have by one level.
11	Life on the fringe of human space can lead to interesting situations. Go to the Life Events table and roll an Unusual Event.
12	You thrive on adversity. You are automatically promoted.

APPENDIX VI: VEHICLE OPTIONS

Spacecraft are very complex, with multiple redundancies and fail-safes. For short-range use, like maintenance pods or cargo handlers, something smaller and simpler on the scale of vehicles is more suitable.

OTV Chassis

The OTV (Orbital Transfer Vehicle) Chassis is used to describe space vehicles that are only suited for very short-ranged operations; maintenance and inspections tasks in an orbital shipyard, for example. This chassis can make use of any of the options in the *Vehicle Handbook*, with vacuum protection and life support being the most common.

While OTV vehicles can accelerate continuously to the limits of their propellant, in practice they are constantly stopping and starting, and move in short bursts. If used to thrust continuously, the OTV has the equivalent of 1 Burn.

OTV	
Skill	Pilot (small craft)
Agility	-2
Spaces Min	1
Space Max	100
Cost Per Space	Lv1000
Hull	2
Shipping	0.5 tons per Space
Speed	
Tech Level	
10	Very Slow
11	Slow
12	Slow
Range	
Tech Level	
10	200
11	400
12	400

Secondary Drive Systems

Wheels, tracks and legs can be added to an OTV chassis, as the Ground Drive (*Vehicle Handbook*, page 48). Tracks increase a vehicle's Cost per Space by +30% and decreases ground Speed by one band. Legs increase a vehicle's Cost per Space by +40%. Speed is as appropriate for a Light or Heavy Walker Chassis.

OTV Chassis

DATA ANNEX

REMOTES AND PROBES

Various small remotes and probes are often carried by starships. They are distinguished from drones by the control requirements and lack of stutterwarp drives. These systems are used in close proximity to the carrying craft or left as static platforms and do not require drone controllers.

PLANETARY PROBE

Each planetary probe includes a de-orbit thruster and a single-use ablative re-entry shield, along with a parasail allowing it to be steered to its final landing spot. Probes are designed to carry out a variety of tests on the planetary environment and include a small solar-powered rover to extend their range. The probe is equipped with environmental samplers and scanners, multiple cameras using multiple wavelengths, a small astronomical telescope and a powerful 25x terrestrial telescope.

TL:	10
Tons:	5
Cost:	MLv0.15

PLANETARY PROBE WITH RETURN CAPSULE

A larger version of the planetary probe, this carries a rocket capable of lofting 0.25 tons of specimens into low orbit of worlds of Size 8 or less. It is otherwise identical to the standard probe.

TL:	11
Tons:	15
Cost:	MLv0.45

INSPECTION REMOTE

Inspection remotes are small, reaction drive units used for close range (<100 kilometres) examination of ships and stations. They are little more than a set of thrusters, a couple of cameras, spotlights and a single manipulator arm. They are not suitable for interface operations and would be destroyed on re-entry.

TL:	10
Tons:	0.5
Cost:	MLv0.1

REPAIR REMOTE

Carrying repair bots allows a ship to make battlefield repairs with Auto-Repair software or when managed by a character with Mechanic or Engineer skills. Repair remotes are similar to inspection remotes but with much smaller reaction drives and fuel systems. In addition to cameras and spotlights, they have an array of manipulator arms and modular tools. Tools carried include plasma welder/cutters, saws, drills and shears, all adapted for use in zero-G. To provide full coverage, one remote is required per 100 tons of ship, while military and explorer vessels may carry more for redundancy.

TL:	10
Tons:	0.1
Cost:	MLv0.2

SATELLITES

Satellites are generally placed in orbit by ships already in orbit around a world. In the rare cases that they are launched from a colony world, they will typically use inexpensive disposable rockets. Survey and exploratory ships routinely use satellites to augment information gained by ground parties.

COMMUNICATION SATELLITE

A solar-powered orbital receiver and relay of tight beam or broadcast communications. Each provides 20 percent coverage of a world, so five satellites evenly spaced in the same orbit would provide 100 percent coverage. Commsats provide voice, video and data connectivity, although data bandwidths are usually low.

An uplink communicator is required to maintain a connection while on the move.

TL:	10
Tons:	0.01
Cost:	MLv0.15

NAVIGATION SATELLITE

A solar-powered orbital broadcast transmitter. Five satellites are required to provide complete coverage of a planetary surface. Each satellite continuously broadcasts its identification and current position. A downlink receiver and microprocessor can, by triangulation with satellites currently transmitting, establish its correct surface location to within half a metre. Link phones can make use of the system as well, as long as there is a Link network available.

Access to a navigation satellite network grants DM+1 to all Navigation checks.

TL:	10
Tons:	0.05
Cost:	MLv0.3

SURVEILLANCE SATELLITE

A solar-powered, Low Orbit satellite designed to detect movement of baseball-sized or larger targets on the surface or in the atmosphere of a world. Each satellite will orbit an Earth-sized planet roughly three times a day and scan the area directly below and 50 kilometres either side of its orbit. Military versions are rumoured to be able to read the fine print on a legal contract.

TL:	12
Tons:	0.1
Sensor Range:	Orbital
Cost:	MLv1.5

SURVEY SATELLITE

A solar-powered photographic satellite for mapping and collecting meteorological data, placed in low orbit to provide surface mapping and data on atmospheric weather conditions. The survey satellite grants DM+2 to all Science (planetology) checks.

TL:	10
Tons:	0.05
Cost:	MLv0.75

WEATHER SATELLITE

A solar-powered satellite intended to provide detailed meteorological information for the world below it. Purpose-built for weather monitoring, it is not suitable for surface mapping, although these satellites have been jury-rigged for such duties on occasion. It usually inhabits a lower polar orbit, passing over the entire globe in the course of many orbits.

TL:	10
Tons:	0.01
Cost:	MLv0.345

DRONES

Drones are a class of object capable of movement under their own power, while remote-operated from a ship by an operator. They are effectively miniature spacecraft, complete with stutterwarp drives.

Combat Drones

Combat drones are weaponised drones, typically equipped with either a directed energy weapon or detonation laser warhead. They represent the most common class of drone, with the most variations and largest number of total vehicles. Drones fitted with a weapon are often termed ‘drone fighters’, while some space militaries call detonation laser models ‘missiles’. A third type, the ‘bus drone’, has just started to appear, where the warhead is deployed to fire while the drone, the ‘bus’, moves to a safe range. This saves the drone body and its expensive stutterwarp drive for future use.

Another is the point defence drone, a variant of the drone fighter that mounts an optimised point defence cluster in place of the laser or particle beam array.

Combat drones are equipped with rudimentary sensors at best and use the link back to the controller or nearby sensor drones for all targeting and guidance.

RITAGE-1

The French-made Ritage-1 missile is the classic remote fighter. Equipped with a folding laser array and a power cell capable of providing five shots, the Ritage-1 is designed to close and engage with a target and then return to its carrier. Ritage-1 drones are also often deployed in a point defence role, protecting their ship from a distance.

NAME: Ritage-1
COUNTRY: France
YEAR: 2279
IN SERVICE: Classified
POWER PLANT: 0.075 MW MHD Turbine, 5 MW Battery for Laser Array
SIGNATURE: 0 (1 if laser array extended)
SENSORS: Terminal Guidance Only

RITAGE-2

The French Ritage-2 is a powerful and modern missile system equipped with a 110 kiloton nuclear warhead powering a single-shot x-ray laser. Using the warhead results in the destruction of the missile, although a recent variant deploys the warhead and then moves away. The effectiveness of this approach has yet to be tested in battle.

NAME: Ritage-2
COUNTRY: France
YEAR: 2289
IN SERVICE: Classified
POWER PLANT: 0.1 MW MHD Turbine
SIGNATURE: 1
SENSORS: Terminal Guidance Only
YIELD: 110 kt

SR-9

Before the War of German Reunification, most German states used space weapons purchased from France, most notably the Ritage-1. Bavaria also had a limited stock of the more powerful Ritage-2. Toward the end of the war, as peace was being negotiated between Paris and the new German capital at Berlin, French commandos were able to infiltrate the Raumswaffe base over Neubayern, recently surrendered by Bavaria to the Hanoverian forces. The commandos were able to destroy the nuclear warheads of the 24 missiles kept at the base. Many suspect they had inside help from former Bavarian allies.

After the war, the united Germany found itself in desperate need of combat drones as France would no longer sell to them, despite the treaty. Germany was forced to create its own weapons. The first was the SR-9, a compact drone that could make use of Ritage-1 bays and packs but mounted a powerful 50 kiloton detonation laser in place of the laser array.

NAME: SR-9
COUNTRY: Germany
YEAR: 2294
IN SERVICE: Classified
POWER PLANT: 0.12 MW MHD Turbine
SIGNATURE: 1 (Reflected 0 Radiated 1)
SENSORS: Terminal Guidance Only
YIELD: 50 kt

SR-10

With the SR-9 filling an interim role for the Raumswaffe, German engineers turned their attention to a more satisfactory replacement. The SR-10 is an innovative design, the first combat drone designed to carry a pair of submunitions along with a larger, more powerful detonation laser designed to separate from the drone bus before firing. However, it is not required to do so, giving operators the choice of how to deploy the more powerful weapon.

As capable as the SR-10 is, it is also a very expensive design and the requirement for three warheads per bus has delayed procurement and deployment of

Combat Drones

Drone	TL	Weapon	Magazine	Damage	Endurance	Tac Speed	Hull	Tons	Cost	Traits
Ritage-1	11	Laser Array	5	1D	6 hours	3	1	2	MLv1.44	Accurate
Ritage-2	12	Warhead	—	3D	6 hours	4	1	2	MLv3.05	Blast 6, Radiation
SR-9	11	Warhead	—	2D	3 hours	5	1	1.4	MLv1.91	Blast 4, Radiation
SR-10	12	Warhead	—	3D	2 hourrs	4	1	2.6	MLv4.04	Blast 6, Radiation
Fan Tan	11	Warhead	—	2D	5 hrs	4	1	1.6	MLv2.94	Blast 4, Radiation
SIM-14	11	Warhead	—	4D	8 hours	4	1	3.8	MLv4.92	Blast 8, Radiation

Submunition	TL	Damage	Magazine	Magazine Tons	Traits
SR-10-2	12	2D	2	0.6	Blast 2, Radiation

this system. Less than half of the main fleet has been equipped with the new missile. Smaller, older ships can only carry it externally; it does not fit the old drone bays designed for the Ritage-1 and Ritage-2.

NAME: SR-10
COUNTRY: Germany
YEAR: 2295
IN SERVICE: Classified
POWER PLANT: 0.12 MW MHD Turbine
SIGNATURE: 1
SENSORS: Terminal Guidance Only
MAIN WARHEAD YIELD: 110 kt
SUBMUNITION YIELD: 25 kt

FAN TAN

The Manchurian Fan Tan uses a mid-size detonation warhead. It was developed in the years leading up to the Central Asian War but it was only used in combat once, during an engagement with Russian forces in the Barnard's Star system. In the years since the end of the war, Manchurian engineers made a number of changes to the drone design. However, only Home Fleet ships have the bloc 2 revision, with Frontier Fleets still using the original design.

NAME: Fan Tan
COUNTRY: Manchuria
YEAR: 2273
IN SERVICE: 100+
POWER PLANT: 0.12 MW Fuel Cell
SIGNATURE: 0
SENSORS: Terminal Guidance Only
YIELD: 50 kt

GLOWWORM

This drone fighter is the mainstay of the Manchurian Frontier Fleet and there are a number of variants. While the base version carries an effective laser array, other versions can mount a PDC or submunitions and there is even a particle beam variant. As the payload can be swapped out easily, it has even been turned into an ersatz sensor drone in the absence of the proper variety.

NAME: Glowworm
COUNTRY: Manchuria
YEAR: 2279
IN SERVICE: 200+
POWER PLANT: 0.09 MW MHD Turbine, 6 MW Battery for Laser Array
SIGNATURE: 1 (Reflected 0 Radiated 1)
SENSORS: Terminal Guidance Only

Glowworm

SIM-14

The Hyde Dynamics Space Intercept Missile Type 14 (SIM-14) is one of the newest combat drones in service and very likely the fastest. Designed for use aboard the Kennedy-class fast missile carriers, this drone sports one of the largest warheads ever installed on a space-based weapon system. Shortly before its release, Russia lodged a diplomatic complaint, alleging the weapon was a first strike missile design for use against hard targets; a nuclear strike missile. They pointed to the nomenclature of the drone, 'missile' as proof of this. However, the United States and its Australian ally have called combat drones missiles for the past 50 years, so the complaint was never taken seriously. The SIM-14 is one of the few combat drones available that incorporate a small rocket for orbital operations.

