Hypertext Slag!™ version 1.1
A game of combat on the high frontier

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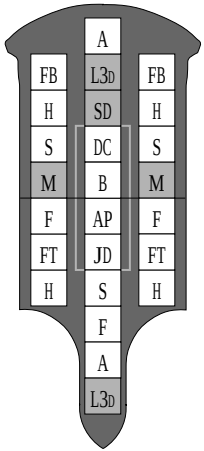
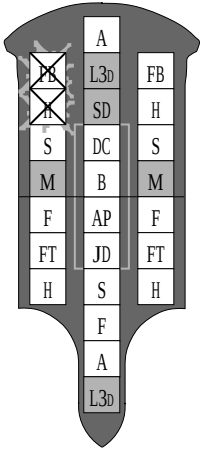


NSS Artemis emerged from hyperspace expecting a fight, and wasn't disappointed. Her residual drive flare, nuclear emissions and jump signature made *Artemis* and every other ship in the fleet visible to enemy spotters within a fraction of a second. The first signs of the attack came in the form of localized increases in the background radiation count, as particle beams interacted with flecks of interplanetary dust or hydrogen molecules, and in the visible flashes detectable only by sensors when laser beams did the same. It was a statistical certainty that some of those invisible packets of energy would intersect *Artemis*, but smart tactics could delay that inevitability for a while. With all hope of subtlety lost, fusion engines roared into life, new stars visible to the naked eye, even at maximum combat range. Decoys with the same thermal and radar signature deployed in a dozen different directions, forcing enemy targeting computers to waste valuable fractions of a second figuring out which target was the real one, and dividing fire between the most likely candidates.

In the meantime, multiple sensors plot the most likely regions of space the attacks are coming from, tracing pinpoint flashes of ionized particles back along a line and pouring all weapons fire into the likely point of origin. This changes second to second, as one enemy ship, then another turns on their drives, not only to maneuver, but to prevent *Artemis* and her sister ships from getting through to the inner system. With this, the second phase of the attack begins. *Artemis* is a missile carrier, armed with long-range unpiloted drones, and medium range cluster munitions.

Enemy sensors pick up several smaller fusion flares as these self-contained war machines are dumped from bays on *Artemis*, each with a particular mission to accomplish.

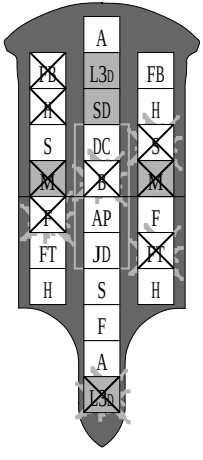
Meanwhile, all is not well in the attacking fleet. *Artemis* is still unscathed, but not due to luck. Several hits have been scored on her, registered as flashes of radiation and light to enemy sensors, but Artemis' armor has largely prevented penetration. Those shots that did get through the metal, ceramic and composite layers of her hull had too little energy left to do more than superficial damage. Crew casulaties have been light, and performance unaffected. Enemy sensors have already figured this out, and their lesser weapons redirected to softer targets. The next hits will be from larger weapons. Already, some of *Artemis* sister ships have taken serious hits. Heavy lasers blast meter-wide gouges in a hull, sending molten debris flying at supersonic speed into delicate electronics and equipment. Neutral particle beams do much the same, but shed their energy more slowly, irradiating everything they touch, secondary X-rays cascading through compartments, eventually dissipating their wrath as heat, but not before reaching deep into the hull, probing to find and kill the central computers and the command crew that runs them. Two of the frigates have already suffered antimatter cascade explosions in their main engines, and now drift helplessly. Still able to fight, they relay sensor data to the rest of the fleet, but within minutes they are silenced by the first of the enemy missiles. If you can't maneuver, you don't stand a chance.



Artemis takes her first major hit, a particle beam of some kind judging by the temporary sensor overload. It strikes the dorsal hangar and cascades through into the hull, leaving radiation and molten debris in its wake. Fortunately, these hangars were empty of their lethal cargo, and combat effectiveness is unimpaired. Artemis responds with a barrage of medium range nuclear missiles. In previous centuries these might have been mistaken for ICBM's, up to two meters wide and ten meters long, massing up to 20 metric tons, powered by a fusion torch and armed with multiple independent nuclear warheads. *Artemis* is a big ship. She launches over a dozen at the enemy flagship, timed to match the arrival of the long-range drones that have survived this long. *Artemis* crew notes a similar launch and tactic by the enemy flagship, and reconfigures all weapons to point defense status. *Artemis'* long range drones arrive first. Each takes several hits to take them out of action, since they were designed for survivability. One gets through. It has no warhead, but it doesn't need one. Fifty tons of *anything* travelling at 100 kilometers a second has as much energy as a large nuclear warhead. Normally this would vaporize the enemy ship, but the debris is travelling so fast it just tears a ragged molten hole in one side and out the other, punctuated only by an additional flash from the drone's exploding antimatter engine.

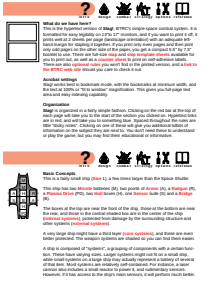
It did its job, though. The temporary loss of sensor data and assessment of damage allowed one of Artemis' missiles to reach their target. Deploying at 100 kilometers out, several independent warheads jet erratically in, and two survive the point-blank barrage of laser fire to detonate at a range of 2 kilometers.

Two small suns flare for an instant, then are gone, registering through the fleets as a burst of heat and gammas. The enemy flagship remains, but glowing and caved-in sections of hull and armor testify to the forces unleashed. Sensor activity is down, at least one engine has been damaged, and the small echos of point defense radars are silent. *Artemis* may be out of missiles, but someone else will finish the task.



Meanwhile, *Artemis* deploys expendable sensor arrays in a cloud around her. These thrust away for several seconds until their engines are depleted, and then scan the heavens, relaying information back to *Artemis* and any nearby friendly ships. The extra data helps *Artemis* lock onto enemy fighters and drones, and all weapons are brought to bear to shoot them down. The missiles and independent warheads are shot down, and most of the long-range drones, but several make it to deployment range. First they scatter smaller missiles, whose warheads detonate, using the thermonuclear pulse to power a one use gamma-ray laser. *Artemis* soaks up most of the energy on its armor and structure, but several key systems suffer the effects. Then, the now empty drones home in and tear massive holes in *Artemis*, leaving white-hot metal and empty space where the bridge used to be. At least it was fast enough that they never felt a thing.

It's a hell of a way to fight a war...



What do we have here?

This is the hypertext version of **Slag!**, BTRC's simple space combat system. It is formatted for easy legibility on 13"to 17" monitors, and if you want to print it off, it prints well at 2 sheets per page (landscape orientation) with an adequate left-hand margin for stapling it together. If you print only even pages and then print only odd pages on the other side of the paper, you get a compact 5.5" by 7.5" booklet to use. There are full-size **map** and **ship template sheets** available for you to print out, as well as a **counter sheet** to print on self-adhesive labels. There are also **optional rules** you won't find in the printed version, and a **link to the BTRC web site** should you care to check it out.

Acrobat settings

Hypertext Slag! works best in bookmark mode, with the bookmarks at minimum width, and the text at 100% or “fit to window” magnification. This gives you full-page text area and easy indexing capability.

Organization

Slag! is organized in a fairly simple fashion. Clicking on the red bar at the top of each page will take you to the start of the section you clicked on. Hypertext links are in red, and will take you to something blue. Spaced throughout the rules are little “sticky notes”. Clicking on one of these will give you additional tidbits of information on the subject they are next to. You don't need these to understand or play the game, but you may find them educational or informative.

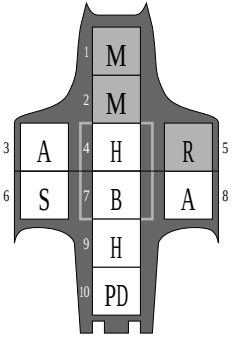
Intro

Slag! is a fast and simple space combat game that you can play anywhere, anytime. You don't need fancy maps, hordes of dice, decks of cards or reams of rules. All you really need is a sheet of paper for your fleet, a handful of spare change, and a space the size of a checkerboard, or a plain old sheet of hex paper if you are tight on space.

Designer's note

Slag! has gone through a number of incarnations before reaching the simple game you've just picked up. It is supposed to take the complex nature of ship construction and space combat, and make it as simple as possible while still keeping whatever realism we can manage without actual experience to draw on.

Many assumptions about the nature of things are abstracted into the rules without being explicitly stated, such as the role of fuel consumption, vector movement, three-dimensional combat, ship structure, and so on. It's supposed to be fun, fast and affordable, and I hope you like it.



Basic Concepts

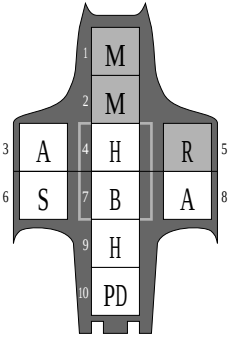
This is a fairly small ship (**Size** 1), a few times larger than the Space Shuttle:

This ship has two **Missile** batteries (M), two points of **Armor** (A), a **Railgun** (R), a **Plasma Drive** (PD), two **Hull** boxes (H), one **Sensor** suite (S) and a **Bridge** (B).

The boxes at the top are near the front of the ship, those at the bottom are near the rear, and those in the central shaded box are in the center of the ship (**internal systems**), protected from damage by the surrounding structure and other systems (**external systems**).

A very large ship might have a third layer (**core systems**), and these are even better protected. The weapon systems are shaded so you can find them easier.

A ship is composed of “systems”, a grouping of components with a certain function. These have varying sizes. Larger systems might not fit on a small ship, while small systems on a large ship may actually represent a battery of several of that item. Most systems are relatively self-contained. For instance, a laser cannon also includes a small reactor to power it, and rudimentary sensors. However, if it has access to the ship’s main sensors, it will perform much better.



These systems are arranged on the display to represent their *approximate* location on the ship, with the exception of armor and hull, which are assumed to be throughout the ship. However, Armor and Hull *do* have separate systems to represent structural weak points.

Example - This ship is a fairly conventional design. It has weaponry in front, engine in the rear, and some hull and the bridge protected well within the hull.

Note - In any vehicle where all the relevant combat data is coming from sensors rather than human senses, it makes no sense to put the brains of the ship anywhere but deep within the hull, protected by as much machinery as you can manage.

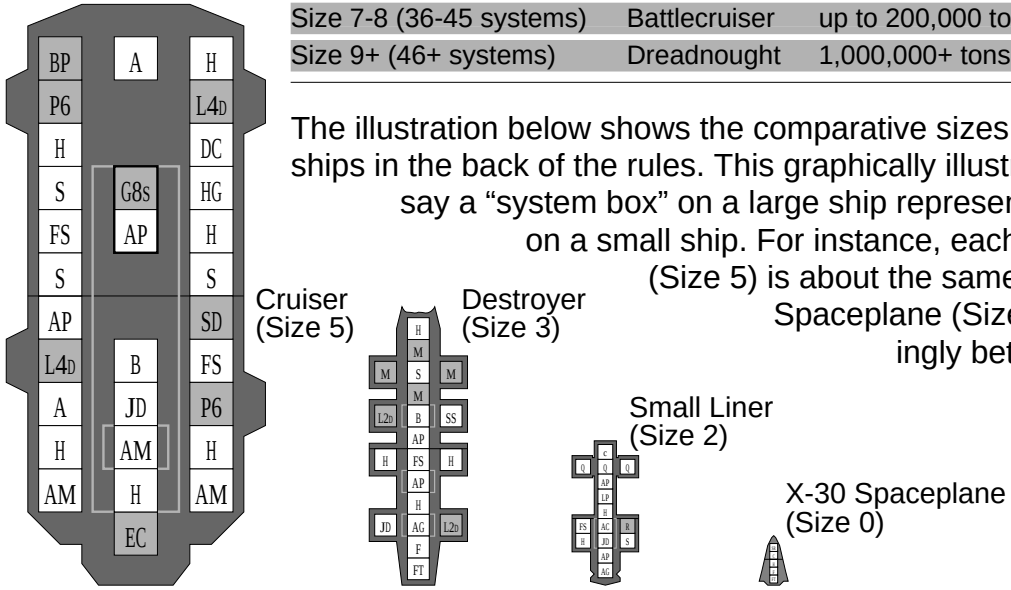
Each box on a ship display represents a single system, no more, no less. The **Size** of a ship is based on the total number of systems it has. A Size 0 ship has 5 or less systems, and each 5 systems after that adds 1 to the Size (round fractions up). The Size of a ship helps to absorb damage, even if it has no **Armor**, and ships will have a **Damage Modifier** of half their Size (round down).

Example - A ship with 6-10 systems is Size 1 and has a Damage Modifier of 0. A ship with 21-25 systems is Size 4, and has a Damage Modifier of -2.

If you need a scale, a Size 0 ship is around 50 metric tons, and each Size increase triples the ship mass. Ships are generally classed as follows:

Ship Size	Classification	Typical mass
Size 0 (1-5 systems)	Fighter	up to 50 tons
Size 1-2 (6-15 systems)	Frigate	up to 400 tons
Size 3-4 (16-25 systems)	Destroyer	up to 3,000 tons
Size 5-6 (26-35 systems)	Cruiser	up to 25,000 tons
Size 7-8 (36-45 systems)	Battlecruiser	up to 200,000 tons
Size 9+ (46+ systems)	Dreadnought	1,000,000+ tons

The illustration below shows the comparative sizes of some of the pre-designed ships in the back of the rules. This graphically illustrates what we mean when we say a “system box” on a large ship represents a lot more stuff than a box on a small ship. For instance, each Sensor (S) on the Cruiser (Size 5) is about the same size as the entire X-30 Spaceplane (Size 0), and it has correspondingly better performance.

