2300AD

HUMANITY DISCOVERS THE STARS

AEROSPACE ENGINEERS' HANDBOOK

Sample file

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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.

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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

Sample file


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

Sample file

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.

Sample file

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)

Sample file

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-2	Efficient, -2 to Reflected signature
Composite	12	1.5	TL+0	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.

Sample file

Hull Configurations

Sample file

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.

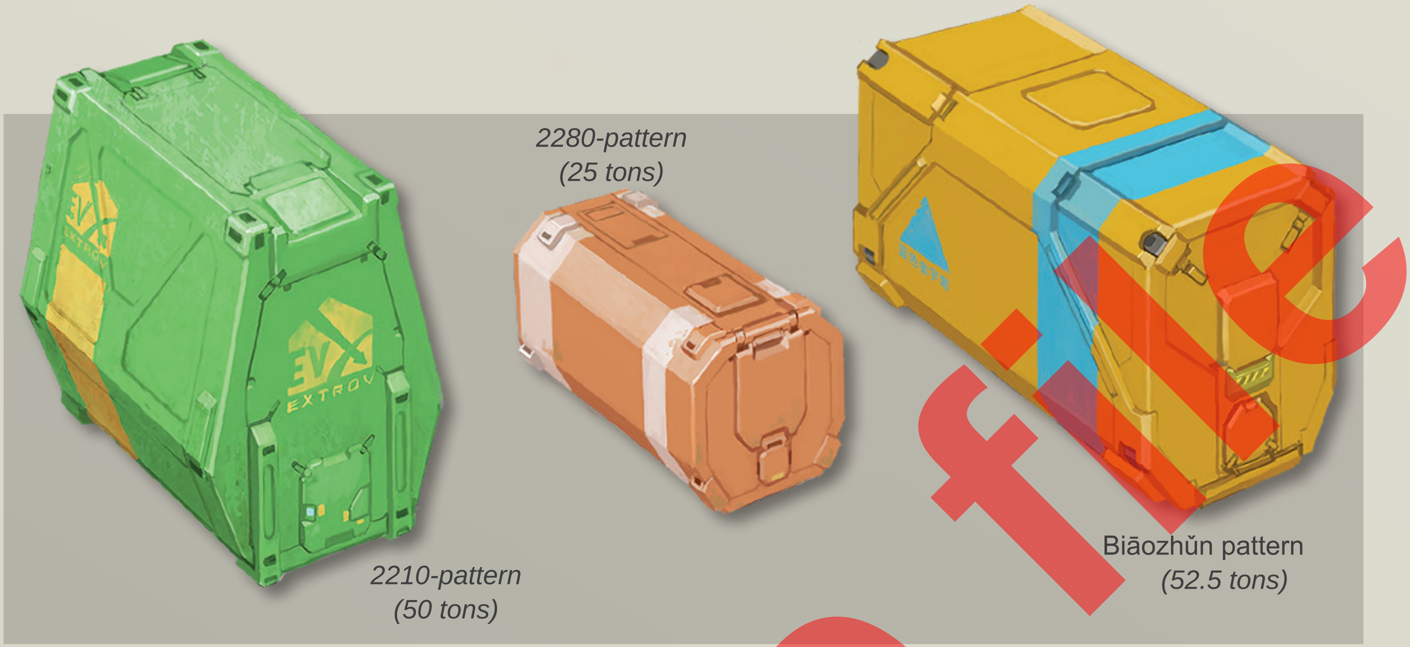
CONTAINER TYPES

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.

Sample file



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. In addition, all streamlined hulls have integral attachment points for solid rocket boosters and external fuel tanks included at no additional cost.

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,

sample file

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.

VTOL 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.

Landing and Take-Off Requirement 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.

Sample file

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	—	-1	x1.05	—
Heat Shield	0.01/ton	—	—	—
Heavy	—	+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 armour value 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. Starships will almost always be detectable by the heat they radiate, unless they employ heat sinks to temporarily store rather than radiate it..

Tough: The Tough trait grants a ship +1 Hull per 50 tons and increases its base cost by 50%. Note that the 'Tough' trait imparted by a Composite hull incurs no additional cost over the cost of the hull material.

Sample file

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 20%) 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 1%).

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 2% 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 0.5%). 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.

Sample file