NAME: SIM-14
COUNTRY: United States
YEAR: 2294
IN SERVICE: Classified
POWER PLANT: 0.27 MW MHD Turbine
BURNS: 2
SIGNATURE: 1 (Reflected 0 Radiated 1)
SENSORS: Terminal Guidance Only
YIELD: 190 kt

ASDL-14

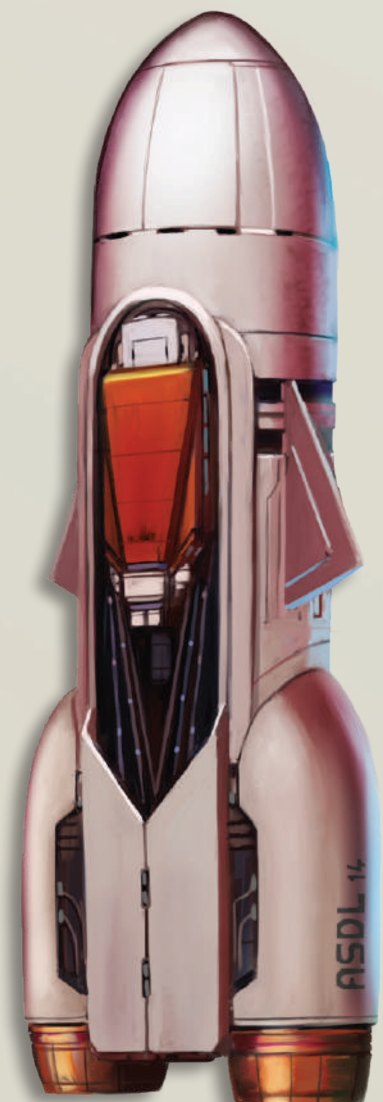
NATION: United States
FIRST EXAMPLE LAID DOWN: 2295
MANUFACTURER: Trilon Aerospace Division
PRODUCTION STATUS: In Production
CONSTRUCTION TIME: 7 Days
SERVICE STATUS: In Service
FLEETS OF SERVICE: United States
NUMBER IN SERVICE: Unknown
HEIGHT: 11.26 m
WIDTH: 4.22 m
TAKE-OFF MASS (FULLY FUELLED): 37.5 tons
POWER PLANT: 0.1 MW battery
REACTION DRIVE: Advanced Rocket, 150 tons thrust

The ASDL is designed to lift the SIM-14 combat drone from a planetary surface and boost it to beyond the Wall, where the stutterwarp drive can be engaged. It is not a booster in the normal sense but a small disposable liquid-fuelled rocket. It is not designed to be recovered or reused.

The ASDL-14 was developed alongside the SIM-14. During the initial planning phase of the SIM-14, the designers presented a case to the American Space Force that the fast, capable drone could also be used for planetary defence. All it required was a launcher to get past the Wall. While the Hyde Dynamics engineers who presented the idea undoubtedly thought their company would get the launcher contract as well, it was instead awarded to Trilon.

The launcher does its job and the Trilon designers over-engineered it so it could lift a larger payload if required.

TL12		Tons	Cost (MLv)
Hull	5-ton Synthetic Ballistic	—	0.12
Hull Features	Advanced, Disposable	—	0.075
Reaction Drive	Rocket (advanced)	0.18	0.2
Power Plant	Battery (Power Hours 4)	—	—
Fuel Tanks	Rocket (6 Burns)	1.2	—
Radiators	Conventional, Capacity 1	0.1	0.005
Bridge	Autopilot	—	0.05
Computer	Primary: Computer/5	—	0.03
Sensors	Minimal	—	—
Ordnance	Combat Drone: SIM-14	2.09	3.2209
Software	Manoeuvre, Robotic Control (improved, skill 1, voice/speech recognition, interactive)	—	0.0125
Cargo		1.43	—
	Total: MLv3.35		



Crew	Passengers	Hull Points	Signature: 1
Autopilot: Pilot 1	—	1	Base Reflected: 1 Base Radiated: 0

Running Costs

Maintenance Cost: Lv279/month Purchase Cost: MLv3.35

Power Requirements	Power
Sensors	1

Silka

Drone	TL	Weapon	Damage	Endurance	Tac Speed	Hull	Tons	Cost	Traits
Silka	11	Warhead	3D	3 hours	5	1	1.8	MLv3.96	Blast 4, Radiation

SILKA

While originally developed as a common weapon for ESA nations, it was only formally adopted by the UK and Azania, as the Space Sparrow. Ukraine and Russia also adopted this weapon, having spent heavily on the joint development fund. It had a very long development time and by the time it was ready, the European partners had moved on to different models, primarily the French Ritage-1. While the detonation laser was substantially more effective than the laser array of the Ritage-1, the Silka had poor endurance and a low speed compared to the drone fighter.

NAME: Silka
COUNTRY: Ukraine
YEAR: 2273
IN SERVICE: 296
POWER PLANT: 0.17 MW Fuel Cell
SIGNATURE: 0 (Reflected 0 Radiated 0)
SENSORS: Terminal Guidance Only
YIELD: 70 kt

Sensor Drones

There are an enormous number of sensor drones in various sizes and capacities available, from the military-only Scout to a large number of civilian deep space survey and support drones.

AMERICAN HD-5 SCOUT

The Hyde Dynamics Scout is the current American military sensor drone, designed to be as cheap and disposable as possible. At only half the speed of the French Voir, more advanced sensors enable it to maintain a longer range from its targets.

It is equipped with advanced military sensors with a folding array, deployed once the drone is clear of the launching vessel.

NAME: HD-5 Scout
COUNTRY: United States
YEAR: 2287
IN SERVICE: Classified
SIGNATURE: 2
POWER PLANT: MHD Turbine (Power 7.8)
SYSTEM SPEED: 2 AU/day
REACTION DRIVE: Thruster (advanced)
BURNS: 2
SENSORS: Advanced Military
ELECTRONICS: Computer/5
SOFTWARE: Manoeuvre, Stutterwarp/1

FRENCH VOIR SENSOR DRONE

The Sortech Voir sensor drone is one of the fastest vessels ever created by humans. The Voir is designed to pass through a military formation too fast for any weapons to get a bead on it, as it is quite fragile. While the Voir's sensors are not as acute as the HD-5, its speed and ability to make a close approach on enemy formations before any opponents can react to its presence is invaluable.

NAME: Voir
COUNTRY: France
YEAR: 2296
IN SERVICE: Classified
SIGNATURE: 1
POWER PLANT: Fuel Cell (Power 8.5)
SYSTEM SPEED: 3.64 AU/day
REACTION DRIVE: Rocket (advanced)
BURNS: 2
SENSORS: Basic Military
ELECTRONICS: Computer/5
SOFTWARE: Manoeuvre, Stutterwarp/1

Decoy Drones

There are only a few decoy drones on the market, although most space militaries field at least one model internally that is usually not for export sale. Many of these are hardened variations of the D-23.

Sensor Drones

Drone	TL	Endurance	Tac Speed	Hull	Tons	Cost	Traits
HD-5 Scout	11	12 hours	3	1	3	MLv7.19	Folding Array
Voir	12	6 hours	6	1	4.3	MLv21.43	

Decoy Drones

Drone	TL	Endurance	Tac Speed	Hull	Tons	Cost	Traits
D-23	11	12 hours	4	1	12	MLv9.71	—

Drone	TL	Weapon	Magazine	Damage	Endurance	Tac Speed	Hull	Tons	Cost	Traits
Goal-keeper	11	PDC-17	6	1D	12 hours	4	1	6	MLv5.86	Accurate, Point Defence, Rapid Fire

D-23 DECOY DRONE

The D-23 is a commercially available decoy drone designed to simulate ships from 50–500 tons in displacement. It does this by deploying an inflatable, reflective ballute and also emulates the specific ship type's electronic signature. What it cannot do is emulate the stutterwarp signature but since this requires dedicated equipment and extended processing time to decipher, it is worth the small risk.

These are quite popular with merchant vessels moving through hostile territory. The type of vessel must be specified at time of purchase, as the drone must have its electronic and physical signature tuned. The D-23 appears to be the vessel it is emulating to sensors. If an attempt is made to determine if the drone is a decoy, a Formidable (14+) Electronics (sensors) check (1D minutes, INT) is required, with DM-2 for each range band beyond Close.

NAME: D-23
COUNTRY: United Kingdom
YEAR: 2298
IN SERVICE: 24+
POWER PLANT: 1.67 MW MHD Turbine
SIGNATURE: 1 (Reflected 0 Radiated1). In decoy mode the drone emulates the signature of the target ship
SENSORS: Basic Nav Array

GOALKEEPER POINT DEFENCE DRONE

The Goalkeeper is a new design, only out in quantity since 2295. Developed by British Exospace in response to a tender from the Royal Navy, the Goalkeeper is designed to intercept missiles at a safe distance and destroy them with its point defence cluster.

NAME: Goalkeeper
COUNTRY: United Kingdom
YEAR: 2291
IN SERVICE: 12+
POWER PLANT: 0.77 MW MHD Turbine
SIGNATURE:1 (Reflected 0 Radiated1)
SENSORS: Basic Nav Array

Hunter sensor drone

CROSSBOW DRONE BOOSTER

NATION: France
FIRST EXAMPLE LAID DOWN: 2279
MANUFACTURER: Giscard Aerospace Division
PRODUCTION STATUS: In Production
CONSTRUCTION TIME: 7 Days
SERVICE STATUS: In Service
FLEETS OF SERVICE: Various
NUMBER IN SERVICE: Unknown
LENGTH: 9.8 m
WIDTH: 4.9 m
LAUNCH MASS (FULLY FUELLED): 24.75 tons
POWER PLANT: 0.2 MW Fuel Cell
REACTION DRIVE: OMS Rocket, 33 tons thrust

Drone boosters were developed to allow stutterwarp drones to be based on orbital stations. The extended burn capability of the booster can not only loft a drone beyond the Wall, it can give it the ability to manoeuvre, and fight, in orbital space. The Crossbow was designed specifically for use with the Ritage series of drones but any drone of similar or smaller size will work.

TL11		Tons	Cost (MLv)
Hull	3.3-ton Synthetic Spaceframe	—	0.0792
Hull Features	Disposable	—	-0.0165
Reaction Drive	OMS Rocket	0.066	0.0198
Power Plant	Fuel Cell (Power 2)	0.17	0.67
Fuel Tanks	OMS Rocket (5 Burns)	0.5775	—
	Power Plant (6 hours)	0.0108	—
Radiators	Conventional, Capacity 2	0.2	0.01
Computer	Primary: Computer/5	—	0.015
Sensors	Minimal	—	—
Ordnance	Combat Drone: Ritage-2	2.2	3.122
Software	Manoeuvre, Robotic Control (basic, skill 0, voice/speech recognition)	—	0.0033
Cargo		0.08	—
Total: MLv3.55			

Crew	Passengers	Hull Points	Signature: 1
Autopilot: Pilot 0	—	1	Base Reflected: 1 Base Radiated: 1

Running Costs

Running Costs
Maintenance Cost: Lv296/month Purchase Cost: MLv3.55

Power Requirements	Power
Basic Ship Systems	0.0165
Sensors	1

LIFEBOATS

Many commercial and military vessels carry escape vehicles. Passenger transports are usually required to have lifeboat space for a minimum of 75% of their passengers.

MAYDAY ONE-TON LIFEPOD

NATION: France
FIRST EXAMPLE LAID DOWN: 2271
MANUFACTURER: L'Étage Aerospace
PRODUCTION STATUS: In Production
CONSTRUCTION TIME: 1 Days
SERVICE STATUS: In Service
FLEETS OF SERVICE: France, United Kingdom, Germany
NUMBER IN SERVICE: 1,200+
HEIGHT: 2.47 m
LENGTH: 6.5 m
TAKE-OFF MASS (FULLY FUELLED): 9 tons
POWER PLANT: Giscard 1 KW Graphene Film Battery, 24 hour charge
REACTION DRIVE: L'Étage Step 4 OMS Rocket, 10 tons thrust

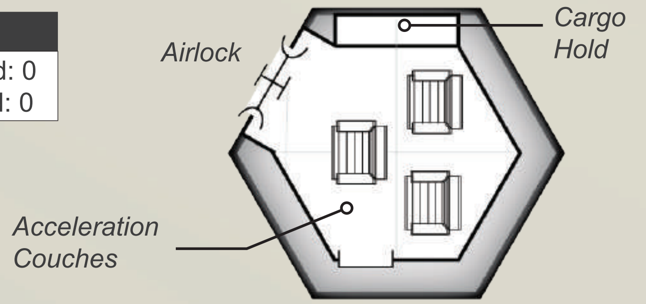
Like most escape vessels, the Mayday lifepod is a squat cone with an ablative heatshield at the base. The one-ton lifepod can accommodate up to three people and consists of little more than a trio of acceleration couches, a small rocket to de-orbit the pod if it is close enough to a planet, a heat shield, and a parachute. An explosive charge blows it free of the vessel. There are sufficient supplies aboard a life pod to provide 21 man-days of food and life support, along with a medkit, survival rifle, and three survival kits. It is worth noting that the medkit included with the lifepod includes three lethal doses of Mercy-7, a barbiturate analogue, along with three doses of MetaboliX, a medical fast drug that puts users into a sort of suspended animation for up to two weeks.

The Manchurian-made LifeSaver is very similar to the Mayday but is not compatible with the conformal berths used by the French design.

TL11		Tons	Cost (MLv)
Hull	1-ton Synthetic Ballistic	—	0.024
Hull Features	Disposable, Heat Shield, Parachute System	0.05	0.015
Reaction Drive	OMS Rocket	0.02	0.006
Power Plant	Battery (Power Hours 2.4)	0.04	0.11
Fuel Tanks	OMS Rocket (1 Burn)	0.035	—
Radiators	Conventional. Capacity 0.1	0.01	0.0005
Bridge	Autopilot	—	0.01
Computer	Primary: Computer/5	—	0.015
Systems	Safety Locker	—	0.05
Accommodations	Acceleration Couches x3	0.75	0.09
Software	Archive, Manoeuvre, Robotic Control (minimal, skill 0)	—	0.0005
Cargo		0.11	—
Total: MLv0.3			

Crew	Passengers	Hull Points	Signature: 0
Autopilot: Pilot 0	—	0	Base Reflected: 0 Base Radiated: 0

Running Costs
Maintenance Cost: Lv25/month Purchase Cost: MLv0.3



FRATERNITÉ 10-TON LIFEBOAT

NATION: France
FIRST EXAMPLE LAID DOWN: 2282
MANUFACTURER: L'Étage Aerospace
PRODUCTION STATUS: In Production
CONSTRUCTION TIME: 5 Days
SERVICE STATUS: In Service
FLEETS OF SERVICE: France, United Kingdom, Germany
NUMBER IN SERVICE: 1,000+
HEIGHT: 5 m
WIDTH: 12 m
LAUNCH MASS (FULLY-FUELLED): 75 tons
POWER PLANT: Giscard Dyno 150 KW Graphene Battery, 24 hour charge
REACTION DRIVE: L'Étage Step 7 Advanced OMS Rocket, 100 tons thrust

The largest of the stock lifeboats is a vessel in its own right, with a small liquid fuel rocket and enough fuel to give it limited-manoeuvrability. The engine is capable of 3 full burns, enough to bring it to low orbit from the Wall and then de-orbit for landing.