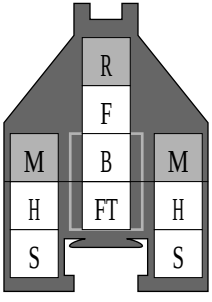


Ship Design

Since you are going to want to design ships eventually, we'll go through ship design *before* combat. That way, you'll already understand most of the concepts you need to know.

Systems

Each box on the ship display represents a single system, no more, no less. Spare systems *do* take separate boxes, and some systems require other supporting systems.



Example - A ship with multiple **Sensors**(S) may be able to hit targets better, but can still function if one of them is knocked out. A ship with a **Fusion Torch**(FT) engine will require a separate **Fuel**(F) system in order to operate. If the fuel is destroyed, the engine no longer works, and if the engine is destroyed, the fuel becomes almost useless (unless there is another engine it could supply).

System abbreviations

The list below covers all ship systems available in **Slag!**.

Engines

AG	Antigrav Drive
AM	Antimatter Drive
BD	Burp Drive (optional)
FT	Fusion Torch
OD	Orion Drive (optional)
PA	Plasma Accel.(optional)
PD	Plasma Drive
JD	Jump Drive
JG	Jump Gate (optional)

Weapons

BP	Boarding Parties
DM	Dogfight Msl. (optional)
G	Graser
GM	Graser Mines (optional)
K	KE Missiles (optional)
KK	Kinetic Kill Msl. (optional)
L	Laser Cannon
M	Missiles
M	Antimatter Missile (optional)
P	Particle Beam
R	Railgun
R	Antimatt. Railgun (optional)
SD	Sensor Drones
SM	Space Mines

Defenses

A	Armor
AA	Ablative Armor (optional)
AF	Absorption Field (optional)
EC	Electronic Countermeasures
FS	Force Screen
ID	Intruder Defense
ND	Nuclear Dampers (optional)
TB	Tractor Beam (optional)

General systems

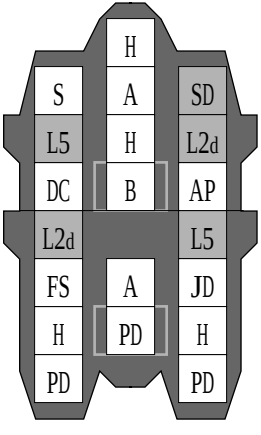
AC	Auxiliary Control
AI	Artificial Intel.(optional)
AP	Auxiliary Power Unit
B	Bridge
BK	Breakaway (optional)
C	Cargo
DC	Damage Control
F	Fuel
FB	Fighter Bay
FP	Fuel Pod
H	Hull
HG	Hangar
LP	Lifepods
Q	Quarters
RS	Redundant Sys.(optional)
S	Sensors
SS	Scout Sensors
SR	Streamlining

Tech Levels

Most ship components have a **Tech Level**, which may affect their performance. The range is from Very Low to High, with a default of Medium Tech. Tech Level affects the point cost and performance of a ship, and certain systems are only available at certain Tech Levels. All of the standard systems are available at Medium Tech, and have the described level of performance.

Engines

Each engine provides a certain number of **thrust points** to a ship. For instance, each **Plasma Drive** provides 2 points of thrust. The actual thrust of the ship is the *total* thrust points minus the **Size** of the ship. Each point of thrust a ship has is roughly equal to one g of acceleration. Also, a ship requires a number of **Hull** systems equal to the half the Size of the ship (round up), plus the number of engines, with a maximum of Size+1.



Example - A Size 3 ship with 3 Plasma Drives will have a final thrust of 3 (3 Engines times 2 points of thrust each, minus 3 for the Size of the ship). This ship also requires 4 Hull systems to support this amount of thrust (Size 3 ship, plus 3 Engines, which would normally be 5 Hull systems, but the maximum ever required for a Size 3 ship is 4 Hull systems). If this ship had 2 Plasma Drives, it would have a final thrust of 1, and still require 4 Hull systems. Most combat ships will end up with Size+1 Hull systems, so you should count on that when working on a design.

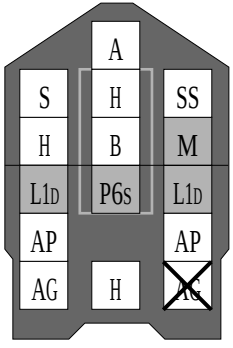
A ship may not have a final thrust of more than 8-Size (minimum of 1), or less than 1. A ship must have a final thrust rating of at least 1 to move in combat. If a ship has engines but a final thrust of less than 1 (from combat damage, for instance), it may still be able to accelerate slowly, but may not maneuver during play. Slow civilian ships without a high thrust requirement may also fall into this category. In play, such a civilian ship would have a fixed direction and speed, and be unable to change it during play, at least compared to speedier military ships.

Engine types

A ship may be equipped with 4 basic types of engines, plus **Jump Drive** for interstellar ships.

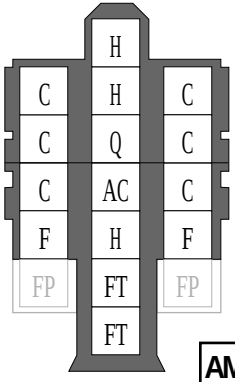
AG **Antigrav (Medium tech+)**

This uses gravity repulsors to push against the interstellar background mass. It requires massive amounts of power to operate, provided by an **Auxiliary Power Unit** system (AP). Each engine of this type must be able to draw power from a *separate* Auxiliary Power Unit. An antigrav engine normally provides 3 thrust points, but if a **planet**, **moon** or **asteroid** is in the ship's rear arc at the *start* of the turn, each engine provides 4 thrust points for that turn (even if the rear arc of the ship does not continue to face that way). Each *extra* Auxiliary Power Unit devoted to a *particular* Antigrav engine provides +1 thrust point from *that* engine. Available power can be shifted before movement starts.



Example - A ship with two Antigrav engines and two Auxiliary Power Units takes damage and loses an Antigrav engine. On the following turn, the ship routes power from *both* Auxiliary Power Units through the remaining engine, giving it +1 thrust point.

FT **Fusion Torch (Very Low tech+)**
This uses a fusion reactor to heat a reaction mass (typically water) to superheated temperatures for use as thrust. It is powerful, but consumes a great deal of fuel. A Fusion Torch engine provides 3 thrust points, but requires a **Fuel** system for each engine. *Each* engine must be able to draw from a *separate* Fuel system in order to operate. Size 0 or Size 1 ships that can operate *only* in atmosphere do not require Fuel for this system (they are assumed to be fusion reactors powering turbojets). A Fusion Torch can provide *double* thrust for a turn if you *consume* an intact Fuel system to power it (normal use *does not* consume significant fuel in the timeframe of combat). Very Low Tech ships *cannot* get double thrust in this way. This Fuel system is marked off at the end of movement, and before combat.



Note - Ships with Fusion Torch engines will sometimes carry extra fuel in **Fuel Pods** (FP). If a ship has two Size numbers, like 2(3), it means the Size for targeting without and with Fuel Pods. Likewise, if the ship has two Thrust ratings, like 3(6), it probably means basic and doubled engine thrust. Remember that if a ship is effectively larger with Fuel Pods, its effective thrust will be a little lower than you would guess at first glance. The only reason the thrust in parenthesis would be smaller (like 3(2)) would be for a Very Low Tech ship that must use fuel each turn, and whose effective thrust goes *up* after dropping Fuel Pods.

AM **Antimatter (Medium tech+)**

This is similar to a fusion torch, but a lot more efficient, and with a self-contained fuel supply. An Antimatter engine provides 3 thrust points, but will explode like a missile warhead if it is ever damaged. The owner of a ship equipped with this type of engine may deactivate the engine at the end of that ship's movement by stating they are doing so. With the antimatter ejected, the engine cannot be used to move the ship, but it has no side effects if damaged. A deactivated or damaged antimatter engine cannot be repaired with Damage Control.

PD **Plasma Drive (Low tech+)**

This uses a fusion reactor to generate and accelerate superheated plasma, and this provides 2 thrust points per engine. It is very fuel efficient and fuel mass is included in the system.

JD **Jump Drive (Medium tech+)**

A Jump Drive is some form of faster-than-light travel. Since we don't know how to do this yet, Jump Drive is just a “black box” that you pump energy into and get FTL travel out of. You can give it special effects of your choosing if you insert **Slag!** into some other game system. No ship can completely escape a battle unless it has access to a Jump Drive. A large ship can Jump with any number of small ships as long as it has enough Fighter Bays or Hangars, but ships of Size 2 or greater usually need their own Jump Drives. A Jump Drive requires a functioning **Auxiliary Power Unit** to operate, and this Auxiliary Power Unit cannot be used for other purposes during the turn the Jump Drive is activated. Jump Drives (and other non-thrust drives like **Burp Drive**) *do not* count as engines for determining a ship's Hull.

General systems

These are the non-weapon essentials of a ship. Some are mandatory (Hull), others are highly recommended (Sensors), and some are useful only for scenario games (Cargo).

AC **Auxiliary Control (Very Low tech+)**
This system operates as a backup bridge *and* sensor array, but is not as good as either. A ship using Auxiliary Control because it has lost its bridge takes a -1 on its Sensor Rating. If using it because it has lost *both* bridge and other sensors it is counted as having a Sensor Rating of -2, but it is better than the default of -4 for having no sensors and no bridge. Many non-military vessels will have only an Auxiliary Control to save space, and in fact the sophisticated electronics of a military ship's Bridge may be prohibited to civilian vessels.

AP **Auxiliary Power Unit (Very Low tech+)**
This is a secondary reactor system to provide electrical power for systems which cannot provide their own, like Jump Drives, Force Screens or Antigrav units. The systems that require separate Auxiliary Power Units will detail their use.

B **Bridge (Very Low tech+)**

The Bridge is where the command crew and computers make their combat decisions, even if the actual movement and weapon direction is handled elsewhere. A ship without a functioning Bridge takes a -2 to its Sensor rating. Size 0 ships are assumed to be single or two-being vehicles and require no Bridge (i.e. they take no penalty for not having one). On Size 0 ships it is assumed to be part of the Hull system(s), and once it is destroyed the ship is no longer functional.

Note - For any sort of role-playing or visualization purposes, think of the Bridge as a low-ceilinged room with armored acceleration couches and control consoles, occupied by people in bulky, armored space suits. The rest of a military ship is equally harsh, and if you think of the environment in a nuclear sub, it's probably pretty close (no windows, limited space, armored bulkheads, etc.)

C **Cargo (Very Low tech+)**

This system is only used on civilian ships as part of predesigned scenarios. On most unarmored ships, cargo is assumed to be detachable pods that are moved about by space tugs, and which can be detached before movement. Such a cargo ship is counted as having a smaller Size if it detaches 5 or more pods, which will alter its thrust, damage modifier and chance to be hit. If a Cargo system is destroyed, all cargo stored in it is lost. See also **Strategic Play.**

DC **Damage Control (Very Low tech+)**
Damage Control is a catch-all system that represents crew members scurrying frantically about with cutting torches, spare parts, weapon reloads, duct tape and bailing wire. Damage Control may be destroyed at the end of any turn to repair any single system, with the exception of antimatter engines and a few others. The maximum number of Damage Control systems a ship can have is equal to its Size (Size 0 ships can have *no* Damage Control systems).

Note - Often you might want a system more useful than Damage Control, but it is a useful way to repair a critical system that was destroyed despite your best tactical efforts.

F **Fuel (Very Low tech+)**
Fuel is generally an inert reaction mass like water which is required by a Fusion Torch engine. Fuel may also be vented into space to form a cloud of ice crystals which will deflect and absorb energy from **Lasers** and **Particle Beams**. If a Fuel system is voluntarily destroyed *before* movement (may not be repaired by Damage Control), that ship will be treated as having an Armor rating 2 points higher than normal vs. Lasers and Particle Beams, until the end of the turn. The maximum benefit that can be gained by this tactic is 2 points of Armor in any given turn. Note that an Engine cannot use fuel *during* movement if it was jettisoned *before* movement.

FB **Fighter Bay (Very Low tech+)**

This is internal hangar space used to carry secondary ships. A “fighter” is any ship of Size 0, and the number of fighters a bay holds is equal to the Size of the carrier minus 1. Fighter Bays can deploy or pick up their entire contents in one turn.

Example - A Fighter Bay on a Size 3 ship can hold 2 fighters.

Once deployed from Hangars or Fighter Bays, ships can be picked up if the carrier starts and ends movement in the same sector as the carried ship. While in the bay, fighters are protected by the carrier’s Armor, but if the bay is damaged, all the ships in it are damaged and unable to be used. If the bay is repaired, the ships in it can be deployed again. If a ship in a Fighter Bay that is damaged uses Antimatter engines, that ship explodes in the Fighter Bay, and the carrier takes damage as if a missile struck that location. All ships in that Fighter Bay are destroyed and cannot be repaired. If any of them had Antimatter engines, they also explode, and apply damage in the same way.