Like other escape vessels, the *Fraternité* is a squat cone with the flattened hemisphere of the ablative re-entry shield on the base. The lifeboat is capable of holding up to 15 people in very close, but relatively comfortable, quarters. Life support and food are provided for a total of 300 man-days. There are enough survival kits for everyone and five air rifles. The four medkits onboard can be used to extend the lifeboat's duration by a factor of 10 with Metabolix and, if necessary, giving the passengers a last resort in the form of Mercy-7. The small cargo bay is filled with survival equipment over and above the contents of a ship's locker or a safety locker.

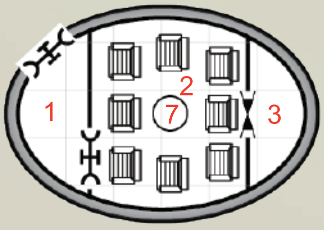
TL11		Tons	Cost (MLv)
Hull	10-ton Synthetic Ballistic	—	0.24
Hull Features	Disposable, Heat Shield, Parachute System	0.5	0.15
Reaction Drive	OMS Rocket (advanced)	0.18	0.12
Power Plant	Battery (Power Hours 36)	0.54	1.62
Fuel Tanks	Orbital Rocket (3 Burns)	0.945	—
Radiators	Conventional, Capacity 1.5	0.15	0.0075
Bridge	Autopilot	—	0.1
Computer	Primary: Computer/10	—	0.08
Software	Archive, Manoeuvre, Robotic Control (improved, skill 1, voice/ speech recognition, interactive)	—	0.065
Sensors	Minimal	—	—
Systems	Safety Locker, Ship's Locker, Simple Fresher	0.75	0.155
Airlocks	Standard Airlock	2	0.02
Accommodations	Acceleration Couches x 15	3.75	0.45
Cargo		1.19	—
Total: MLv2.65			

Crew	Passengers	Hull Points	Signature: 0
Autopilot: Pilot 1	15	1	Base Reflected: 0 Base Radiated: 0

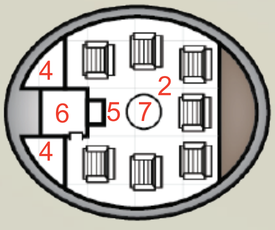
Running Costs

Maintenance Cost: Lv221/month Purchase Cost: MLv2.65

Power Requirements	Power
Basic Ship Systems	0.01
Sensors	1



Deck 1



Deck 2

1. Airlock
2. Acceleration couches
3. Cargo
4. Systems
5. Reaction drive
6. Power plant
7. Deck access

SMALL CRAFT

Small craft are generally considered to be spacecraft under 100 tons, whether or not they are stutterwarp-capable. Most would not have the endurance or navigational capabilities to cross between stars. They are normally system-range craft, sometimes even just orbital craft.

SABOURIN L-50 LIGHT DROP POD

NATION: Germany (Bavaria)
FIRST EXAMPLE LAID DOWN: 2282
MANUFACTURER: Sabourin Cargo Systems
PRODUCTION STATUS: In Production
CONSTRUCTION TIME: 9 Days
SERVICE STATUS: In Service
FLEETS OF SERVICE: Germany, United States, Brazil
NUMBER IN SERVICE: 200+
HEIGHT: 9 m
WIDTH: 24 m
LAUNCH MASS (FULLY-FUELLED): 375 tons
POWER PLANT: Hyde Everlast 10 KW graphene battery, 8 hours duration
REACTION DRIVE: Royce J500 OMS Rocket, 500 tons thrust

The L-50 drop pod is typically used to drop supplies and light equipment from low orbit and not designed to traverse the space between the Wall and a planet. Since it is small enough to use a parasail, it can be accurately guided to its destination. For this reason, it is also used by military groups to land supplies and equipment to troops in the field. This is only done when the dropping forces possess air superiority above the conflict zone.

TL11		Tons	Cost (MLv)
Hull	50-ton Synthetic Ballistic	—	1.2
Hull Features	Heat Shield, Parachute System	2.5	1
Reaction Drive	OMS Rocket	1	0.3
Power Plant	Battery (Power 0.25, 4 Hours, maximum output Power 2)	0.03	0.09
Fuel Tanks	OMS Rocket (1 Burn)	1.75	—
Bridge	Autopilot	—	0.5
Computer	Computer/5	—	0.03
Software	Manoeuvre, Robotic Control (minimal, skill 0)	—	0.025
Cargo		44.72	—
Total: MLv2.83			

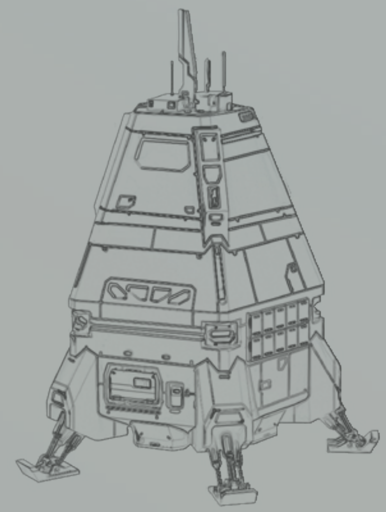
Crew	Passengers	Hull Points	Signature: 0
Autopilot: Pilot 0	—	5	Base Reflected: 0 Base Radiated: 0

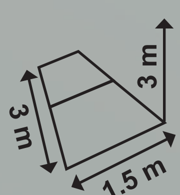
Running Costs
Maintenance Cost: Lv236/month Purchase Cost: MLv2.83

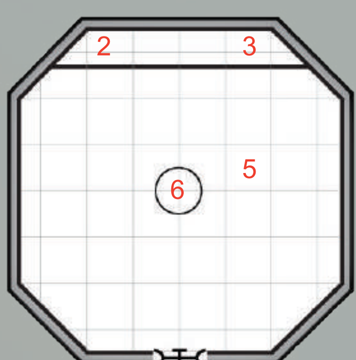
Power Requirements	Power
Basic Ship Systems	0.25 (No Life Support)

LEGEND

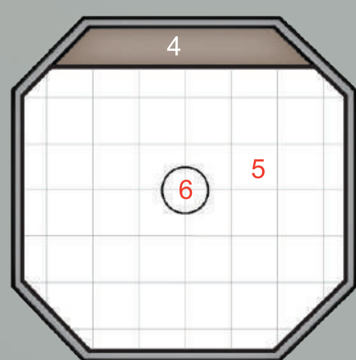
1. Parachute system
2. Reaction drive
3. Power plant
4. Fuel tank
5. Cargo hold
6. Access tube



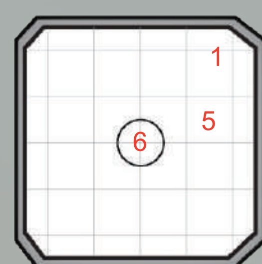




Deck 1



Deck 2



Deck 3

SPARROWHAWK SPACEPLANE

NATION: United States
FIRST EXAMPLE LAID DOWN: 2274
MANUFACTURER: Trilon Aerospace Division
PRODUCTION STATUS: In Production
CONSTRUCTION TIME: 13 Days
SERVICE STATUS: In Service
FLEETS OF SERVICE: United States, Australia, Brazil
NUMBER IN SERVICE: 12
LENGTH: 15.34 m
WIDTH: 5.11 m
WINGSPAN: 6.14 m
TAKE-OFF MASS (FULLY FUELLED): 225 tons
POWER PLANT: Hyde T-3 'EverSet' 0.3 MW Fuel Cell
REACTION DRIVE: 2 Trilon Aspire-G Air-Breathing Rockets, 900 tons thrust total
ATMOSPHERIC FLIGHT SPEED (STANDARD DENSITY/ PRESSURE): 1,200 km/h
TAKE-OFF ROLL: 240 m
LANDING ROLL, UNPOWERED: 405 m
LANDING ROLL, POWERED: 135 m
MAXIMUM AIRSPEED: Transonic
CRUISING AIRSPEED: Subsonic
ENDURANCE: 1 Hour per Burn

The Sparrowhawk is a small, fast VTOL spaceplane. While it has minimal cargo capacity, its operational flexibility has made it popular with explorers and the American Space Force. The six-day operating time of the fuel cell allows it to serve as the heart of a camp and is used as such by survey teams and adventurers. The small cargo hold is usually used to carry camping equipment and maybe a small ATV or two.

In ASF service, the Sparrowhawk is used to effect personnel and mail transfers from planetside stations to ships in orbit. ASF bases will have a half-dozen or so as part of their aerospace wing, while many major combatants will carry one.

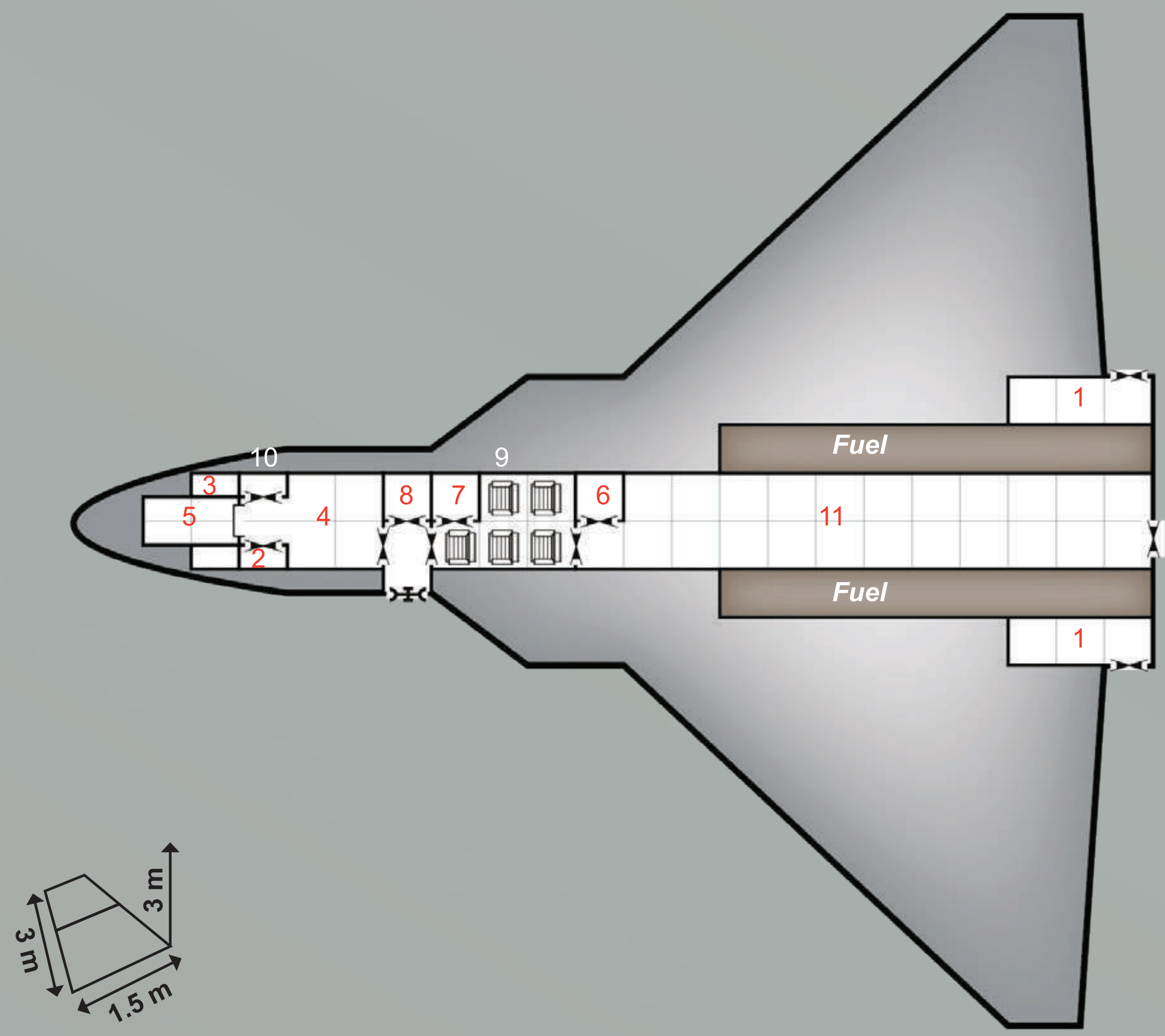
TL11		Tons	Cost (MLv)
Hull	30-ton Synthetic Lifting Body	—	0.84
Hull Features	Heat Shield, VTOL, Frontier Operations	0.3	0.63
Reaction Drive	Rocket (air-breathing, advanced)	1.5	1.875
Power Plant	Fuel Cell (Power 3)	0.25	1
Fuel Tanks	Rocket (7 Burns)	8.4	—
	Power Plant (144 hours)	0.3888	—
Radiators	Conventional, Capacity 3	0.3	0.015
Bridge	Dual Cockpit, Encrypted Comms	2.5	1.15
Computer	Primary: Computer/10 Secondary: Computer/5	—	0.095
Sensors	Basic Nav Array	1	0.1
Systems	Zero-G: Safety Locker, Ship's Locker, Simple Fresher	0.75	0.155
Accommodations	Acceleration Couches x10	2.5	0.3
Software	Archive, Intellect, Manoeuvre	—	1
Life Support Consumables	14 days for 12 people	0.34	—
Cargo		11.28	—
Total: MLv6.56			

Crew	Passengers	Hull Points	Signature: 1
Pilots x2	10	3	Base Reflected: 0 Base Radiated: 1