FP **Fuel Pods (Very Low tech+)**

Ships using FT drives consume huge amounts of fuel at maximum thrust. For increased combat endurance, some ships carry external fuel stores which are dropped immediately after use. These count as normal fuel systems, but are mounted outside other *external* systems, and must be used *first* when fuel is consumed. A ship may have up to 1 of these per FT engine, and they *do* increase the Size of the ship for targeting and usable thrust purposes while attached. A ship that is hit by weapons always loses 1 Fuel Pod per hit, regardless of where they are mounted. This is in *addition* to any other damage the ship takes from that hit. Used Fuel Pods are discarded at the end of movement, and *before* combat. Fuel Pods *do* cost like a single system for a ship the Size they are mounted on (*not* the Size it becomes).

Example - A Size 2 ship (15 systems) has 2 Fusion Torch engines, and 2 Fuel Pods. This ship now has 17 systems, making it Size 3, which increases the chances of being hit in combat and decreases the total thrust of the ship.

Fuel pods or internally carried **Fuel** may also be used in combat to reduce the effects of Laser or Particle Beam fire.

H **Hull (Very Low tech+)**

This is the framework to which all ship systems are attached. If a ship ever loses all its Hull systems, it is *immediately* destroyed and removed from play. A ship must have a number of Hull equal to half its Size (round up), plus the number of engines it has, with a maximum required amount of its Size+1 (e.g. a Size 0 ship never has to have more than 1 Hull). Any base or ship has to have at least 1 Hull. In general, Hull will be ≈15-20% of most ships systems.

Example - A Size 8 ship (45 systems) has 3 Antigrav Engines, for a total of 9 thrust points. Minus its Size, this gives it a final thrust of 1. It also requires 7 Hull systems, 4 for its Size, plus 3 more for its Engines (it also takes at least 3 APU's to power the antigrav, but that's a separate issue).

HG **Hangar (Very Low tech+)**

This is internal hangar space used to carry secondary ships. A Hangar can carry ships of Size 0 *or* Size 1, and the number of ships a hangar can hold is equal to the Size of the carrier minus 2. Ships in Hangars are treated exactly as those in Fighter Bays in case of damage. However, a ship can only launch *and* retrieve one ship per turn from a Hangar, since it is designed to handle multiple ship sizes, not the specialized deployment and retrieval of Size 0 ships.

Example - A Hangar system on a Size 5 ship can hold three Size 0 or Size 1 ships.

LP **Lifepods (Very Low tech+)**

Lifepods *theoretically* allow the crew of a doomed ship to escape with their lives. A ship with an intact Lifepod automatically ejects it if the last Hull system is destroyed. Treat the Lifepods as one or more Size 0 ships with a thrust of 1 and a single system box (Very Low Tech Lifepods have a thrust of 0). If they take *any* damage, they are destroyed. Any ship of Size 1+ which starts *and* ends its movement in the same sector as the lifepods may pick up survivors before combat begins. A rescued lifepod is worth the originating ship's Size in points to the side that picks it up, *if* the rescuing ship survives until the end of the game. If a Lifepod can escape the map, the Lifepod is considered rescued by friendly forces if any Jump-capable ship also exits that map edge. Lifepods are considered to have **Streamlining**, and may make safe landings on a planet or moon with a friendly base, if they survive combat on the turn they land. Most civilian ships of Size 2+ will be required to have a Lifepod system. Most military ships will not have them at all.

Q **Quarters (Very Low tech+)**

This system is only used on civilian ships or as part of predesigned scenarios. If it is destroyed, passengers in that area are presumed lost. Military ships have their crew stuffed anywhere they will fit, and are usually considered to be somewhere in the Hull when not at their stations.

S **Sensors (Very Low tech+)**
These are used for targeting a ship's weapons, and providing secondary guidance to missiles. The rating of a Sensor is the Size of the ship it is mounted on. If a ship has more than one Sensor, it gets a +1 to the total rating per *two* regular Sensors after the first (round down). If a ship has no working Sensors in a firing arc, it is assumed to have a rating of -2. The maximum effective Sensor rating a ship can use in combat is twice its (Size+1).

Note - The term "maximum effective Sensor rating" is the bonus you can get to hit from any combination of Sensors, Scout Sensors, Sensor Drones and inherent weapon bonuses *except for* **Defense Arrays** and **Close Combat** bonuses. For instance, for a Size 4 ship, this can never exceed (Size+1) times 2, or 10.

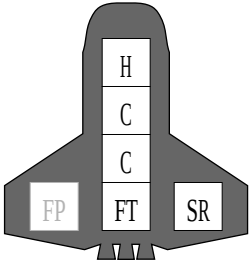
SS **Scout Sensors (Very Low tech+)**
These are used for targeting a ship's spine-mounted weapons. These act as normal Sensors with a few exceptions. A Scout Sensor gives a ship a Sensor rating of Size+2, but *only* in the spine arc. It cannot be used at all in other firing arcs. *Regular* Sensors and bonuses to Sensor rating can increase this spine arc Sensor rating, up to the maximum allowed for that ship Size and Tech Level. Base stations cannot gain the benefits of Scout Sensors.Scout Sensors are useful both on capital ships which want a longer range punch, and on small ships which are designed around spinal arc weapons (a ship with only a Scout Sensor would have a Sensor rating of its Size+2, but *only* in its spine firing arc).

Example - A Size 4 ship with one Sensor and one Scout Sensor will have a general Sensor rating of 4, and 6 in the spine arc. If it loses the Scout Sensor, it will *still* have a general rating of 4, and if it loses the regular Sensor, it will *still* have a rating of 6 in the *spine* arc, but a -2 in all other arcs. If this ship had three regular Sensors, it would have a general rating of 5, and 7 in the spine arc.

If a ship has two Sensor ratings (like 3(5)), this means overall Sensor rating, and spine arc Sensor rating.

SR **Streamlining (Very Low tech+)**

This specialized system allows a ship to operate in an atmosphere. This requires a number of Streamlining systems equal to the ship's Size, with a minimum of 1. A ship without enough intact Streamlining systems may not exceed a thrust of 1 during any turn in an atmosphere for purposes of dodging incoming fire, and such a ship will take damage on entering an atmosphere from space equal to one system for each Streamlining system that is lacking. Ships in an atmosphere are immune to Particle Beam attacks and may only use Particle Beams vs. missiles aimed at them. Ships in atmosphere are also immune to Railgun attacks unless the attacker is in the atmosphere *and* in close combat.



Example - The Space Shuttle is a Size 0 ship (5 systems), of which one system is Streamlining (the others would be counted as Hull, Cargo, Cargo and "Fusion Torch", with a Fuel Pod to represent the external tank).

Defenses

These systems are those that a ship will use to prevent or at least slow down attempts to damage it.

A **Armor (Very Low tech+)**

Armor is any structural means used to absorb, deflect or otherwise make harmless any damage which hits the ship. The Armor rating of the ship is the total number of Armor systems it has. Armor as a system can only be destroyed by explosive damage, like that from Missiles or impact from exploding Antimatter engines. The maximum number of Armor *systems* a ship can have is its Size+1, but its total Armor rating may vary.

EC **Electronic Countermeasures (Very Low tech+)**

This system represents active means of confusing sensors, like jamming, and passive means, like stealth technology. Each system subtracts 1 from the ship's apparent Size to enemy Sensors, with a maximum reduction of 2 from its actual Size. Extra ECM systems have no additional effect other than acting as spares. The *total* ECM effect is reduced in effectiveness by 1 for each Tech Level of difference between the attacker and defender, and vice versa. This differential *can* exceed the two points of EC bonus allowed between ships of the same Tech Level.

Example - Size 4 ships with two EC systems will normally appear on sensors as Size 2 for targeting purposes. If a Size 4 Low Tech ship with two EC systems engaged a Size 4 High Tech ship with two EC systems, the EC of the Low Tech ship would be completely negated, so it would still appear as Size 4, while that of the High Tech ship would be increased by 2, so it would appear as Size 0.

FS **Force Screen (Medium tech+)**

This is a standard but hypothetical item for ship design, since it exceeds any known science for its construction. It is either a field that extends out from the body of the ship, or a means of using energy to increase the strength of atomic and molecular bonds within the outer skin of the ship. In either case, each Force Screen system adds 1 to the Armor Rating of the ship, except vs. ramming attacks, Railguns or other kinetic energy damage. If a Force Screen is not used to increase Armor Rating during a turn, it may be used instead to negate Missile hits, and one Force Screen can stop (Size+1) Missile hits per turn. The player controlling the ship must make this decision when they are first targeted by weapons each turn, and this decision holds for the remainder of the turn.

Example - A ship with two Force Screens goes through a minefield. Though this is not combat, the ship is being targeted by weapons, so even if none of the mines would hit, that player would have to allot Force Screens, i.e. "One Force Screen is being used to negate Missiles, and the other to increase Armor rating". This allocation of energies is now “locked” for the rest of the turn.

In this case, one Force Field is used for general structural protection, while other is targeted to deflect the energies of a specific, known source (since you can see the Mine, you know where to reinforce shields, whereas with a Laser, you can't see it coming).

Force Screens *do not* affect the functioning of Boarding Parties. A single functioning Force Screen can substitute for all needed Streamlining on a ship, and a ship cannot have more Force Screens than half its Size (round down), plus 1. Unlike Armor, a Force Screen system *can* be destroyed if hit by regular weapons, and a Force Screen system requires a functioning Auxiliary Power Unit in order to operate. Any number of screens can operate from a single Auxiliary Power Unit, but an Auxiliary Power Unit running screens may not be used to power any other system, such as Jump Drive, Antigrav Drive, and so on.

Example - A ship has an Armor of 2 and two Force Screens. If this ship is targeted by a damage 3 Particle Beam, it will be deflected by the Force Screen + Armor combo. If the ship were targeted by Missiles, it might elect to use the Force Screens to negate some of the Missile hits, so the Particle Beam would do damage through the 2 points of Armor.

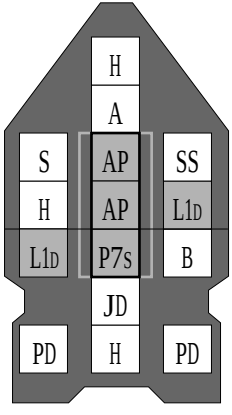
Weapons

Weapon systems are those involved in doing damage, either directly by the application of brute force, or indirectly by making it easier to hit an opponent. They are systems that civilian ships will not have except for the smallest amount deemed necessary for the illusion of security.

Weapon options

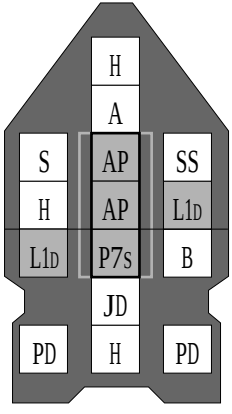
The *default* weapon mount in **Slag!** is a steerable array with as wide an arc of fire as the shape of the ship will allow. It is armored to the same level as the rest of the ship, and any Force Screens are modulated to allow outgoing fire through flickers or windows in them. General maneuvering will usually bring most weapons to bear fairly often over the course of a turn. A weapon system on a larger ship represents a larger version of that same weapon type, so a Laser Cannon on a Size 8 ship is a substantially larger item than a Laser Cannon on a Size 1 ship. There are other types of weapon mounts, however **Boarding Parties**, **Missiles**, **Sensor Drones**, **Space Mines** or **Graser Mines** may *not* take advantage of them due to the nature of these weapons.

Spine mount - A spine mount is aimed down the centerline of the ship, and fires best at targets directly in front of the ship. Since ships will maneuver substantially during a turn, they can always fire at *any* target, but ships with a spine mounted weapon will take a penalty on their Sensor Rating if shooting at any target not *directly* in front of the ship (and any Scout Sensors will not apply). However, the damage a spine mounted weapon does is 2 points more than normal. Railguns and Missiles may *not* be spine mounts. A spine mounted weapon *must* be on an internal or core layer of a ship. Base stations can have spine mounted weapons, but the weapon *always* takes a -2 on its Sensor Rating because it is so easy to avoid its limited arc. Spine mounts can be further enhanced by the addition of *dedicated* Auxiliary Power Units to make a weapon that takes up multiple system boxes. Each APU attached to the weapon adds 1 to its damage. The weapon and all dedicated APU must be adjacent internal or core systems, and if *any* of the systems take damage, the weapon will not function. The power provided from the APU's may not be used for any other ship function *except* powering Jump Drives. Such a dedicated weapon system is denoted by a heavy line bordering all the systems involved in the weapon mount.



Example - This ship is built around a massive particle accelerator. Normally a ship this size would mount a “P5S” system, but the 2 extra Auxiliary Power Units make it a “P7S” system instead. If the P7S or *either* of the Auxiliary Power Units is damaged, the entire weapon is taken off-line. The system boxes remain intact, but the weapon is inoperable until all its systems are functioning again.

Defense array - A defense array is a weapon system that is a large number of small damage weapons rather than a single large one. This modifier allows you to add the half the Size of the ship (round up) to its Sensor rating for determining multiple hits (in addition to normal use of Sensors). This *does not* increase the maximum effective Sensor Rating of the ship. The damage a defensive array weapon does is 3 points less than normal, and must be at least a final value of 1. **Railguns** and **Missiles** may not be defense arrays, but may be used in a point defense role if necessary. A defense array weapon *can* take advantage of Scout Sensors if the target is in the spine arc of the ship during combat. A large weapon in a defense array is a very effective means of countering large numbers of small but well-armored ships.