Running Costs
Maintenance Cost: Lv535/month Purchase Cost: MLv6.56

Power Requirements	Power
Basic Ship Systems	0.3
Sensors	2

LEGEND
1. Reaction drive
2. Power plant
3. Radiators
4. Dual cockpit
5. Sensors
6. Safety locker
7. Ship's locker
8. Fresher
9. Acceleration couches
10. Life support supplies
11. Cargo hold



LC-10

NATION: France
FIRST EXAMPLE LAID DOWN: 2281
MANUFACTURER: General Services Aerospace Division
PRODUCTION STATUS: Out of Production
CONSTRUCTION TIME: 25 Days
SERVICE STATUS: Out of Service
FLEETS OF SERVICE: France, Independent
NUMBER IN SERVICE: 90
LENGTH: 16.88 m
WIDTH: 5.63 m
WINGSPAN: 6.75 m
TAKE-OFF MASS (FULLY FUELLED): 309.6 tons
POWER PLANT: General Services G140 1.4 MW MHD Turbine
REACTION DRIVE: General Services RK-50 Air-Breathing Thruster, 1,200 tons thrust
STUTTERWARP: 0.3 MW General Services M17 'Dasher' Gen II Jerome Effect Stutterwarp
ATMOSPHERIC FLIGHT SPEED (STANDARD DENSITY/ PRESSURE): 1,200 km/h
TAKE-OFF ROLL: 320 m
LANDING ROLL, UNPOWERED: 540 m
LANDING ROLL, POWERED: 180 m
MAXIMUM AIRSPEED: Transonic
CRUISING AIRSPEED: Subsonic
ENDURANCE: 1 Hour per Burn

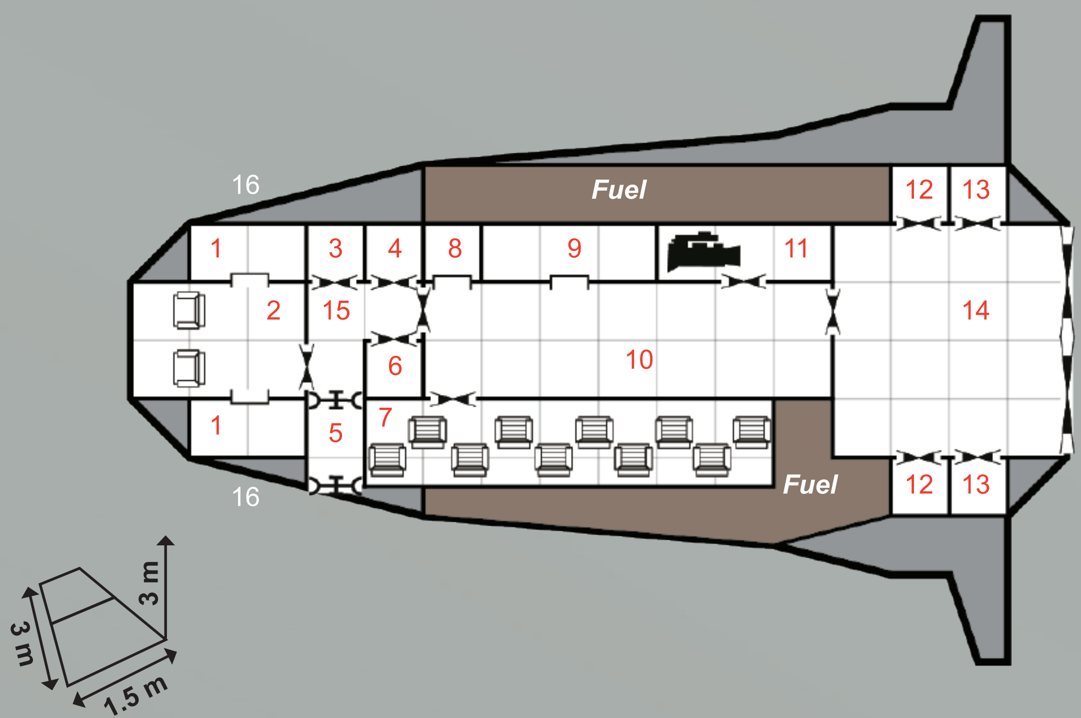
The LC-10 was a commercial effort to provide an inexpensive long-range combat lander, capable of reaching a planet from beyond the Wall with a single light vehicle and squad of troops. It is a stutterwarp-capable landing vessel, lightly-armed for self-defence. These spacecraft were manufactured, and unfortunately destroyed, in large numbers during the early phases of the Central Asian War. They were rapidly withdrawn from service, stripped of armament and sold off or simply scrapped. Some mercenary companies picked them up but most went into civilian hands as a light, stutterwarp-capable cargo or even passenger lander. A few brave souls have upgraded the navigation systems, added an external fuel tank and used them as an uncomfortable interstellar vessel.

Civilian models remove the chin-mounted chaingun and strip out the ordnance bays. The space vacated by the cannon is effectively unusable but the emptied bays are often used for carrying small cargo items and personal effects.

TL11		Tons	Cost (MLv)
Hull	40-ton Synthetic Lifting Body	—	1.12
Hull Features	Heat Shield, VTOL, Frontier Operations	0.4	0.904
Armour	4	1.28	0.26
Reaction Drive	Thruster (air-breathing, advanced)	1	1.25
Stutterwarp	1.62 ly/day, Tac Speed: 2 System Speed 1.05 AU/day	0.87	1.73
Power Plant	MHD Turbine (Power 14)	1.4	0.56
Fuel Tanks	Thruster (8 Burns)	8	—
	Power Plant (24 hours)	0.504	—
Radiators	Conventional, Capacity 14	1.4	0.07
Bridge	Flight Deck, Encrypted Comms	3	1.015
Computer	Primary: Computer/10 Secondary: Computer/5	—	0.095
Sensors	Basic Military	2	4
Weapons	25mm rotary AC in Retractable Mount, Aero-12 in Retractable Mount x8	1.8	0.2
Systems	Safety Locker, Ship's Locker, Simple Fresher	0.75	0.155
Sub-Craft	Lynx Wheeled Armoured Scout in Berth	8.25	1.241
Accommodations	Acceleration Couches x10	2.5	0.3
Software	Archive, Manoeuvre, Stutterwarp Control	—	0.616
Life Support Consumables	14 days for 10 people	0.28	—
Cargo		7.07	—
Total: MLv12.16			

DATA ANNEX

LEGEND
1. Sensors
2. Bridge
3. Fresher
4. Ship's locker
5. Airlock
6. Life support supplies
7. Acceleration couches
8. Heat shield
9. Radiators
10. Cargo hold
11. Power plant
12. Stutterwarp
13. Reaction drive
14. Craft berth
15. Rotary AC
16. Aero-12



Crew	Passengers	Hull Points	Signature: 1
Pilots x2	10	3	Base Reflected: 0 Base Radiated: 1

Power Requirements	Power
Basic Ship Systems	0.4
Reaction Drive	4
Stutterwarp	3
Sensors	5

Running Costs
Maintenance Cost: Lv1013/month Purchase Cost: MLv12.16

JS-30 JIAN LIGHT FIGHTER

NATION: Manchuria
FIRST EXAMPLE LAID DOWN: 2287
MANUFACTURER: Manchurian Aerospace Science and Industry Corporation (MASIC)
PRODUCTION STATUS: In Production
CONSTRUCTION TIME: 53 Days
SERVICE STATUS: In Service
FLEETS OF SERVICE: Manchuria
NUMBER IN SERVICE: 120+
LENGTH: 15.34 m
WIDTH: 5.11 m
WINGSPAN: 6.14 m
TAKE-OFF MASS (FULLY FUELLED): 295.2 tons
POWER PLANT: MASIC D350 3.5 MW MHD Turbine
REACTION DRIVE: MASIC Vs9 Air-Breathing Thruster, 900 tons thrust
STUTTERWARP: MASIC ST106 0.6 MW Gen II Jerome-effect Stutterwarp
ATMOSPHERIC FLIGHT SPEED (STANDARD DENSITY/ PRESSURE): 1,800 km/h
TAKE-OFF ROLL: 256 m
LANDING ROLL, UNPOWERED: 432 m
LANDING ROLL, POWERED: 144 m
MAXIMUM AIRSPEED: Supersonic
CRUISING AIRSPEED: Transonic
ENDURANCE: 1 Hour per Burn

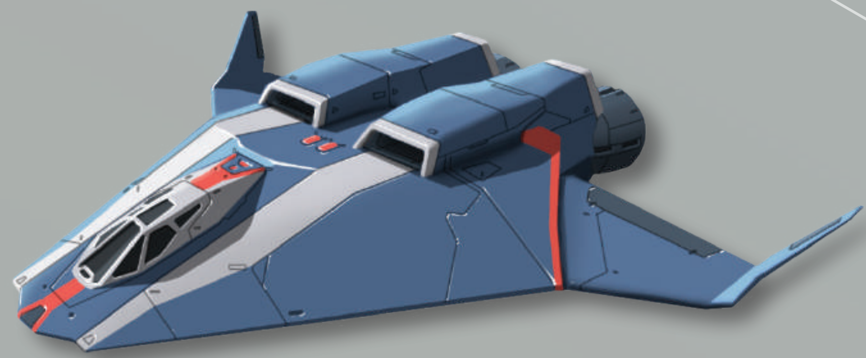
The Manchurians are late to the production of fighters, having relied on missiles for remote force projection until the Central Asian War. However, as the piracy and raider situation on the Manchurian Arm grew worse, the need for a human presence became more pronounced. The JS-30 Jian is the result of this requirement. It is a small, agile fighter in space and, most importantly, inexpensive, allowing the Manchurians to rapidly build their forces.

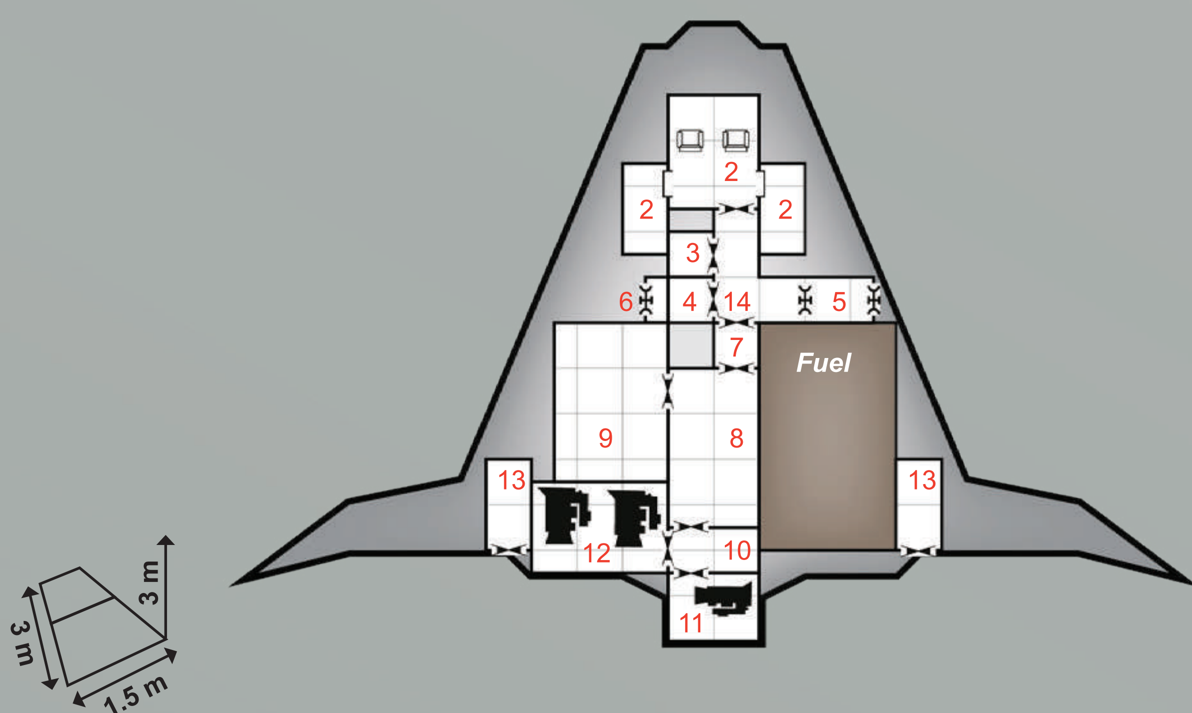
The JS-30 carries a single moderate-output laser array, retractable for interface operations, along with a sling for a Fantan missile. It cannot launch or re-enter atmosphere with the missile attached, however. The JS-32 is a clumsy flyer in atmosphere and not armed for surface support. It can launch and reach the Wall with its internal fuel load and retain enough for limited orbital operations and a planetary approach.