Example - The ship to the left is Size 2 (15 systems), and would normally have a 4 point **Laser Cannon**. Instead, it has its lasers in defense arrays (L1D), which have a damage 3 points lower, but which give each one +1 hits (half ship Size).

Nomenclature - Normally, a weapon system is listed as its letter, followed by its damage, with an "S" after the damage if the weapon is a spine mount, or a "D" for a defense array.

Example - A system labeled "P3S" would be a 3 point, spine mounted Particle Beam. A system labeled "L2D" would be a 2 point defensive array Laser Cannon, and a system labeled "G4" would be a 4 point Graser in the default mounting.

BP **Boarding Parties (Very Low tech+)**

Boarding Parties are armed and armored soldiers who can raid opposing ships. They are deployed in a number of single-use, high thrust pods with lots of ablative armor and ECM to survive the short jaunt across open space to the target ship. If the carrying ship is in the same sector as a target, declares **Close Combat** during movement *and* ends combat with a higher thrust than the target, the Boarding Parties may attack. Boarding Parties ignore Armor and Force Screens, and the *attacker* may damage a number of adjacent systems (starting on the outer layer) equal to the total strength of all hostile Boarding Parties, minus the total strength of all friendly Boarding Parties, minus the Damage Modifier of the defending ship, with a minimum damage of zero. Offensively used Boarding Parties are a one-use system. After they have dropped their demolition charges and retreated back to their carrier, the survivors are too shot up and tired to do anything else. Consider that system destroyed. You *may* use Damage Control to provide backup troops and equipment, however. The strength of Boarding Parties is always equal to the Size of the ship carrying them.

Example - A Size 6 ship has Boarding Parties with a strength of 6 for both offensive and defensive purposes.

Gn **Graser (Medium tech+)**

A Graser is a **G**amma **r**ay l**aser**. It is like a laser cannon in principle, but fires short-wavelength x-rays instead of visible or near-visible light. These pulses penetrate armor much better than normal wavelengths. A Graser halves the Armor rating and Force Screens of a ship for purposes of penetrating it (round each one down). If one point of damage gets through defenses, it will damage one external ship system, and if two or more points get through it can damage *one* other system in the same manner as a Particle Beam. The damage a Graser system does is equal to the Size of the ship, minus the Damage Modifier of the defending ship, with a minimum damage of zero. Halving of armor and screens is done *after* applying the Damage Modifier.

Example - A Size 4 ship mounting a Graser would have one with a strength of 4, and would be designated as “G4”. If this weapon hit a Size 2 ship (Damage Modifier of -1), it would have an effective strength of 3 before counting Armor and Force Screen effects.

ID **Intruder Defense (Very Low tech+)**

This system is a network of internal weapon turrets, remotely controlled armored doors, and possibly force fields that stop any intruders. In game terms, it acts as Boarding Parties, but *only* defensively, with a strength of Size+1.

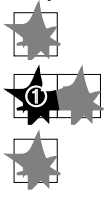
Ln **Laser cannon (Very Low tech+)**
This is a tightly focussed laser array that directs a short pulse of high-intensity photons at its target. They *can* be used in an atmosphere. If they penetrate armor, they damage *one* ship system, regardless of the laser's strength. The damage a Laser Cannon system does is equal to the Size of the ship plus 2, minus the Damage Modifier of the defending ship, with a minimum damage of zero.

Example - A Size 3 ship mounting a Laser would have one with a strength of 5, and would be designated as "L5".

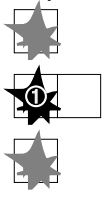
M **Missiles (Very Low tech+)**
These are proximity fuzed nuclear missiles, capable of doing significant damage to most ships (which you will probably find out the hard way). Each hit destroys whatever system it hits, and also destroys *up to* 3 *non-diagonally* adjacent systems, including non-diagonally adjacent internal or core systems, minus the **Damage Modifier** of the defending ship, *with a minimum of 1 system destroyed*. Any intact internal or core layer that could be affected is dropped first, followed by an adjacent system on the same layer that was hit, chosen by whoever targeted the Missile's damage site. That is, the normal Missile damage pattern is a crater. On larger ships, the crater does not extend as deep or wide, and on very large ships, the effect is to only destroy a single system.

The advantage of Missiles is that they are capable of destroying Armor, and are not affected by the Armor rating of the ship they hit.

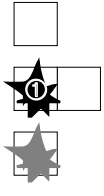
Size 0-1 ship



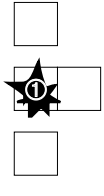
Size 2-3 ship



Size 4-5 ship



Size 6+ ship



Example - A Size 4 ship is hit by a Missile. This could do a maximum of 4 systems worth of damage, 1 for the primary location, plus up to 3 more adjacent systems. However, the Damage Modifier of the ship (-2) means it takes 2 less hits than normal, so the Missile will only destroy the targeted location and 1 of the adjacent locations on the same layer.

If Armor is targeted, that Armor system is *destroyed* and the total Armor rating of the ship is reduced. Armor *adjacent* to the target system is *not* destroyed and may soak up a system's worth of damage with no effect. Missiles or explosions of other kinds are the *only* way to reduce the Armor rating of a ship, and only if the Armor is the target of the hit. Since a Missile system on a large ship represents more missiles, half the Size of the firing ship (round up) is added to its Sensor rating to represent the increased chance to hit this gives. Missile systems are one-use devices. Once used, that system is considered destroyed. A Damage Control system may be used to reload the racks, however.

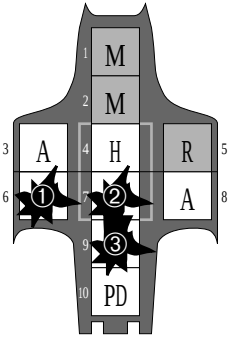
Note - Remember that exploding Antimatter Engines are counted as Missile hits on the location of the engine. Also note that on a Size 6+ ship (Damage Modifier of -3 or more), the only location affected by such an exploding engine is the engine itself.

If a Missile hits a ship that has *no* engines, it is counted as a *direct* hit, not a *proximity* hit. *Each* hit is counted as *two* Missile hits, applied to the same physical location, but if an internal or core layer is exposed by the first hit, the closest one to the first hit is directly targeted by the second. If a ship has the use of *any* engines, even those which are not enough to move the ship, missile hits are treated normally (no extra damage). **Space Mines** are *always* treated as regular missile hits, even if the target cannot maneuver.

Pn **Particle Beam (Very Low tech+)**

This is a high energy accelerator system that directs a pulse of neutral particles at opponents at close to lightspeed. They are not deflected by natural magnetic fields, but they are quickly disrupted by any type of atmosphere. They destroy a number of ship systems equal to their effective strength. Any attacks that have damage remaining after penetrating armor, shields and an external component *may* migrate to adjacent inner or core layers per remaining point of damage until the core of the ship is hit. Remaining damage then works its way *out* of the ship until it penetrates the outer layer again. Any remainder at this point is lost into space. No matter how big a Particle Beam is, it can only damage 2 systems if there are no inner or core layers adjacent to the first location hit (one on the way in, and an adjacent one on the way out). The damage a Particle Beam does is equal to the Size of the ship plus 1, minus the Damage Modifier of the defending ship, with a minimum damage of zero.

Example - A Size 3 ship would have a Particle Beam with a strength of 4, and would be designated as “P4”. If striking a Size 2 ship, it could do a maximum of 3 points of damage (since a Size 2 ship has a Damage Modifier of -1).



Example - The ship to the left takes 3 points of Particle Beam damage after its Armor is taken into account. The first hit is to an outer layer system (Sensor). There are adjacent inner layers, so the beam hits one (Bridge), and then heads back out of the ship and hits another outer layer system (Hull). Note that the concept of “side” is different in **Slag!**. Both the right and left of a ship silhouette represent the “outside” of the ship, not necessarily its right and left sides. So, the first and last systems to take damage in this example are close to each other, but one might have been on one side, while other was on the top, and the particle beam went through the side of the ship, hit the bridge, and exited the top.

R **Railgun (Very Low tech+)**

This is a rapid fire cannon, using a magnetic accelerator to fire large quantities of tiny projectiles at short range targets. A railgun does only 1 point of damage, regardless of Tech Level or the ship it is on, but it adds half the Size of the ship (round up) to its Sensor rating for purposes of getting multiple hits, and ignores Force Screens. A Railgun can only be used against ships in close combat situations, and does no appreciable damage to any ship of Size 2 or more (since they have a **Damage Modifier** of at least -1).

SD **Sensor Drones (Very Low tech+)**
Sensor drones are similar to Space Mines, but they seed an area not with small missiles, but with small sensor arrays. They are dropped in any sector the ship is in during its movement, and remain in that hex for the duration of play. Any friendly ship in this sector or an adjacent sector with a working Bridge or Auxiliary Control will get a +1 to its Sensor Rating from the extra information these provide. No more than a +1 is possible from Sensor Drones in a given sector, although getting drone information from several adjacent sectors *is* cumulative (but a ship still cannot exceed its **maximum effective Sensor Rating**). Sensor Drones are considered a limited-use device, and that system is considered destroyed after it has dropped (Size/2)+1 drone counters (round down). Sensor Drones are extraordinarily useful, and every successful fleet will probably have some.

Any ship with a Railgun or any **defensive array** weapon system may destroy all *hostile* Sensor Drones in a sector if they both start and end their turn in that sector, that weapon system is not used during combat, *and* survives combat.

SM **Space Mines (Very Low tech+)**
Space Mines are small, hard to spot drones that are dropped and remain in a given sector. Any enemy ship passing through or ending movement in that sector after they are dropped will immediately take missile attacks with a base number of hits equal to its Size plus the number of Space Mine counters in the sector.

Example - A Size 4 ship with a Thrust of 2 enters a sector with 3 Space Mine counters. The ship takes a number of Mine attacks equal to its Size (4), plus the number of counters (3), minus its thrust (2), for a total of 5 possible hits that must be countered with Force Screens or weapons used in point defense roles.

A ship which declares no movement for a turn (including drifting) will not be attacked by Space Mines, since the limited range of the mines means they can only attack targets passing near them, and ship following a straight-line course and not using its engines is both more likely to be mistaken for debris and less likely to pass near a mine platform. However, this means the ship does not get to use its thrust rating to evade other types of attacks. Any ship that is not counted as having a Bridge or Auxiliary Control system is assumed to be a hostile ship, including *all* Lifepods (but since Lifepods are Size 0 and have a Thrust of 1, they take a base of zero attacks unless there is more than one Mine counter in a sector). A Space Mine system is a limited-use device and that system is considered destroyed after it has dropped (Size/2)+1 mine counters (round down). A Damage Control system may be employed to reload the mine racks, however.

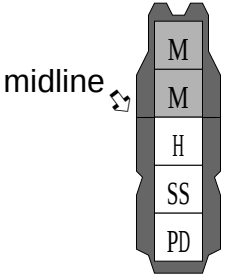
Any ship with a Railgun or any defensive array weapon system may destroy *all* Space Mines in a sector if they both start and end their turn in that sector, that weapon system is not used during combat, *and* survives combat.

Ship Layout

As important as a good combination of ship systems is the way in which they are arrayed. The series of boxes that represents your ship is arranged in approximately where these systems are placed. Looking at a ship, the front is towards the top, and the rear of your ship is towards the bottom. This is vitally important to remember, as the facing of your ship will make a difference in where it can be hit, and which weapons you can most effectively bring to bear on opponents. Ships in **Slag!** have a front half, a rear half, a single side facing, an outer layer, and an inner layer. These last two are conceptually important. They are *not* "right side" and "left side", since a ship can be in any orientation in space.

Midline

Each ship will need a small dividing line separating half its systems from the other half. That is your ship's midline. In the case of rounding, the designer can choose to put the extra system in the front or rear half. If an attack hits in your *front* arc, the initial hit must be forward of this line, if possible. If the front half of your ship is completely blown off, hits can be *anywhere* on the outer layer of the ship, but you get the idea. If an attack comes from your *rear* arc, only the rear half of your ship can be an initial hit location, unless the rear of your ship is blown off. Fuel Pods are added *after* construction, and do not affect placement of the midline.



Note - If the *only* systems left in the front or rear half of the ship are Armor, then the initial hits to the front or rear will bypass the Armor and go the other half of the ship for the initial hit location.

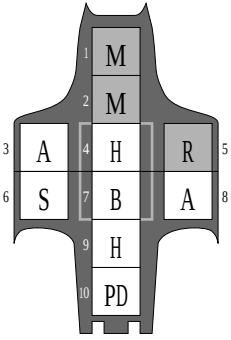
As an example of how this works, look at this fighter. If this ship lumbers towards an opponent, the opposing player will only be able to target the front of the ship. The missile launchers are at the front, and if unfired will be able to absorb damage that might otherwise destroy the fighter.

Sides

Due to the way **Slag!** works, which side a particular system is on is irrelevant, and ships *do not have to be symmetrical*. The ship layout is only an *approximation* of the actual appearance. For instance, the Railgun on the right side of the ship on the next page may actually be several railguns mounted around the hull, somewhere in front of the midline. Likewise, right or left does not matter for combat. Since space combat is three-dimensional, ships will frequently be pivoting around their long axis, and all sides will be visible to an opponent during the course of a turn.

Layering

Most of a ship will be systems on or near the outer surface of the hull. Whether on the left, right, front or rear, any system that does not have a shaded box around it is an *external system*.



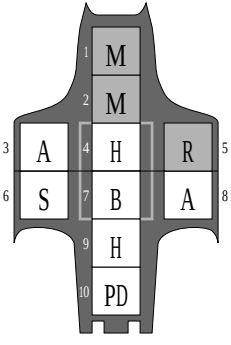
On this ship, one Hull and the Bridge are *internal* systems, while all of the systems around them are *external* systems. In order to damage the internal systems, a weapon must first do enough damage to destroy an adjacent external system. The remainder of the damage can then penetrate further into the vessel to strike better protected locations. In this case, the Bridge is internal to protect the command crew, and a Hull is internal to make it harder to destroy the ship (it is not destroyed until all Hull are gone).

For each 4 *external* systems a ship has, it *may* have 1 *internal system*. Internal systems are protected by some other system on the outer layer of the ship, and are harder to damage. So, a Size 0 ship (≤5 systems) can have either 5 external systems, or 4 external systems and 1 internal one. Typical construction is below:

Ship	External	Internal	Core	Base	External	Internal	Core
Size 0	4	1	0	Size 0	4	1	0
Size 1	8	2	0	Size 1	8	2	0
Size 2	12	3	0	Size 2	12	2	1
Size 3	16	4	0	Size 3	16	3	1
Size 4	20	4	1	Size 4	19	4	2
Size 5	24	5	1	Size 5	23	5	2
Size 6	28	6	1	Size 6	26	6	3
Size 7	32	7	1	Size 7	30	7	3
Size 8	35	8	2	Size 8	33	8	4

If a ship has *more than* 20 systems (Size 4+), then for each 4 *internal* systems, it can have 1 *core* system. To damage this system, you have to first go through an external system *and* an internal one. It takes a ship with *more than* 40 systems (Size 8+) to have more than 1 core system.

Remember that you don't *have* to use layering or use all your potential internal or core systems. You *can* have a large ship that is flat or open structure, with all components near the surface. This can actually be an advantage vs. penetrating weapons, but remember that the more powerful spine mounted weapons *must* be internal or core systems.

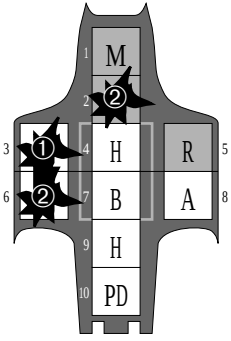


Layers and damage

Damage to a ship *always* starts on the external layer, and extra damage is to adjacent locations, *remembering that adjacent locations means adjacent horizontally, vertically or on a 45 degree diagonal.*

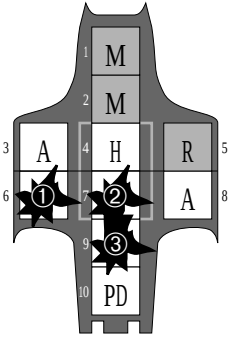
Example - Take our sample Size 1 ship. While slow, it is otherwise a fair design for withstanding damage:

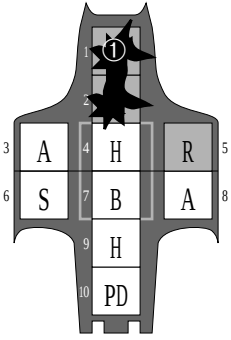
This ship has an armor of 2. If it were hit from the side by a 3 point particle beam, 1 point would get through armor and damage the ship.



Case 1 (left) - The *ship owner* says location 3 is the initial hit. Not a good move, since Armor is not actually damaged by anything except Missiles. So, the system destroyed is an adjacent one, *either* the Missile system at location 2, *or* the Sensor system at location 6, *chosen by the attacker*, since choice of hit location alternates. The armor is not actually damaged in either case. If the ship owner said location 6 was the initial hit, then the Sensor will take the point of damage that got through armor, and that would be it.

Case 2 (right) - The ship is hit by a 6 point particle beam attack (4 points get through armor). The owner of the ship chooses location 6 at the initial target. Since there *are* adjacent *internal* locations, the attacker could choose location 4, 7 or 9 as the second hit, since particle beam damage *may* go in 1 layer per hit if there are adjacent internal or core systems, and both the Hull at 4 and Bridge at 7 are adjacent. The attacker chooses the Bridge. After hitting the Bridge, the owner of the ship would migrate the damage *out* one layer to an *undamaged* external location. The ones available are the Hull at 9 and the Railgun at 5. The ship owner chooses 9, so the particle beam destroys location 9, and then exits into space, the last point of the damage wasted.





Case 3 (left) - The ship is hit by a Missile. The ship owner chooses location 1 as the target. The Missile destroys location 1, the adjacent Missile at location 2, and that is it. The only location adjacent to location 1 is location 2, so these two locations are destroyed and there is no further damage. Note that if location 2 had been previously destroyed, there would be *no* locations adjacent to location 1, so location 1 would be the only location destroyed in that case.

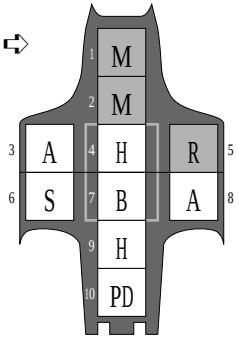
You can see that how you place your ship's systems will make a large difference in how well it can take different types of damage. This design might have done better to place the Railgun in front, backed up by Armor, with the Missiles to either side. That way a hit by *any* weapon could have been taken on the Railgun and any collateral damage soaked off on the Armor, leaving both Missile systems intact.

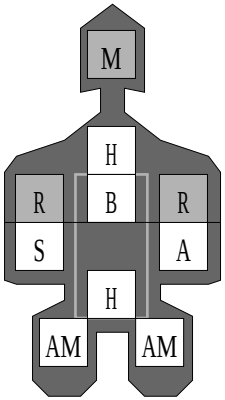
System placement rules

There are certain rules that apply to the design of a ship, and migration of damage through a ship. Understanding these is *vitally* important to designing a survivable ship.

1. All ship systems must be vertically or horizontally adjacent to at least one other ship system when the ship is intact. Internal or core systems must be horizontally and/or vertically adjacent to at least 2 *unique* systems on the next layer out (i.e. there is no way that 3 external systems qualify as unique for any 2 internal systems).

Right - This ship is correctly designed. All its systems are vertically or horizontally adjacent to at least 1 other system.

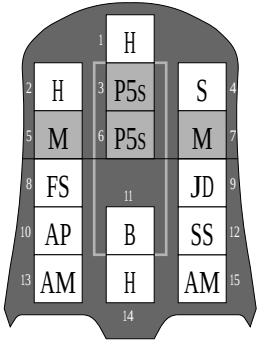




Wrong - The open spaces and solely diagonally adjacent locations make the design to the left illegal. It would be counted destroyed the instant it shows up.

2. Systems are considered adjacent for most purposes if they are vertically, horizontally, or 45° diagonally adjacent (1 system over and 1 up/down).

Open spaces *do not* prevent *external* systems from being adjacent *unless the ship's midline is between the systems*. External systems *are* adjacent if they pass through an open area of an internal or core area. Any internal or core systems between external systems keep them from being adjacent. Any destroyed systems are “still there” for purposes of checking for adjacent locations.



Example - On the ship to the left, system 8(FS) is adjacent to external systems 5(M), 9(JD) and 10(AP), and internal systems 6(P5s) and 11(B). Normally, the internal layer of the ship prevents the Force Screen from being adjacent to the Jump Drive, but the ship layout has left a gap in the core, so the open area makes locations 5 and 9 adjacent. If this ship did not have an APU at location 10, then the Force Screen at location 8 *would* be adjacent to the Antimatter Engine at location 13, even though there would be open space between them.

3. Internal or core layers are only adjacent if there are no gaps between them.

Ships with a gap in their *internal* systems are assumed to have structure between them, so for instance, systems 6(P5s) and 11(B) on the previous ship are *not* considered adjacent.

Aesthetics

Now, you can place systems in virtually any order you want. If you want your engines at the front and the fuel at the rear, you have a weird looking ship, but you *can* do it. There are exceptions to this. Mainly, the following systems must *always* be on the external layer:

Armor of any kind	Lifepods
Fighter Bay	Sensors
Force Screens	Scout Sensors
Hangar	Streamlining
Jump Gate	Tractor Beam

All weapons *except* Boarding Parties & those that are spine-mounted.

Everything else can be on an internal or core layer, even the engines (one presumes they are surrounded by machinery with only the exhaust nozzle exposed in a very limited arc).

Sequence of Play

Slag! keeps things simple: Turns are basically Movement and Combat. The full sequence is below:

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1. **Setup**
   a. Decide fleet sizes
   b. Decide map size & features
   c. Decide game length
   d. Place terrain features
   e. Place ships
2. **Movement**
   a. Ships move
   b. Attacks by Space Mines
   c. Drop Sensor Drones/Space Mines
   d. Deploy/retrieve carried ships
3. **Combat**
   a. Each ship may fire *one* weapon in order of Sensor Ratings
   b. Each ship fires all other weapons in order of Sensor Ratings
   c. Apply damage from Missiles
   d. Ramming attempts resolve
   e. Boarding parties attack
4. **Post-turn**
   a. Apply Damage Control

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1. Setup

a. Both players decide on a fleet size. We recommend a total of 50-100 points of ships per fleet, split between any number of ships or installations. **Medium Tech** ships have a cost of their (Size+1), squared. **Very Low Tech** ships cost x.6 this amount, **Low Tech** ships cost x.8 this amount, and **High Tech** ships cost x1.4 this amount (round to nearest .1 point). If a ship somehow has systems of different Tech Levels, find the "cost per system" for a Medium Tech ship, and apply the multiplier to the number of systems at other Tech Levels. The table below gives the overall cost and the cost per system for various ship Sizes and Tech Levels.

Ship Size	V.Low Tech	Low Tech	Medium Tech	High Tech
0	.6 pt(.1)	.8 pt(.2)	1 pt(.2)	1.4 pts(.3)
1	2.4 pts(.2)	3.2 pts(.3)	4 pts(.4)	5.6pts(.6)
2	5.4 pts(.4)	7.2 pts(.5)	9 pts(.6)	12.6pts(.8)
3	9.6 pts(.5)	12.8 pts(.6)	16 pts(.8)	22.4pts(1.1)
4	15 pts(.6)	20 pts(.8)	25 pts(1.0)	35pts(1.4)
5	21.6 pts(.7)	28.8 pts(1.0)	36 pts(1.2)	50.4pts(1.7)
6	29.4 pts(.8)	39.2 pts(1.1)	49 pts(1.4)	68.6pts(2.0)
7	38.4 pts(1.0)	51.2 pts(1.3)	64 pts(1.6)	89.6pts(2.2)
8	48.6 pts(1.1)	64.8 pts(1.4)	81 pts(1.8)	113.4pts(2.5)

Example - A Size 3 Medium Tech ship costs 16 points, or .8 points per system, so if the ship had one High Tech system, it would cost .3 points more, because one system on a High Tech Size 3 ship is 1.1 points.

All ships must be equipped with Jump Drive, or be carried in or on a ship with Jump Drive. Exceptions are made for ships which start from on-map bases, or players whose ships are Low or Very Low Tech and unable to use Jump Drive. Players may set limits between themselves as to the Tech Levels that may be used and the maximum ship Size allowed.

b. Both players must agree on a board size for the battle. The included map is good for ships of ≤Size 3, but you can play on any size map that is mutually agreeable. For larger ships at least 4 pages of maps are recommended. Decide whether the map is “fixed” or “floating”. A fixed map is one where if a ship leaves the map, it is gone from the game. A floating map means that if a ship leaves the map, a new map is put down and play continues there.

c. Both players decide on game length. This is not when the game is over, but how long before anyone is allowed to retreat off-map or Jump out with their ships (Lifepods don't count. They can run away any time they want). We recommend 10 turns as more than enough.

d. Each player has the option of placing *one* terrain feature *facedown* anywhere on the board, the winner of a coin toss deciding who chooses and places first. After all terrain is placed, flip them over. Any bases must have appropriate Fighter Bays/Hangars for any ships to be launched from that base, and players may have mutually agreed upon limits regarding bases and/or types of terrain.

Terrain Types

Gas giant - Actually, the top of a steep gravity well near a gas giant that is outside the plane of combat. Ships with no working engines are dragged 1 hex towards this sector each turn, and are destroyed when they enter this sector. No bases may be placed in this sector.

Planet - A terrestrial-sized planet that fills the sector. Apply -1 to all Sensor ratings for ships or bases firing into or out of this sector. Ships operating in its atmosphere may not be hit by Particle Beams, and Railguns may only only fire at targets on the same side of the atmosphere. All Space Mines are outside the atmosphere, and may not be launched from within the atmosphere. Bases may be constructed in this terrain. Ships launched from ground-level bases must spend 1 point of movement to reach orbit in the same sector. Ships entering the sector must spend an additional point of movement if they want to enter the atmosphere. Each ship must be declared as in or out of the atmosphere at the end of its movement.

Airless Moon - Apply -1 to all Sensor ratings for ships or bases firing into or out of this sector. Bases may be constructed in this terrain.