TL12		Tons	Cost (MLv)
Hull	32-ton Composite Lifting Body	—	1.088
Hull Features	Heat Shield, Advanced	—	0.96
Armour	5	0.8	0.48
Reaction Drive	Thruster (air-breathing)	1.408	0.96
Stutterwarp	2.99 ly/day, Tac Speed: 3 System Speed: 1.93 AU/day	1.15	5.77
Power Plant	MHD Turbine (Power 35)	2.92	1.6
Fuel Tanks	Thruster (9 Burns)	7.2	—
	Power Plant (12 hours)	0.63	—
Radiators	Conventional, Capacity 35	3.5	0.175
Bridge	Dual Cockpit, Encrypted Comms	2.5	1.15
Computer	Primary: Computer/15 fib Secondary: Computer/10 fib	—	1.62
Sensors	Basic Military	2	4
Weapons	EA122 (retractable surface mount)	3	1.4
Targeting	Light TTA	2	0.25
Ordnance	Combat Drone: Fan Tan, Submunition: LHH-637	4.46	4.9876
Drone Controllers	1	0.25	0.5
Systems	Safety Locker	—	0.05
Software	Archive, Manoeuvre, Fire Control/1, Stutterwarp Control	—	3.14
Cargo		0.49	—
Total: MLv25.32			

JS-30 JIAN LIGHT FIGHTER

LEGEND
1. Bridge
2. Sensors
3. Fresher
4. Ship's locker
5. Airlock
6. Drone controller
7. Cargo area
8. Radiators
9. Combat drone and submunition
10. Stutterwarp
11. Reaction drive
12. Power plant
13. Targeting
14. EA122





Crew	Passengers	Hull Points	Signature: 2
Pilot, Co-pilot/ Weapons Officer	—	3	Base Reflected: 0 Base Radiated: 2

Running Costs

Maintenance Cost: Lv2110/month Purchase Cost: MLv25.32

Power Requirements	Power
Basic Ship Systems	0.32
Reaction Drive	3.2
Stutterwarp	6
Sensors	5
Drone Controllers	2
Weapons	22.5

STARSHIPS

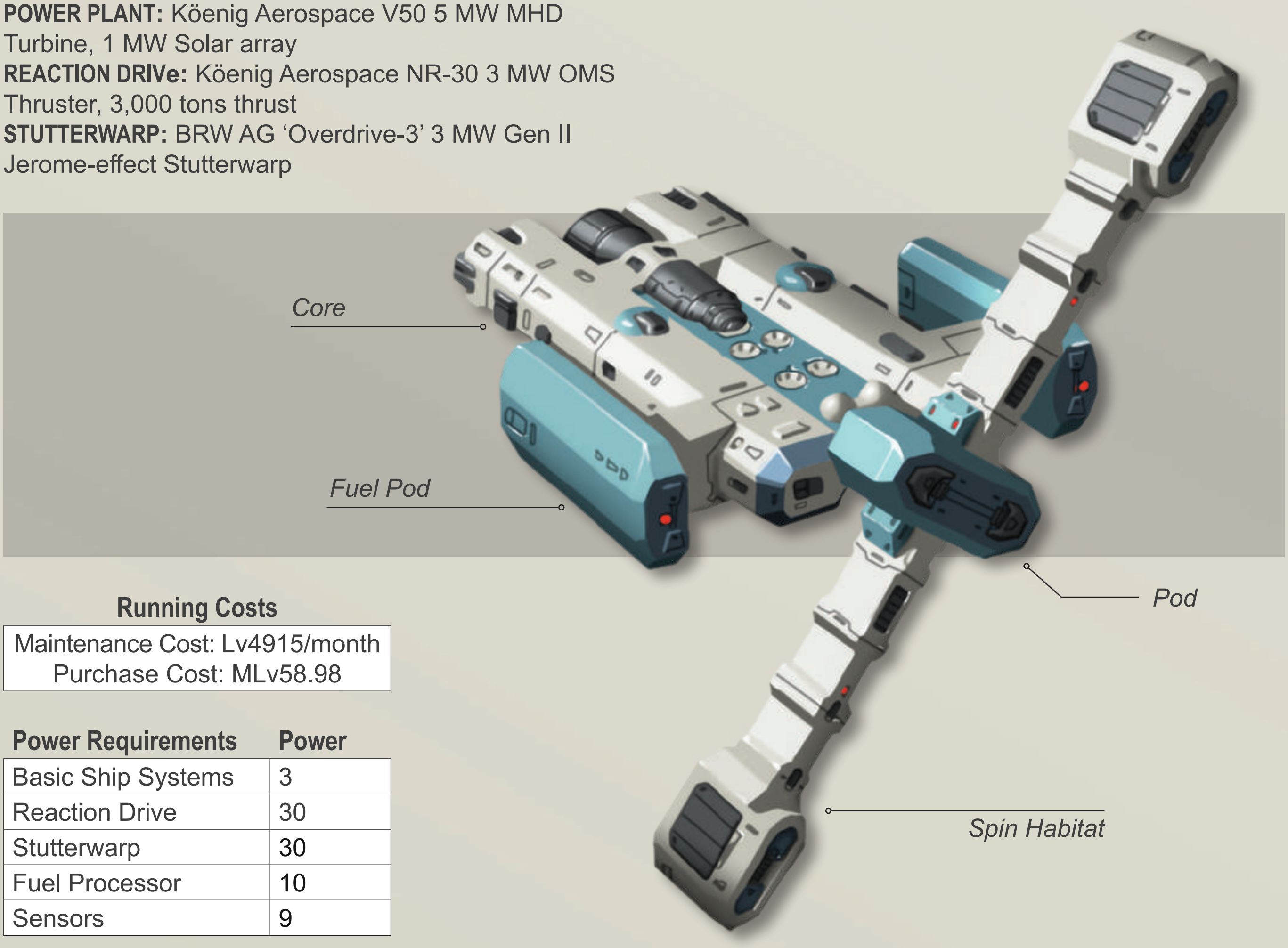
Starships not only possess stutterwarp drives, they have the endurance and navigational capability to cross the vast gulf between stars.

HAMID EXPLORATION AND SURVEY VESSEL

NATION: Germany
FIRST EXAMPLE LAID DOWN: 2250
MANUFACTURER: Köenig Aerospace
PRODUCTION STATUS: Out of Production
CONSTRUCTION TIME: 129 Days
SERVICE STATUS: In Service
FLEETS OF SERVICE: Germany, United Kingdom, Freihafen
NUMBER IN SERVICE: 52
LENGTH: 44.06 m
WIDTH: 22.03 m
LAUNCH MASS (FULLY FUELLED): 3,000 tons
POWER PLANT: Köenig Aerospace V50 5 MW MHD Turbine, 1 MW Solar array
REACTION DRIVe: Köenig Aerospace NR-30 3 MW OMS Thruster, 3,000 tons thrust
STUTTERWARP: BRW AG 'Overdrive-3' 3 MW Gen II Jerome-effect Stutterwarp

The Hamid-class survey ship has been responsible for most of the frontier expedition by the various German states for the past 50 years, since the ESA retired the old exploratory cruisers. This vessel is not as sophisticated as more modern designs but has yet to be replaced as the workhorse of German exploration. Although it is a Hanoverian design, it was in widespread use throughout the various German states, even Bavaria.

The Hamid is one of the most popular small survey ships in use on the French Arm. It carries a variety of laboratories and scientific personnel, and is equipped with a Turmfalke spaceplane for interface operations, allowing limited planet-side operations. Some models in independent service carry a DC-30 lander instead. In either case, interface operations are limited by the amount of fuel it can carry for the lander. If sources of water or ice are available, the Hamid can deploy a solar-powered fuel processor, greatly extending its operational range.



Running Costs

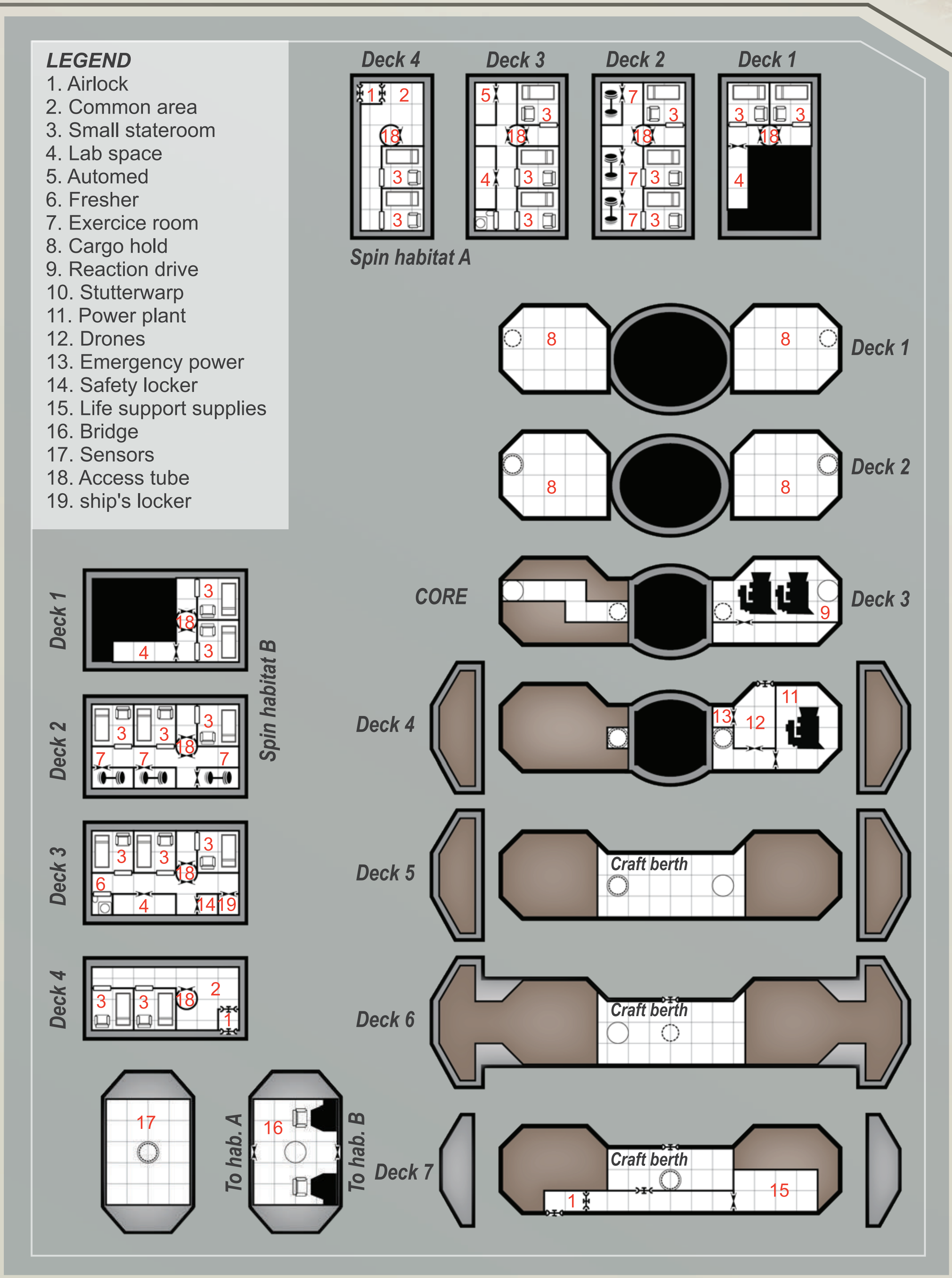
Maintenance Cost: Lv4915/month Purchase Cost: MLv58.98

Power Requirements	Power
Basic Ship Systems	3
Reaction Drive	30
Stutterwarp	30
Fuel Processor	10
Sensors	9

DATA ANNEX

TL11		Tons	Cost (MLv)
Hull	300-ton Aligned Crystal Steel Spaceframe	—	6
Hull Features	Advanced, Radiation Shield	—	7.5
Reaction Drive	OMS Thruster (advanced)	8.1	7.2
Stutterwarp	1.87 ly/day, Tac Speed: 2 System Speed: 1.2 AU/day	2.74	5.48
Power Plant	MHD Turbine (Power 50), Solar Panels (Power 10)	5	2
Emergency Power	Power 3 (24 hours)	0.36	0.36
Fuel Tanks	OMS Thruster (6 Burns)	48.6	—
	Power Plant (2 weeks)	25	—
	Subcraft Fuel 2 refills	13.4	—
Fuel Processing	2 tons per day	0.2	0.4
Radiators	Conventional, Capacity 50	5	0.25
Bridge	Small	10	1.5
Computer	Primary: Computer/20 Secondary: Computer/15	—	7
Sensors	Basic Nav Array, DSS, GADS, Standard Survey, Telescope	10.274	8.248
Weapons	Hardpoints x2	—	0.2
Drone Controllers	1	0.25	0.5
Systems	Under Spin: Automed, Safety Locker, Ship's Locker, Simple Freshers x2, General Lab Space x4, Exercise Equipment x6, Common Areas x10	33.25	6.91
Sub-Craft	Turmfalke Spaceplane in Berth	22	6.32
Airlocks	Standard Airlocks x3	—	—
Accommodations	Under Spin: Small Staterooms x35	70	3.5
Artificial Gravity	Spin Capsules (107.17 tons Under Spin)	13.93	6.97
	Radius: 60 m, 2 RPM, Gravity: 0.27 G, Spin Up/Down: 16.2 minutes		
Software	Archive, Intellect, Manoeuvre, Stutterwarp Control	—	1.712
Life Support Consumables	56 Days For 34 people	3.81	—
Cargo		28.61	—
Total: MLv58.98			

Crew	Passengers	Hull Points	Signature: 2
Captain, Bridge Officer, Astrogators x2, Flight Engineers x2, Pilots x2, Sensor Techs x2, Reaction Drive Engineers x2, Stutterwarp Engineers x2, Power Engineers x2, Small Craft Tech, Life Support Techs x2, Electronics Techs x2, Administrator, Small Craft Pilots x2, Specialists x8 **Comfort Rating**: 0	—	33	Base Reflected: 2 Base Radiated: 2


LEGEND
1. Airlock
2. Common area
3. Small stateroom
4. Lab space
5. Automed
6. Fresher
7. Exercice room
8. Cargo hold
9. Reaction drive
10. Stutterwarp
11. Power plant
12. Drones
13. Emergency power
14. Safety locker
15. Life support supplies
16. Bridge
17. Sensors
18. Access tube
19. ship's locker
Deck 4
Deck 3
Deck 2
Deck 1
Spin habitat A
CORE
Deck 1
Deck 2
Deck 3
Deck 4
Deck 5
Deck 6
Deck 7
Craft berth
Craft berth
Craft berth
Spin habitat B
Deck 1
Deck 2
Deck 3
Deck 4
To hab. A
To hab. B