Asteroids - A “movie style” asteroid belt. Apply -2 to all Sensor ratings for ships or bases firing into or out of this sector, except for Missiles and Space Mines, which act normally. Bases may be constructed in this terrain and automatically count as having 2 points of Armor in addition to any Armor systems used (this may exceed normal Armor ratings for a base). Bases here can be *really* tough to crack if you don't have enough Missiles.

Empty Space - No game effects. Bases may be constructed in this terrain.

Alien base - No bases may be constructed in this terrain. The alien base automatically attacks the largest ship in its sector or adjacent sectors (*all* ships of that size if more than 1) with a 6 point Graser and a Sensor Rating of 4. The alien base can only be deactivated by Boarding Parties with a total strength of 3+.

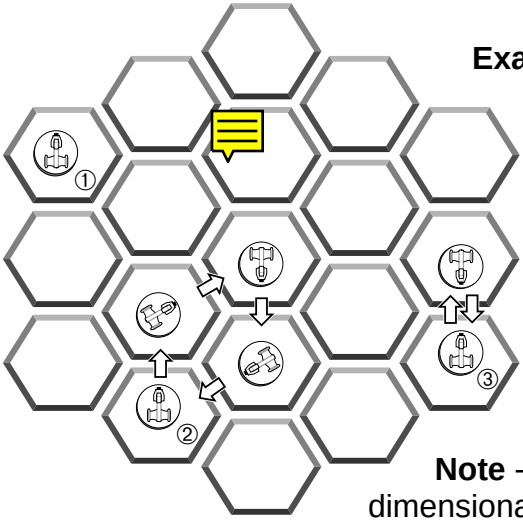
e. The player who placed the first terrain feature also places the first ship on the board edge, alternating ship placement between players until all ships are in play. Bases or other fixed installations at a terrain feature must be the first items placed on the map. All other ships may be placed *along* a single map edge, adjacent to one of the hexes on that player's side of the map. A ship entering play must enter the hex it is adjacent to, and the first hex of movement does require using a point of thrust. Your opponent will know the *apparent* Size and number of your ships, whether or not they have Force Screens up, and the type of engine they use. They will only get to look at your exact ship layout when they get to assign any damage to it.

2. Movement

a. Movement scale and turn length in **Slag!** are subjective and flexible. Each hex on the map is also known as a "sector". Normally, we assume a sector is some thousands of kilometers across and each turn is several minutes long. A coin toss is used to determine initiative. Ships in **Slag!** alternate in movement from lowest thrust rating to highest thrust rating. Within equal thrust ratings, the larger ship moves first, and further ties are broken by having the person who lost initiative move first.

Ships may move any distance equal or less than their current thrust rating. Each hex of movement counts as use of one point of thrust, and movement may be into half hexes on a map if necessary.

A ship's movement is always in the direction it is facing, and it may change to any other facing *after* moving a hex. However, a ship expending its last thrust point stays at the facing it used to enter that sector. If it has movement to spare, it may change to any facing after that movement. A ship which does not leave the sector it starts the turn in may change to any facing it desires as its movement.



Example - If the ship to the left had a Thrust Rating of 4, all of the following moves would be legal.

1. Sit and do nothing
2. Move in a circle
3. Backtrack

In *each* case the ship is assumed to use its *full* thrust to the best effect to avoid enemy fire. Even for the first case, the ship is *not* sitting still, but careening violently around the sector it is in.

Note - While **Slag!** is played on a two-dimensional grid, it *is* a three dimensional game. If a ship passes *through* the sector of an enemy ship, it is *assumed* to be moving above or below it. If you wanted to attack an enemy ship at close range, you would end your turn in the same sector, and the flexible turn scale would assume that this combat is taking place at the optimum distance for your weapon systems, not some game-mandated “combat phase”.

b. The only attacks that take place *during* movement are those by **Space Mines**. These resolve immediately upon a target ship entering their sector. This does not affect further movement by that ship (unless it was destroyed!), but weapons used defensively may *not* be fired again during combat except for continued point defense use, and hits on Force Screens count for the rest of the turn.

c. Space Mines and **Sensor Drones** may be dropped in a sector immediately after any other Space Mines have resolved.

d. Ships may be dropped from Fighter Bays/Hangars during or at the end of movement, and they may attack and apply *normal* thrust for dodging attacks (do *not* consume Fuel). They may *not* move out of the sector they were dropped into, or deploy weapons like mines or sensor drones until the following turn. If the carrier ends a turn in **Close Combat**, and dropped ships in that sector, these ships may declare as being in or out of Close Combat (ones in Close Combat *may* ram or make boarding attempts).

Movement options
Ships have a number of tactics that they can do in addition to just moving from sector to sector.

Close Combat - Each sector is thousands of kilometers across, so colliding with an enemy ship is very difficult. Even ships with Boarding Parties do not usually make contact with an enemy ship, but send over short-range pods containing space marines. Declaring “close combat” at the end of a ship's movement is *required* for any ramming or boarding attempts, and can only be done vs. a ship with a *lower* thrust rating. Close Combat is entering the same sector as your opponent, with intent to get absolutely as close as possible to a *particular* enemy ship (you *can* be in the same sector as enemy ships *without* Close Combat). If the attacker still has a thrust rating higher than their target *after* combat, the ram or boarding attempt is successful. Ships in Close Combat do not *have* to ram or board, and need not declare *those* intentions until the appropriate part of the turn.

Drifting - Normally, ships with no usable engines are permanent sitting ducks in the sector where the damage took place. Optionally, such ships may drift in space. If ships are allowed to drift, they do so *before* all other movement, and drift *one* sector per turn in the direction they are facing, unless affected by a gas giant, in which case they drift towards it first. The ship may *not* change facing after this move. A ship with working engines but a thrust of less than 1 may elect to avoid drift effects from nearby gravitational bodies, and change facing before drifting.

Sprinting - A ship may also declare “sprinting” as its movement. If so, it must move in a straight line and may thereafter drift its *full* movement each turn. However, its thrust will *not* apply towards dodging attacks while sprinting or drifting. **Slag!** makes the assumption that ships in combat are trying to move unpredictably, rather than just vectoring in a given direction, which is why sprinting is a special case, and also why vectors are not usually retained from turn to turn.

Silent running - A ship can make itself much harder to hit by powering down all systems with a tell-tale signature. In practical terms, this means all engines, APU's, Force Screens, Absorption Fields, Nuclear Dampers, Tractor Beams and Sensors. The ship becomes an inert piece of flotsam, very hard to spot. Such a vessel has a base to hit of -5 hits instead of zero, **ECM** effects are increased by 1 and total Sensor ratings are halved (round down). It takes a full turn to power systems back up, during which the ship has its final Thrust, Sensor and Force Screen ratings halved (round down). A ship *can* declare silent running as its initial move, and it may drift at a constant speed (up to its sprint move) each turn.

Coup de grace - Normally, combat takes place at ranges that preclude targeting specific systems. If a target has *no* usable engines, an attacker may elect to end movement in Close Combat and declare themselves as using zero thrust. They are closing to visual range and carefully aiming. This attacker may specifically aim some or all of their weapons to hit any external systems of *their* choice (including previously destroyed ones), each weapon hitting only once that turn.

3. Combat

a. Combat is resolved in order of *effective* Sensor Ratings, high to low, alternating between ships for ties, with the initiative winner firing first. A ship with Scout Sensors and a spine arc target may use their increased Sensor rating in the spine arc if they are going to use a weapon vs. a target in their spine arc. Each ship first *may* fire *one* weapon system. Damage is resolved ship by ship for all weapon hits except Missiles.

Note - Weapon bonuses do not count towards Sensor Rating. So, a Size 4 ship with a Sensor Rating of 4 and a +2 Defense Array weapon would still fire *after* a ship with a Sensor Rating of 5.

b. Then, each ship may fire any remaining weapons, again in order of *current* effective Sensor Rating. Each weapon system may only be used once during each turn, and they are either declared as being against a *particular* ship, or used for point defense. Point defense weapons do not fire unless a ship is successfully attacked by Missiles, and may only be used against Missiles aimed at a ship in the same sector. *Basically, 3a and 3b mean everyone gets to shoot one weapon system, effects from these weapons are resolved, and then everyone cuts loose with everything that is left.*

Slag! has a diceless combat resolution system. Given the length of a turn, the technology and the number of times a weapon may fire, the question is usually not whether you hit, but how many times you hit. **Start off with zero hits, then**:

Add:

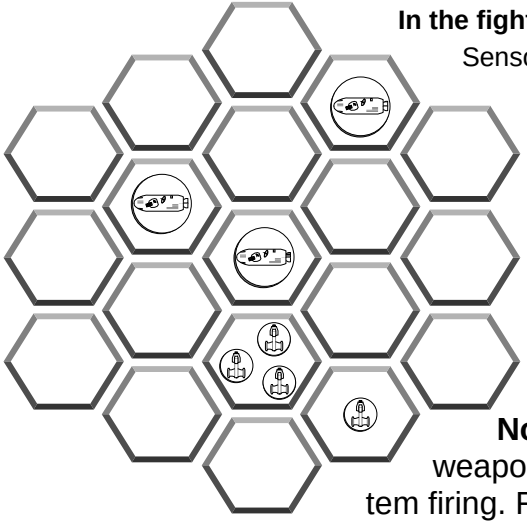
your ship's Sensor Rating
the Size of enemy ship
any weapon system bonus (Railguns, Missiles and defensive array weapons add half your ship's Size (round up))
add other sensor bonuses (sensor drones, close combat, etc.)

Subtract:

the range in sectors (adjacent hexes are a range of 1)
enemy ship's Thrust Rating at the end of the movement phase.
enemy ship's effective Electronic Countermeasures
any terrain modifiers or arc modifiers (rear arc, spine mounts, etc.)
for battle damage (no bridge on attacking ship, etc.)

If the final number is zero or less, you completely missed your target. If it is 1 or more, that is the number of times that weapon system hit the intended target. All hits from a ship are resolved before the next ship fires, and damage effects are instantaneous for everything except Missiles.

Example - A Size 4 Destroyer with a thrust of 1 is being attacked by adjacent fighters with a Sensor Rating of 0.



In the fighter's favor:
Sensor Rating of 0
Enemy ship Size of 4

In the destroyer's favor:
Thrust Rating of 1
Range of 1 (subtracts 1)

The total is 2, so each of the fighters gets 2 hits with whatever weapon it was using.

Note - If a ship has *identical* weapons in *identical* arcs, the weapons may be grouped vs. one target and add 1 hit per *extra* system firing. For instance, two Railguns that each get zero hits may combine to get a total of 1 hit instead. Identical Size 0 or Size 1 ships in the same sector may also group identically arced weapons in this way, so a squadron of fighters can group to get extra hits. These extra hits from multiple systems *do not* count towards Sensor Rating or Sensor Rating limits.

Point defense - *Any* weapon may be assigned to a point defense role against Missiles targeting that ship or any other ship *in that sector*. Anti-missile systems are assumed to start with zero hits. Missiles have no subtractions for size or thrust (they are small and fast, but *really* close when you shoot them down). The total number of hits a point defense weapon gets is the total number of missiles that can be shot down during the turn. Shooting down a missile aimed at a *different* ship counts as the use of 2 hits from *one* weapon. To avoid bookkeeping, unless the weapon system is destroyed in the (**3a**) weapon volley, it is assumed to shoot down missiles over the entire turn. If a ship would encounter Space Mines during movement, it may assign one or more weapons to point defense to shoot down incoming drones.

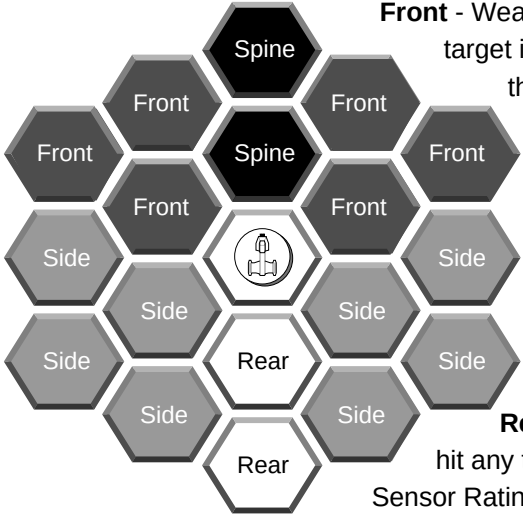
Example - A Size 4 Destroyer with working Sensors allocates a Missile system to a point defense role. The system starts with zero hits, plus the Sensor Rating of 4, plus half the ship Size for 2 more (because this is a Missile system), for a total of 6. That Missile system can shoot down up to 6 enemy missiles this turn (or 3 aimed at someone else). If it has to shoot down *any*, the Missile system is considered used up, and counted as destroyed. If this had been a Railgun system, if would have gotten the same number of hits, but it would not have run out of ammunition.

Close Combat - Ships engaged in close combat get an automatic +4 to their Sensor Rating, but only vs. each other, or any other ship in close combat with either of them.

Example - If ship 1 is in close combat with ship 2, and ship 3 is in close combat with ship 2, then ships 1 and 3 are also in close combat range with each other.

Yes, you *can* declare after movement that you are in close combat range with your own ships, just to provide mutual defense, like fighters protecting a carrier. Ships can be in the same sector without being in close combat, and may declare close combat without attempting to ram or board an opposing ship. Ships in close combat are assumed to have the relative facings they did when entering the sector. If there is any doubt, the faster ship may decide which side of a slower ship it is on. Close combat *does not* affect point defense. **See also optional Close Combat rules for dogfighting**.

Weapon arcs - Weapons can fire into *any* arc during a turn, but may take penalties to certain arcs based on their placement within your ship:



Front - Weapons in the rear half of the ship take a -2 to their Sensor Rating to hit any target in the front arc. Attacks on your ships from within your front arc must strike the front half of your ship if possible. Spine mounts freely target anything directly in front of them, but take a -2 for all other front arc attacks.

Side - All weapons except spine mounts fire equally well at targets in this arc. Spine mounted weapons take a -4 to their Sensor Rating to hit targets in this arc. Attacks on your ships from attackers in your side arc may strike the front or rear half of your ship with equal ease. *All* point defense is assumed to be fire into a side arc.

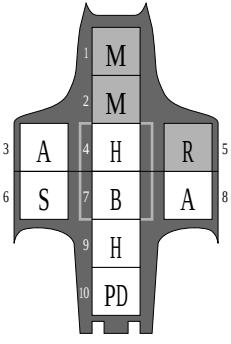
Rear - Weapons in the front half of the ship take a -2 to their Sensor Rating to hit any target in the rear arc. Spine mounted weapons thus have a total -6 to their Sensor Rating to hit targets in this arc. Attacks on your ships from attackers in your rear arc must strike the rear half of your ship if possible.

Note - When it says these arcs affect Sensor Rating, it *does* apply towards combat sequencing. Firing at something in a disadvantageous arc may allow an opponent to fire first even if their ship's basic Sensor Rating is lower.

c. Weapon fire is resolved for beam and other weapons, and then after *all* these hits have been resolved, Missile hits are resolved simultaneously. This means that the number of Missile hits is figured as they are fired, but the actual damage is not applied until after beam weapons have had their effects. This is because even at short range, missiles are going to take significantly longer to reach their targets than beam weapons. It is quite possible that missiles could be launched at a target that is already destroyed by the time they get there. Remember also that point defense weapons, once declared, work for the duration of the turn unless destroyed in the **3a** weapon volley, so even if blown up, these point defenses may still be active when missile hits are resolved.

Allocation of ship damage in **Slag!** is also handled without dice, and basically consist of a you-me-you-me alternation of hits. The *attacker* always gets to choose the target of Missile attacks against a ship without the ability to maneuver. Otherwise, the *owner* of the ship being hit may choose and mark off an *undamaged* hit location, or allow their opponent to target *any* hit location (previously damaged locations have no effect, but might be adjacent to intact internal locations). If the hit does multiple points of damage, the other person chooses a second location for damage, then the first person, etc. Any location that can be hit from the attack arc may be first, but *all* locations are assumed to be protected by the ship's Armor, and Armor only takes damage if hit by Missiles or Space Mines. Internal or core locations may only be the *initial* target of an attack if all adjacent layers closer to the surface have already been damaged.

Note - A “hit” is a single strike by *a* weapon system. A weapon can get multiple hits, each hit doing multiple points of damage, points which the players alternate allocating. For instance, a particle beam that does 4 points of damage to a ship could get 2 hits. Each hit is a separate allocation of 4 points of damage.



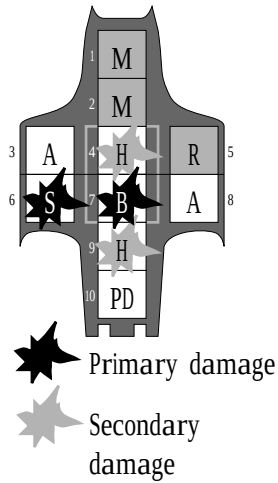
Example - This ship has an Armor of 2. If hit with a 3 point attack and the owner of the ship chose location 6 as the first hit, then the Sensor would be hit. If they chose location 3 as the first hit, the Armor suffers no damage, and since the owner of the ship chose the first location, the attacker can choose the second (no system was destroyed on the Armor hit, so there is still damage to resolve). In this case it would either be the diagonally adjacent Missile or the Sensor. The first hit must always be to an *external* system (if at all possible), so locations 4 and 7 are not valid for the first hit.

If a location has secondary damage effects (like a loaded fighter bay or antimatter engine being hit), these effects take place *after* the main effects of that particular hit.

A weapon doing multiple points of damage may damage locations adjacent to the previous hit. Adjacent means one of the *closest* undamaged systems on the same or adjacent layers, counting 45° diagonals as well as vertical or horizontal movement.

Particle Beams always do damage to an external location if possible, and *may* move in a layer for each subsequent hit, *if* there is an adjacent system on an inner or core layer. Otherwise the hit is to an adjacent surface system. Once a Particle Beam reaches as far into a ship as it can get, it moves out a layer for each hit, to *any* undamaged adjacent location. If there are none, it just exits into space. *If particle beam damage is not moved in a layer at first opportunity, it may not do so later*.

Missiles hit a single location and destroy it utterly. Missile hits that strike Armor as the primary location *will* destroy that Armor system, *immediately* reducing the overall Armor Rating of the ship. Missile hits will also destroy up to 3 adjacent location *except* diagonally adjacent ones, and Armor. The number of these adjacent locations is reduced by the **Damage Modifier** of the ship, so a Size 0-1 ship (Damage Modifier of 0) could have up to 3 adjacent locations destroyed, while a Size 4-5 ship (Damage Modifier of -2) would have a maximum of 1 adjacent location destroyed.



Example - What if this ship was hit by a single Missile *after* its engine had been destroyed? The *attacker* chooses location 6. The Sensor is destroyed, as is the Bridge at location 7. Then the damage is applied again, but to *location 7*, which pulverizes the Bridge at location 7 (again) and Hull at 9, hits but does not damage the Armor at location 8, and knocks out the last Hull (location 4), destroying the ship.

d. A ship which successfully rams another is completely destroyed if it is of smaller Size than its target. The ram attack does damage to the target equal to a 10 point Particle Beam hit, plus attacker's Size, minus the Size difference between attacker and defender. The target's Damage Modifier *does not* apply vs. ramming, as this is already taken into account by the Size difference. Force Screens *do not* apply vs. ramming damage. The *attacker* always gets to assign the first point of collision damage and *all* damage resulting from exploding engines on the ramming ship.

Example - A Size 0 fighter ramming a Size 4 destroyer will do damage like a 6 point Particle Beam hit, ignoring Force Screens and the destroyer's Damage Modifier. The Damage Modifier *would* apply vs. any exploding engine damage.

A larger ship ramming a smaller one completely destroys it if any damage gets through the smaller one's Armor. The larger ship takes damage like the smaller one had done the ramming, but the owner of the larger ship chooses where they take the first point of damage. Collisions between ships of equal Size do normal damage, but each person gets to assign the first point of damage on the opposing ship.

Example - A Size 4 destroyer ramming a Size 0 fighter will take damage like it had suffered a 6 point particle beam hit. The Size 0 fighter is utterly destroyed.

A ship with any functioning antimatter engines at the time it rams (or is rammed by a larger ship) will do damage like *a* Missile hit at the target location *after* all of the ramming damage is applied. This means that if Armor is the initial target, it will not be affected by the collision damage, but it will be affected by the exploding engine. Armor targeted in this way *does* count towards the “particle beam” damage, and *does not* get rerouted like a normal particle beam hit would.

Note - A well-designed Size 0 or Size 1 ship can be a very large, quite effective missile, especially since the attacker assigns the initial damage location. The trick is getting it to survive a round of combat at close combat range so that it can deliver the attack. If you consider a normal Missile to be about the size of an ICBM, then a Size 0 suicide drone is about the size of a B-1 bomber.

e. Boarding Parties on a ship in close combat range may deploy at this time. Unassigned point defense hits may be used to attack the Boarding Parties. It takes 2 hits to reduce the strength of the Boarding Parties by 1, since they are somewhat armored and tough to hit.

Boarding Parties that make it through any flak barrage then fight any defending Boarding Parties or Intruder Defenses, and apply the difference **as described under the system**.

4. Post-turn

a. A ship with an intact Damage Control system may use it after all combat damage for the turn is resolved. The Damage Control system is destroyed, and one other ship system is counted as being repaired. Any effects which occur after damage control do so in player-specified order unless directed otherwise by a specific rules section.

Victory Conditions

After the predetermined minimum game length has elapsed, each player has the option of trying to retreat from the field of battle. Whichever side has lost the fewest points worth of ships and systems to *use or damage* is considered the victor at the instant only one player's ships remain on the field of battle. Whoever is ahead at the end of the minimum game length probably has an advantage, and may want to annihilate their opponent, or they might feel the tide is turning and it is time to leave. Or, a given scenario may have other victory conditions.

Note - This *does* mean that using Missiles, Fuel, Damage Control, etc. counts against you when determining victory (they are expensive resources which you have to replace).

Once a ship has left the edge of the map it came in on, it is removed from play. That ship suffers no further damage unless it cannot use a Jump Drive or be carried by a ship with Jump Drive. In this case, the opponent will eventually catch up with it and destroy it, so all its system boxes go against your total unless it has **Lifepods**, in which case you can at least retrieve the crew for a few points.

If a friendly base station is on the map, play continues until it is wiped out, all attackers are wiped out or leave, or no one is able to do any damage to anyone else. In all of these cases, you tally the damage done and find out the winner.

Tech Levels and Handicapping

An experienced player can give an opponent more points as a way to offset this experience. Another way to do handicapping is to employ Tech Levels, or TL's. Low Tech ships cost less, but have lower capabilities. High Tech ships cost more, but have built-in benefits. Ship systems will only interact reliably with other ship systems of the same Tech Level. So, you can't get a cost savings by using Low Tech Auxiliary Power Units to power your High Tech Force Screens, or get a bonus to your sensors by putting High Tech Sensors on a Low Tech ship.

Normal interactions:
Hull and Armor Weapons and Sensors and Bridge
APU's and any system that requires an APU

Very Low Tech

This represents early fusion era space travel (roughly **CORPS** TL12). Each ship's Sensor Rating and all weapon damages except for Railguns and Missiles is reduced by 1 (including Boarding Parties), and the maximum number of Armor *systems* a ship can have is reduced by 1. Grasers, Jump Drives and Force Screens are not available. The only high thrust engines available are **Fusion Torches**, which produce 1 thrust point less than normal, and each engine used during a turn *consumes* one **Fuel** system. Not all of a ship's engines have to be used, but the Thrust Rating that applies for purposes of being hit is the level that corresponds to fuel usage. Non-movement engine use (avoiding planetary gravity, for instance) consumes one Fuel system per turn, regardless of ship size. Optionally, **Orion Drives** are available at the thrust listed in their system description.

Low Tech

Represents late fusion era ships (roughly **CORPS** TL13). The only engines available are Fusion Torches and **Plasma Drives**, and each engine provides 1 less thrust point than normal. Jump Drive has not been invented yet, so a Jump-equipped opponent must be an interstellar invader of some kind. Each ship's Sensor Rating is reduced by 1. Force Screens and Grasers are also not available yet. Note that Low and Very Low Tech players do not have the option of leaving the map once they enter it, and must fight to the finish.

However, if *both* players are exclusively Low and/or Very Low Tech, ships which retreat off the map are assumed to safely reach their home planet, since this is obviously an interplanetary rather than interstellar conflict.

Medium Tech

The standard level of technology for interstellar travel and conflict (roughly **CORPS** TL14-15). No special game effects.

High Tech

Represents a more advanced level of interstellar civilization (roughly **CORPS** TL16-17). All engine types produce 1 thrust point more than normal, each ship's Sensor rating and *maximum effective Sensor rating* is increased by 1, all weapon damages except Missiles and Railguns are increased by 1 (including Boarding Parties), and all ships get 1 point of Armor without having to have a system devoted to it (it is not a system that can be targeted, nor does it count towards ship Size).

Strategy

There are as many strategies in **Slag!** as in any other space combat game, which are mainly **design strategies**, **combat strategies** and **psychological strategies**.

Design Strategy

Slag! bears many resemblances to a tank combat game, albeit one set in a featureless desert with unlimited visibility. If you have weapons that can hurt your opponent, and superior sensors and mobility, it will be damned hard for you to lose except through sheer stupidity. Therefore, having a fleet with these qualities is to be desired, and avoiding giving them to your opponent equally important.

Quick tips!

You'll no doubt have to experiment a while to find a strategy that works, but here are some tips:

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1. Watch that antimatter! If you install antimatter engines, put them near the rear of your ship, and make sure no vital internal or core layer components are adjacent, especially other antimatter engines! Putting Armor as adjacent components will minimize the damage of an engine explosion (you can direct part of the extra damage onto Armor, which ignores it since it wasn't a direct hit).

2. Armor-Hull-Armor. If your ship has a fair amount of Armor, make sure you put some on either side of a Hull system. That way, you can choose Hull as the initial target of a Missile hit, and minimize the actual damage to your ship, since Armor is unaffected by Missiles if it is *adjacent* to the hit. Putting a Hull on each end of a ship, followed by Armor lets you soak off a Missile hit with minimum damage.

3. Put the expendable stuff where it will do the most good. If you have a small ship, it will probably be fairly fast, and be closing with its main target nose first. Put the systems that are expended upon use in the front, because you're probably going to lose them anyway. They'll either absorb damage before you can use them, or you'll use them and then hightail it out of there. If you have enough room to put something inert or expendable up front between weapon systems (Armor or Hull), do so. That will keep you from losing two adjacent weapon systems to a missile hit.