CARGOMAX FREIGHTER

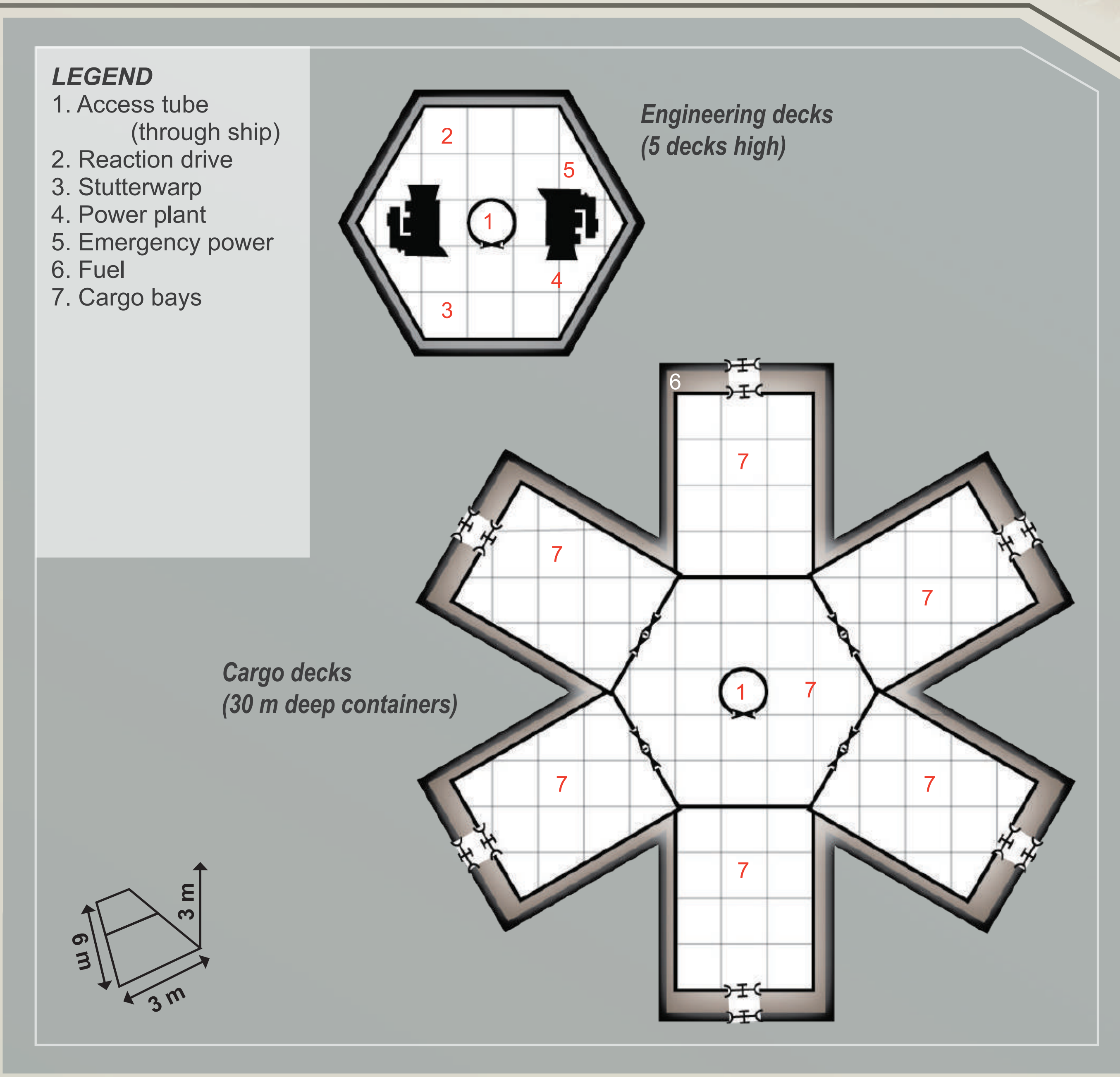
NATION: United States
FIRST EXAMPLE LAID DOWN: 2196
MANUFACTURER: American Linear Reaction Products
PRODUCTION STATUS: Out of Production
CONSTRUCTION TIME: 546 Days
SERVICE STATUS: In Service
FLEETS OF SERVICE: United States, Australia
NUMBER IN SERVICe: 41
LENGTH: 124 m
WIDTH: 41 m
LAUNCH MASS (FULLY-FUELLED): 40,000 tons
POWER PLANT: American Linear Reaction Products MK60 60 MW Fission Reactor
REACTION DRIVE: American Linear Reaction Products 'Hercules' Nuclear OMS Thruster, 40,000 tons thrust
STUTTERWARP: ALRP 'Hopper'-series 15 MW Gen II Jerome-effect Stutterwarp

The CargoMax is one of the largest bulk carriers produced and can move an immense amount of cargo. While incapable of making planetfall, it has sufficient thruster capability to approach low orbit around most planets, allowing it to either transfer cargo to spaceplanes or simply release cargo modules in drop pods.

Unlike the Metal-class, the Cargomax carries its cargo in internal cargo holds rather than external containers. At the time of the Cargomax's initial design in 2196, it was unknown what the effects of interstellar stutterwarp travel would be on exposed cargo pods. The Max, as it is often called, was one of the first commercial ships to use the Generation II stutterwarp drives, so the caution is understandable.

TL10		Tons	Cost (MLv)
Hull	4,000-ton Aligned Crystal Steel Spaceframe	—	80
Hull Features	Radiation Shield	—	20
Reaction Drive	Nuclear OMS Thruster	120	120
Stutterwarp	0.87 ly/day, Tac Speed: 1 System Speed 0.56 AU/day	6.55	8.18
Power Plant	Fission Reactor (Power 600)	100	20
Emergency Power	Power 40 (24 hours)	19.2	19.2
Fuel Tanks	Nuclear OMS Thruster (6 Burns)	240	—
Radiators	Conventional, Capacity 600	60	3
Bridge	Standard	60	20
Computer	Primary: Computer/10 Secondary: Computer/5	—	7
Software	Archive, Intellect, Manoeuvre/0, Stutterwarp Control	—	1.348
Sensors	Basic Nav Array, DSS	3	1.6
Weapons	Hardpoints x4	—	—
Drone Controllers	4	1	2
Systems	Automeds x2, Exercise Equipment (20 person), Office x8, Safety Lockers x2, Ship's Locker, Simple Freshers x6	54.5	5.93
	Cargo Arms x20	10	2
Remotes	Inspection Remotes x10	1.1	0.31
Sub-Craft	Workerbees in Berth x4	6.6	0.81
Life Boats	Sauvatage-10 Lifeboats x10	100	15
Airlocks	Standard Airlocks x40	—	—
Accommodations	Small Staterooms x82, Staterooms x10	204	13.2
Life Support Consumables	28 Days	4.928	—
Cargo		3006.97	—
Total: MLv303.76			

DATA ANNEX

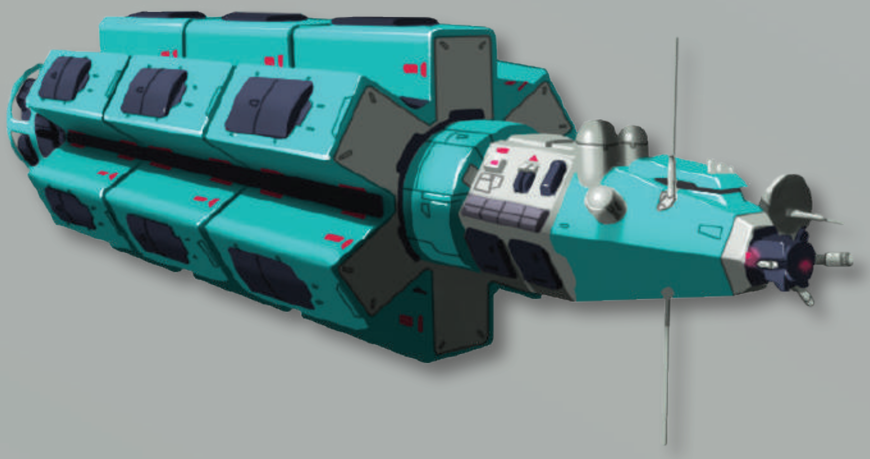


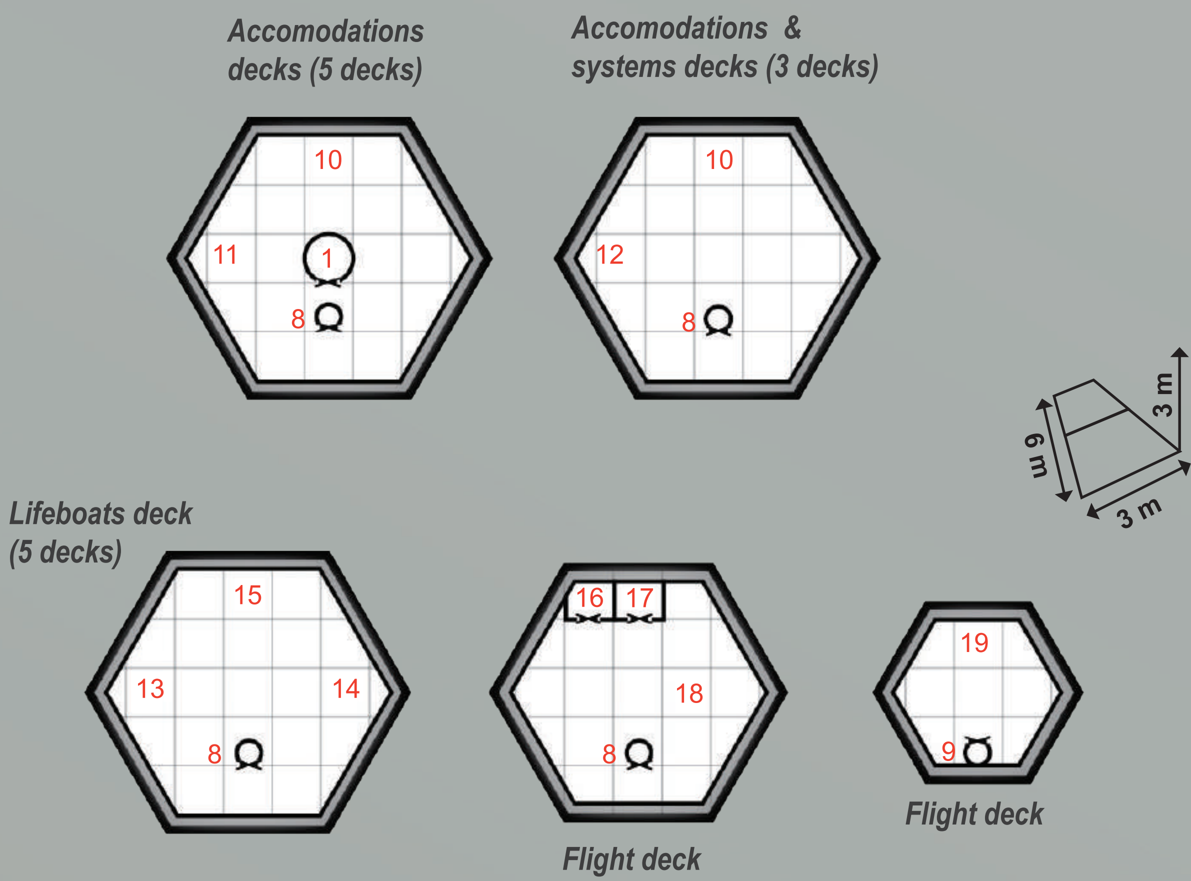
Crew	Passengers	Hull Points	Signature: 4
Captain, Bridge Officer, Astrogators x2, Flight Engineers x2, Pilots x2, Sensor Techs x2, Reaction Drive Engineers x2, Stutterwarp Engineers x2, Power Engineers x26, Small Craft Techs x4, Life Support Techs x2, Electronics Techs x2, Small Craft Techs x2, Administrators x8, Cargo Handlers x15, Small Craft Pilots x8, Specialists x6 **Comfort Rating**: 1	—	400	Base Reflected: 4 Base Radiated: 3

Running Costs
Maintenance Cost: Lv25313/month Purchase Cost: MLv303.76

Power Requirements	Power
Basic Ship Systems	40
Reaction Drive	400
Stutterwarp	150
Sensors	2

LEGEND
8. Access tube
9. Hatch to sensors
10. Small staterooms
11. Staterooms
12. Systems
13. Lifeboats berths
14. Workerbees bays
15. Remotes (5)
16. Drone controller
17. Remotes (5)
18. Bridge (9 m high)
19. Sensors





KENNEDY FAST MISSILE CARRIER

NATION: United States
FIRST EXAMPLE LAID DOWN: 2291
MANUFACTURER: Trilon Aerospace Division
PRODUCTION STATUS: In Production
CONSTRUCTION TIME: 1191 Days
SERVICE STATUS: In Service
FLEETS OF SERVICE: United States
NUMBER IN SERVICE: 32
LENGTH: 63.55 m
WIDTH: 31.78 m
LAUNCH MASS (FULLY FUELLED): 8,100 tons
POWER PLANT: Norton-Thales GRW-1200 120 MW Fusion Reactor
REACTION DRIVE: Trilon Orbital Systems Fusion-Pumped 9 MW OMS Thruster, 9,000 tons thrust
STUTTERWARP: Trilon System-400 40 MW Gen II Jerome-effect Stutterwarp

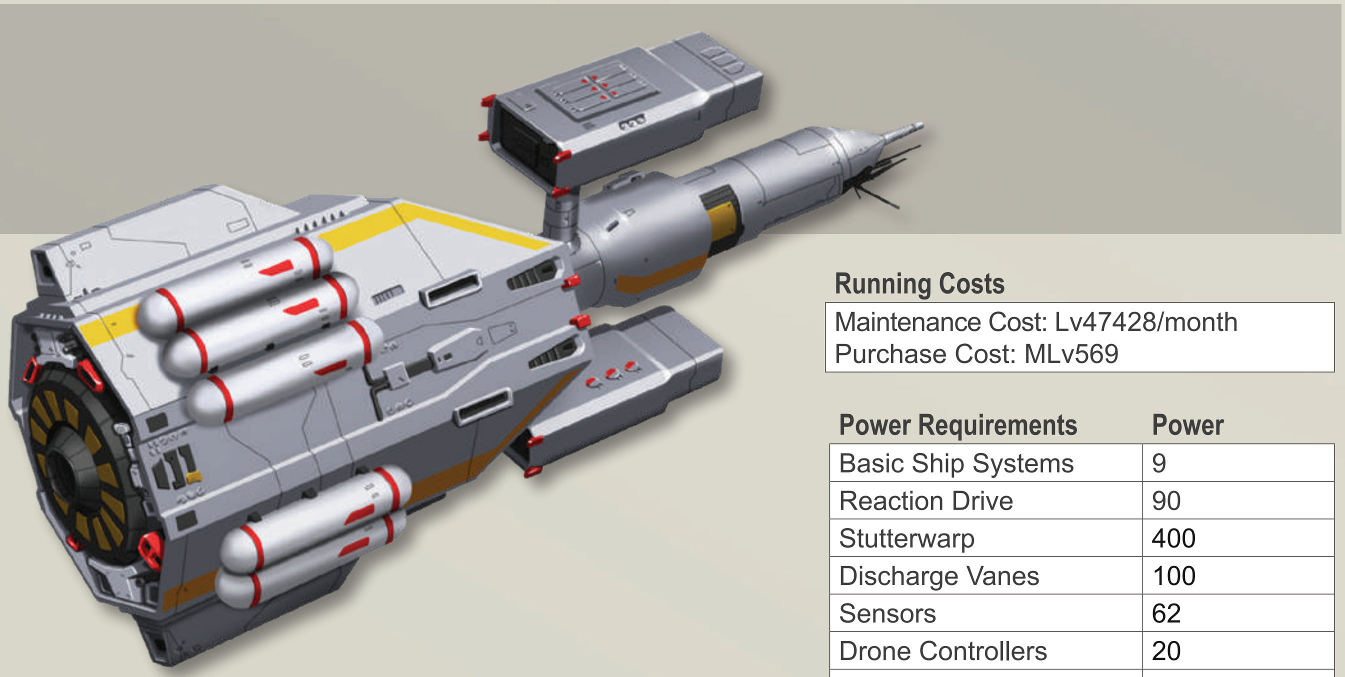
In the waning days of the Central Asian War, American military planners started re-evaluating the American Space Force. Up to that point, it had drawn on the successes and experience of the French Space Navy, which emphasised big, multirole ships that could operate independently. While the French dominated the space portion of the war, American planners noted the disproportionate successes of Manchurian drone carriers, despite their disadvantage in both speed and gun systems.

This led to a new development in American warship design. Speed and drone capacity, rather than the ability to 'do everything' became the guiding philosophy.

This change led to the development of the Kennedy fast missile carrier and her big sister, the Columbia system dominance vessel. It should be noted that in American usage, combat drones with detonation warheads are termed 'missiles'. Both vessels are heavy on their missile complement but to achieve the high speed the vessel is known for, the Kennedy must accept trade-offs, most notably in her lack of armour, screens and substantial gun armament.

Fusion-powered, the Kennedy has terrific performance at warp efficiency 4.83. The stutterwarp unit itself is a completely new design built by American Space Force engineers within the last 10 years. Most of the mass of the ship is centred in the fusion plant in order to take advantage of every bit of energy for greater speed. The American Kennedy-class is perhaps the fastest ship in service today but its overwhelming cost to firepower ratio makes its use prohibitive.

The ship can have up to 10 deployed drones 'in the air' at once. The most common missile for the Kennedy is the Hyde Dynamic SIM-14. Most ships of this class also pack a remote sensor drone, usually the Hyde Dynamics Scout. Armament is variable; most mount high output EA-1000 lasers arrays, although several of the newer models replace one or two of the laser arrays with type 29 PDCs.



Running Costs

Maintenance Cost: Lv47428/month
Purchase Cost: MLv569

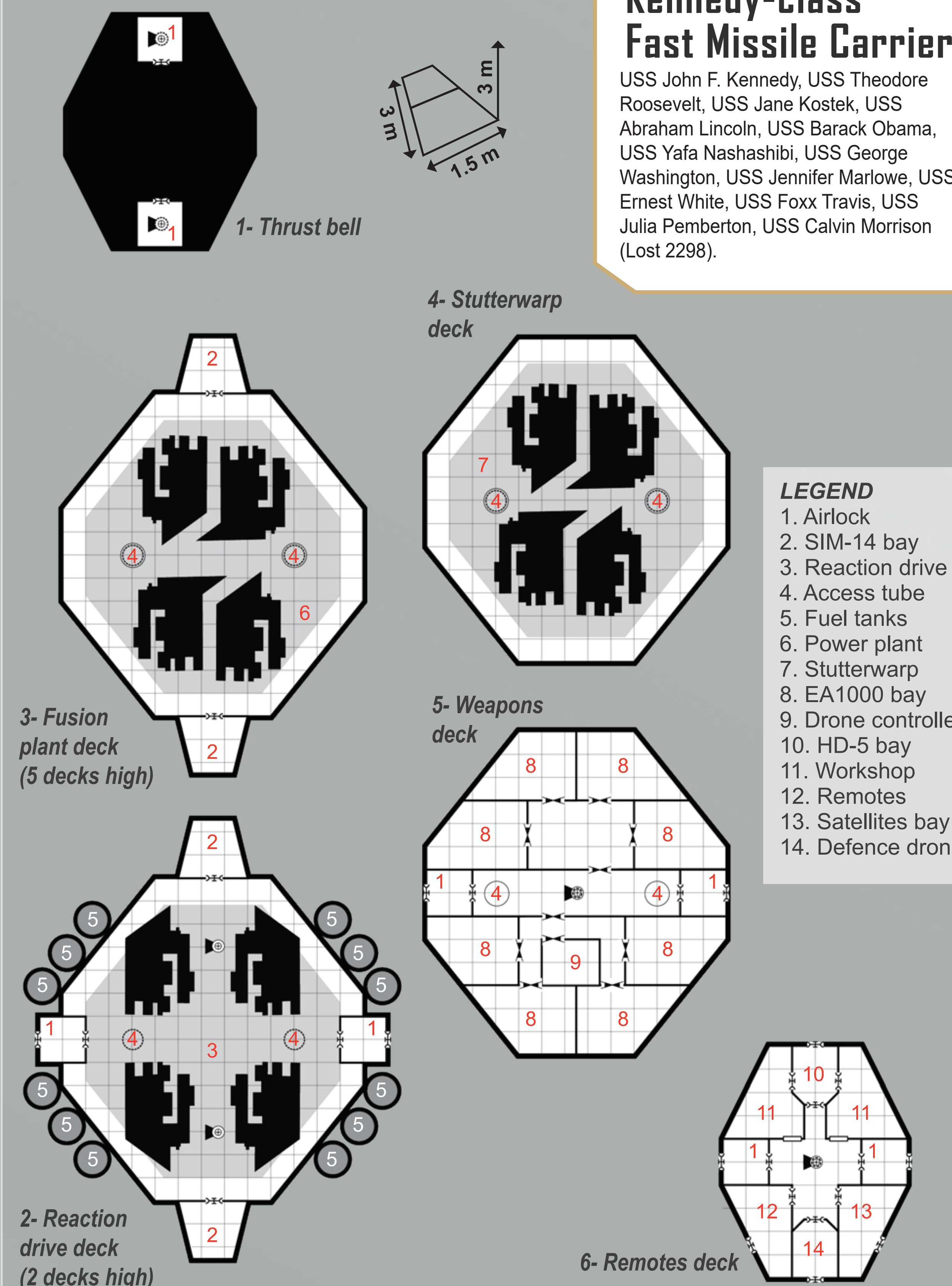
Power Requirements	Power
Basic Ship Systems	9
Reaction Drive	90
Stutterwarp	400
Discharge Vanes	100
Sensors	62
Drone Controllers	20
Weapons	225

TL12		Tons	Cost (MLv)
Hull	900-ton Synthetic Spaceframe	—	21.6
Hull Features	Advanced, Radiation Shield	—	22.5
Reaction Drive	Nuclear OMS Thruster (advanced)	24.3	54
Stutterwarp	4.6 ly/day, Tac Speed: 5 (discharge vanes) System Speed: 2.97 AU/day	19.43	67.14
Power Plant	Fusion Reactor (Power 1,200)	80	96
	Power 9 (24 hours)	0.216	0.216
Fuel Tanks	Nuclear OMS Thruster (8 Burns)	64.8	—
Radiators	AHDR (oversized), Capacity 2,400	120	60
Bridge	Large, Neural Link, Encrypted Comms, Laser Comm	40.5	12.75
Computer	Primary: Computer/30fib Secondary: Computer/25fib	—	24
Sensors	Very Advanced Military, Advanced Military, Standard Survey, DSS, GADS, Telescope	39.94	41.31
Weapons	EA1000 x8 (retractable mounts) w/UTES, Type-29 PDC	37	31.9
Targeting	UTES (+1), Targeting Comp (+3)	—	—
Ordnance	Combat Drones: SIM-14 x20	41.8	64.418
Drone Controllers	10	2.5	5
Tactical Action Centre	22 Personnel (command, gunners x9, remote operators x10, sensor operators x2)	22	2.2
Systems	Under Spin: Armoury, Automeds x5, Briefing Rooms x12, Exercise Equipment x20, Galleys x10, Medbays x2, Safety Lockers x2, Ship's Lockers x2, Simple Freshers x10, Workshops x2 Zero-G: Safety Locker, Simple Freshers x6, Workshops x2	106.25	34.68
	Loading Arms x2, Slings (55 tons)	6.75	1.05
Drones and Remotes	HD-5 Scout, Repair Remotes x10, Inspection Remotes x4, Communications Satellites x10, Goalkeeper Defence Drone	12.1	16.5
Airlocks	Standard Airlocks x9, Small Cargo Airlock	4	0.04
Accommodations	Under Spin: Small Staterooms x90, Staterooms x4	196	11
Artificial Gravity	Type: Extendable Spin Capsules (294.83 tons under spin)	53.07	53.07
	Radius: 45 m, 3 RPM, Gravity: 0.45 G, Spin Up/Down: 27 minutes		
Software	Archive, Auto-Repair/1, Intellect, Manoeuvre, Neural Interface, Stutterwarp Control; Targeting Comp: Fire Control/3	—	13
Life Support Consumables	56 days for 90 people	10.08	—
Cargo		17.76	—
Total: MLv596			

Crew	Passengers	Hull Points	Signature: 4
Captain, Bridge Officers x2, Astrogators x3, Flight Engineers x3, Pilots x3, Sensor Techs x3, Reaction Drive Engineers x3, Stutterwarp Engineers x3, Power Engineers x15, Life Support Techs x3, Electronics Techs x3, Gunners x18, Drone Pilots x20, Drone Technicians x2, Security x3, Medics x3, Steward **Comfort Rating**: +1	—	99	Base Reflected: 4 Base Radiated: 2 (oversized radiator) Spin Hab Retracted: -1 Discharge Vanes Extended: +1

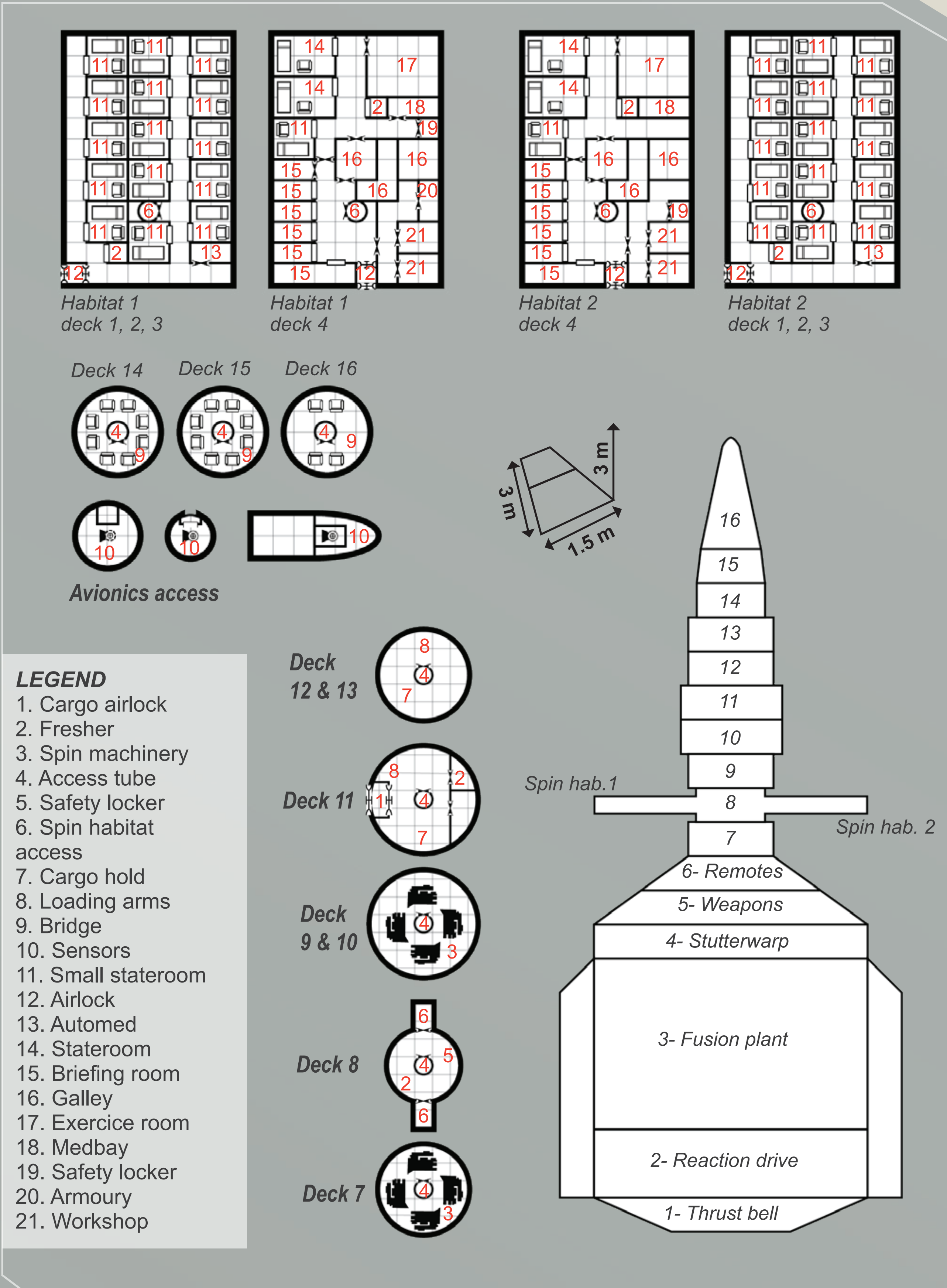
Kennedy-class Fast Missile Carriers

USS John F. Kennedy, USS Theodore Roosevelt, USS Jane Kostek, USS Abraham Lincoln, USS Barack Obama, USS Yafa Nashashibi, USS George Washington, USS Jennifer Marlowe, USS Ernest White, USS Foxx Travis, USS Julia Pemberton, USS Calvin Morrison (Lost 2298).



LEGEND

1. Airlock
2. SIM-14 bay
3. Reaction drive
4. Access tube
5. Fuel tanks
6. Power plant
7. Stutterwarp
8. EA1000 bay
9. Drone controller
10. HD-5 bay
11. Workshop
12. Remotes
13. Satellites bay
14. Defence drone


Habitat 1
deck 1, 2, 3
Habitat 1
deck 4
Habitat 2
deck 4
Habitat 2
deck 1, 2, 3
Deck 14
Deck 15
Deck 16
Avionics access
3 m
3 m
1.5 m
Deck 12 & 13
Deck 11
Deck 9 & 10
Deck 8
Deck 7
16
15
14
13
12
11
10
9
8
7
Spin hab.1
Spin hab. 2
6- Remotes
5- Weapons
4- Stutterwarp
3- Fusion plant
2- Reaction drive
1- Thrust bell
LEGEND
1. Cargo airlock
2. Fresher
3. Spin machinery
4. Access tube
5. Safety locker
6. Spin habitat access
7. Cargo hold
8. Loading arms
9. Bridge
10. Sensors
11. Small stateroom
12. Airlock
13. Automed
14. Stateroom
15. Briefing room
16. Galley
17. Exercice room
18. Medbay
19. Safety locker
20. Armoury
21. Workshop

KAEFER BETA CRUISER

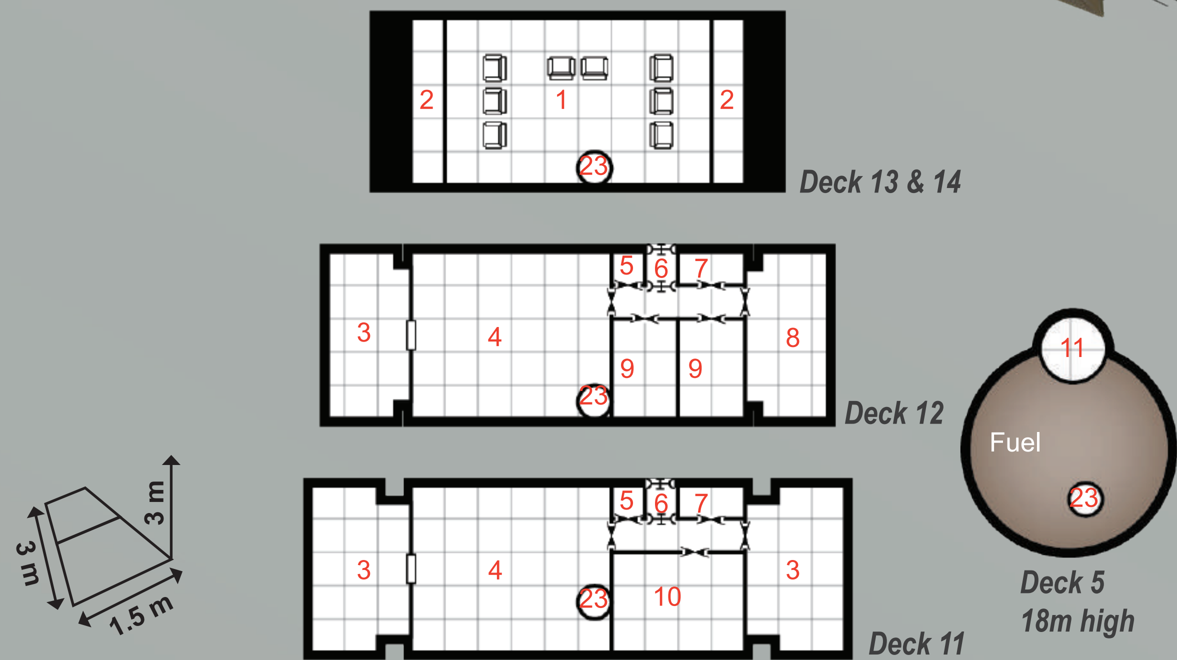
NATION: Kaefer
FIRST EXAMPLE LAID DOWN: Unknown
MANUFACTURER: Unknown
PRODUCTION STATUS: Unknown
CONSTRUCTION TIME: Unknown
SERVICE STATUS: In Service
FLEETS OF SERVICE: Kaefers
NUMBER IN SERVICE: Unknown
LENGTH: 70 m
WIDTH: 25 m
LAUNCH MASS (ESTIMATED): 12,500 tons
POWER PLANT: 110 MW Fusion Reactor
REACTION DRIVE: Nuclear OMS Thruster, 12,000 tons thrust
STUTTERWARP: 24 MW Stutterwarp

The Beta is the most common Kaefer capital ship encountered. It is a powerful vessel in its own right and carries a significant troop complement with landers and ground vehicles. These troops appear to be initial assault forces, whose role is to prepare beachheads for an Epsilon to deposit its large loads of infantry.

It carries three landing craft but no support aerospace craft to escort them to a planetary surface. Armament is heavy, including four Golgotha heavy particle beam weapons, the most powerful such weapon in use anywhere. Missile loadout appears to be relatively light, however.

TL13		Tons	Cost (MLv)
Hull	1,100-ton Aligned Crystal Steel Spaceframe	—	22
Hull Features	Radiation Shield, Advanced	151.25	27.5
Armour	11	151.25	12.1
Reaction Drive	Nuclear OMS Thruster	33	33
Stutterwarp	2.65 ly/day, Tac Speed: 3 System Speed: 1.71 AU/day	11.62	58.09
Power Plant	Fusion Reactor (Power 1,100)	61.11	73.33
Emergency Power	Power 12 (48 hours)	0.528	0.528
Fuel Tanks	Nuclear OMS Thruster (20 Burns)	148.5	—
	Subcraft Fuel (2 refills)	80	—
Radiators	AHDR, Capacity 1,200	60	30
Bridge	Standard, Encrypted Comms	40	6.5
Computer	Primary: Computer/25 Secondary: Computer/20	2	11.6
Sensors	Basic Military, DSS, GADS, Basic Survey, Telescope	10.16	16.91
Weapons	Grumblers x6 w/UTES in Surface Mount, Golgothas x4 w/UTES in Heavy Gun Tower	92	64.8
Targeting	UTES (+1) Fire Control (+1)	—	—
Ordnance	Combat Drones: X-Ray x20	55	60.55
Drone Controllers	10	2.5	5
Systems	Armouries x2, Shrines x2, Training Area for 50, Simple Freshers x20	113	11.3
	Breaching Tubes x4, Slings x200	26	14
	Warhead Workshop	8	1.2
Sub-Craft	Llama-class Landers in Berth x2	176	17.6
Airlocks	Standard Airlocks x12	—	—
Accommodations	Nest for 480, Burrows x3, Cocoons x20	56	500.06
Software	Fire Control/1, Manoeuvre, Stutterwarp Control	—	3.26
Life Support Consumables	60 days for 500 people	90	—
Cargo		13.53	—
Total: MLv881.89			

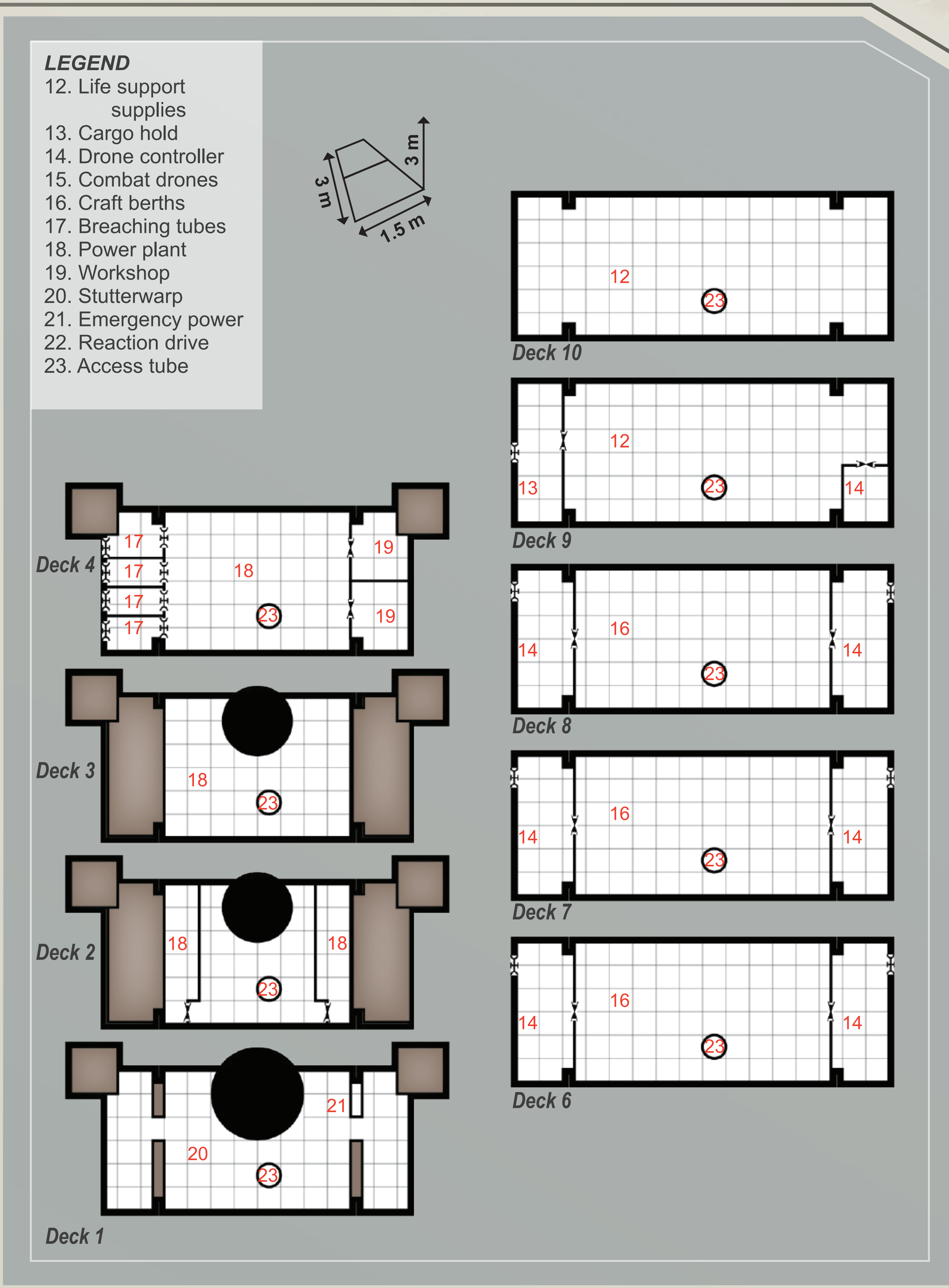
LEGEND
1. Bridge
2. Sensors
3. Burrow
4. Nests
5. Armoury
6. Airlock
7. Shrine
8. Cocoons
9. Freshers
10. Training area
11. Sling



Crew	Passengers	Hull Points	Signature: 4
Captain, Bridge Officers x2, Astrogators x3, Flight Engineers x3, Pilots x3, Sensor Techs x3, Reaction Drive Engineers x6, Stutterwarp Engineers x6, Power Engineers x15, Small Craft Techs x4, Life Support Techs x3, Electronics Techs x3, Gunners x36, Drone Pilots x20, Drone Technicians x2, Damage Control x110, Security x16, Ship's Troops x200, Small Craft/Fighter Pilots x6 **Comfort Rating**: N/A	—	121	Base Reflected: 4 Base Radiated: 4

Running Costs
Maintenance Cost: Lv70162/month Purchase Cost: MLv841.94

Power Requirements	Power
Basic Ship Systems	11
Reaction Drive	110
Stutterwarp	240
Sensors	11
Drone Controllers	20
Weapons	650


LEGEND
12. Life support supplies
13. Cargo hold
14. Drone controller
15. Combat drones
16. Craft berths
17. Breaching tubes
18. Power plant
19. Workshop
20. Stutterwarp
21. Emergency power
22. Reaction drive
23. Access tube
3 m
3 m
1.5 m
Deck 10
Deck 9
Deck 8
Deck 7
Deck 6
Deck 4
Deck 3
Deck 2
Deck 1

INDEX

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