4. Hide that Hull and Bridge! On ships of Size 2+, consider keeping the Bridge and a Hull on an internal layer, since a Size 2+ ship can protect internal locations from Missile hits. Make it as hard as possible for an opponent to knock out that last Hull box or take out both your Bridge *and* Sensors.

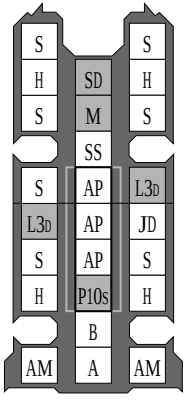
5. Take your opponent's strategy into account. The ships we've designed for you are *generally* good, but a fleet designed around a certain tactic (maneuverability, sensor superiority, armor, missiles, stealth, etc.) will beat generalist ships every time. There is no “best design”, which means you have a lot of work cut out for you to build a reliably winning fleet.

Things to try

There are myriad ways to design ships in **Slag!**, and this is one appeal of the system. You can put together brand new ships in short order, and test them out just as fast. Here are some of the themes that came up during playtest:

Sensor God

Sensor God	
Size (systems/5)-1, round up	4
Dmg. mod. -(Size/2), round towards 0	-2
Ship cost	25(1.0)
Sensors	7(9)
Thrust	2
Armor/Shields	1/0



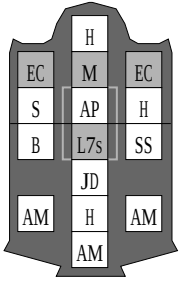
Sensor God

This is a ship of Size 4+ that has the maximum practical Sensor rating, in some combination of Sensors, Long Range Sensors and Sensor Drones, and a really big spine mounted weapon. The idea is that with such a large Sensor rating, not only will you be able to shoot first, but you'll be able to get a free turn of fire by shooting at a range where your opponent can't counterattack.

Strengths - On a small map, it can be devastating, as you can usually get multiple hits on the first turn (it's scary). It is one of the few tactics that works against No See-ums, and if the weapons are big enough, can chew up Space Bricks and spit out Space Gravel.

Weaknesses - The specialized armament means that it needs support ships to keep from being “swarmed”. If your opponent has a big enough Space Brick, you've got problems.

No See-um	
Size (systems/5)-1, round up	2(0)
Dmg. mod. -(Size/2), round towards 0	-1
Ship cost	9(.6)
Sensors	2(4)
Thrust	6
Armor/Shields	0/0



No See-ums

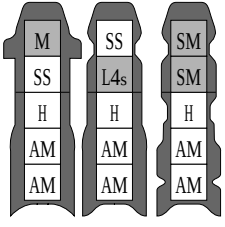
This is a fleet built around Size 2 ships with the maximum allowed thrust and ECM, armed with Missiles and/or a spine mounted weapon. The idea is that even though the ship is very vulnerable to any hits, it won't be hit at all if you play your cards right, since it starts off at -6 hits (Size 2, 2 points of ECM, thrust of 6).

Strengths - Maneuverability and stealth. These ships can pop into the best firing arc and range, cut loose with a volley of accurate fire and be gone in no time. Little ships can't touch them because they are so hard to hit. Big ships can't catch them because they are too fast. High tech versions are even harder to lay a hand on.

Weaknesses - If you can hit them, they're space toast. This can be done with faster ships and Close Combat, multiple defense arrays targeting a single ship, or multiple Sensor Gods covering each other's blind spots. They're usually not weaponed enough to take out a Space Brick.

Swarmers

Size (systems/5)-1, round up	0
Dmg. mod. -(Size/2, round towards 0	0
Ship cost	1(.2)
Sensors	0(2)
Thrust	6
Armor/Shields	0/0



The Swarm

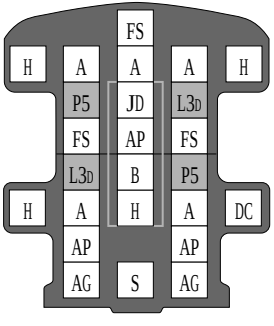
This is a typical carrier group tactic. Size 0 ships are cheap and expendable. Build a few ships that carry lots of them, and send them all out on suicide missions while claiming they are all unpiloted drones. An Antimatter powered fighter can be as hard to hit as a No See-um, and can use both a Missile and collision damage to good effect.

Strengths - Strength in numbers. You can't get them all, and even if only a fraction survive, it's going to hurt.

Weaknesses - Since victory is based on point cost of ships surviving, you're spending victory points to get a victory. It might not work. A Space Brick might be able to soak up the damage and chew up your carriers at the same time. Also, you have to bring them to the fight somehow, and anything that can't get back home is a write-off in terms of points.

Space Brick

Size (systems/5)-1, round up	4
Dmg. mod. -(Size/2), round towards 0	-2
Ship cost	25 (1.0)
Sensors	4
Thrust	2
Armor/Shields	5/3



Space Brick

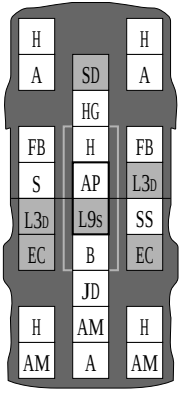
Take the largest ship you can, put on enough engines to make it move, add as many Armor, Force Screens and other protective technologies as you can, then see what's left for weapons and sensors. The idea is to be impervious to as much of your opponent's fleet as possible, while still being able to dish out the damage.

Strengths - Tough to hurt, tough to kill, has decent guns and decent sensors to point them with. Little ships just can't cope a lot of the time. Battles with No See-ums often end up a draw, as the Space Brick can't hit the No See-ums, and the No See-ums can't hurt the Space Brick.

Weaknesses - Spine weapons are impractical most of the time, as you will be too slow to get a good bead on opponents. **Slag!** is designed so that ships the same Size can't be impervious to each other's weapons, so a more maneuverable ship of your Size might be able to slowly whittle you down to nothing.

Silent runner

Size (systems/5)-1, round up	4
Dmg. mod. -(Size/2), round towards 0	-2
Ship cost	25 (1.0)
Sensors	4(6)
Thrust	4
Armor/Shields	3/0



Silent Runner

This is usually a ship of around Size 4, designed for assault against stationary targets, It has the highest thrust allowed, good Sensors and good ECM. If using a sprint move, a Size 4 ship can have a base of -4 hits and drift at 4 towards its target (Size 4, -5 for **silent running**, -2 for **ECM**, -1 more for ECM bonus). This is better than it could do if powered up, but at the cost of halved Sensor and Force Screen ratings. Such a ship usually is armored, and carries Size 0-1 fighters or drones, plus Scout Sensors and Sensor Drones to keep its own Sensor Rating at a decent level.

Strengths - Tougher than normal to spot, and carries weapon systems (fighters) that aren't affected by its own reduced sensor rating.

Weaknesses - If someone gets close and can hit, the ship has to spend a turn powering systems up to full, during which it is vulnerable as it loses its silent running bonus and is still operating at half power.

Generalist

This isn't so much a design strategy as a compromise. A fleet that is halfway good at *everything* will get slagged by a fleet that is very good at *something*. Most of the pre-designed ships in the rules are Generalist ships, just to give you a feel for the game. You're expected to pit your wits against opponents using your own design strategies.

Combat Strategies

Slag! has some basic ideas behind tactical space combat:

To intercept a maneuvering target, you have to maneuver.
To maneuver, you have to expend energy.
If you expend energy, you can be seen.
If you can be seen, you can be hit.
If you can be hit, you can be killed.

Therefore, since almost all ships in **Slag!** are maneuvering, all ships are on the map and visible to all opponents. What remains is making sure you can get to within targeting (sensor) range and have weapons capable of hurting your foe.

Why is it so hard to hit things sometimes?

Most of our perceptions of space combat are shaped by movies and television, where to make things interesting, all the combatants are crammed onto the large (or small) screen, while in “real life” they would separated by huge distances. If you make the assumption that one hex in **Slag!** is about 10,000km, then a Size 6 ship (25,000 metric tons) at a range of 1 has about the same visual and radar signature as a penny at a range of 4 kilometers. Combat in **Slag!** is someone tossing that penny into the air and you trying to shoot it down from a speeding car bouncing over a rough road. Consider it a minor miracle that you can hit at all.

Your weapons are isolated from the vibration of the ship's engines, and your computers know exactly when to compensate for your accelerations, but the ranges are still ridiculously long and the targets so small that you may fire hundreds or thousands of shots to get one hit. And if your target is small enough, fast enough or shielded enough, you may not be able to hit at all, especially if your own sensors aren't that good. A fighter engaging a target in an adjacent hex is like a B-1 bomber off Washington, DC locking onto a target somewhere in Iraq.

Terrain

There is not a lot of terrain in the empty space of **Slag!**, so what terrain there is can often be used to good effect by a smart player. Terrain usually affects how an opponent can move, and how effective their sensors are. If you have a sensor deficit compared to your opponent, you can hide in the sensor shadow of terrain to force your opponent to get closer. Then you can leave the terrain shadow so that you can get some hits before they retreat out of your targeting range. Likewise, if you know your opponent favors a certain type of ship, you can choose your terrain to work against them. For instance, if they don't use Missiles, then you could have a near-uncrackable asteroid base. If they favor Particle Beams, then your ships could use Lasers and operate in the atmopshere of a terrestrial planet. You could fire out, but they couldn't fire back. There is one terrain you do have control over: Sensor Drones. They might not be a planet or asteroid belt, but they are a stationary fixture on the map that *you* place, an island of extra sensor data that gives you and only you a bonus to hit. Use it to good effect.

Deployment

There is sometimes a temptation to put all your ships in a big stack and just go looking for trouble. While it concrentrates your forces, it also limits your options. Different weapons and weapon mounts work best against different ship types, and if your opponent splits forces, then if you don't deploy intelligently you'll end up with bad position every turn. Spine mounts work best against slower ships, missile carriers need to get close to make these one-use weapons count, stealthy ships need to carefully choose engagement range, and so on. A fleet which is built around a single tactic can hang together and be very powerful, but there is always a chance that someone will be able to catastrophically exploit its weaknesses.

Psychological Strategies

Think like a ship captain would. Obviously you want to win, and do so with a minimum of losses. But, once the high-energy photons start flying, your exact ships layout will have to be revealed, and with it, much of your potential strategy. Take advantage of the scenario conditions. If you have a floating map, and deal the first serious damage, you can simply turn tail and run. You don't have to ruin a foe to win, just do more points of ship damage to them than they do to you. Keep your opponent off-guard with whatever threats or potential threats you have, for instance, playing chicken with capital ships. It's difficult to get a mental edge when everything in the game is so open, but every little bit helps...

Optional Rules

After playing the game a few times on large or small maps, you may want to explore variations on the basic **Slag!** theme. Any or all of these may be negotiated between players before the start of a game. These are **random hit quantity**, **dogfight combat**, **random hit location**, **slow missiles**, **very low tech combat**, **optional ship systems**, **money cost for ships** and **strategic play notes**.

Randomized hit quantity

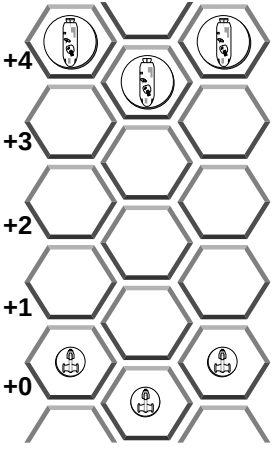
Slag! assumes a long enough turn that uniform results are gotten from your volley of several *hundred* shots. To prevent an opponent from being able to reliably sit just outside of your range, use the base number of hits, then add the roll of a six-sided die, and subtract 3. So, you will get more hits about half the time, less about a third of the time, and the same number of hits about a sixth of the time. This gives you about the same number of hits, and extends the maximum possible range of hits by 3 hexes.

Example - A die roll of ‘4’ means 1 more hit than normal, while a die roll of ‘1’ means 2 less hits than normal.

The other way of doing random hit quantity gives more variation, but adds a little more positional uncertainty and allows for those lucky shots that everyone knows and loves from other space combat games. If you have the time for the extra die roll, we recommend it.

Rather than using the simple 1d6-3 hits, take the total number of hits you would get (even if negative), and add 7. You must roll equal or less than this number on 2d6 to hit. Making the roll exactly is 1 hit, making it by 1 or 2 points is 2 hits, making it by 3 or 4 points is 3 hits and making it by 5 or more points is 4 hits. This also applies to point defense, but you double the number of hits you get. This gives small ships a chance of hitting, while reducing the number of hits from larger vessels. You can work out for yourself the tactical implications of more hits for small ships and less hits for large ships.

Example - A fighter fires at a ship and gets -2 hits. Adding 7 to this is 5, so the ship must roll 5 or less to hit. A roll of 5 is 1 hit, a roll of 3-4 is 2 hits, and a roll of 2 is 3 hits. The ship fires back at the fighter and gets 3 hits. Adding 7 is 10, so it needs 10 or less on 2d6 to hit. A roll of 10 is 1 hit, a roll of 8-9 is 2 hits, a roll of 6-7 is 3 hits and a roll of 5 or less is 4 hits.



Dogfight combat

This is a way to break down **Close Combat** into something more interesting than massive ship vaporization (MSV). Close Combat will resolve *before* all other combat. Take a separate sheet of hex paper and lay all ships involved in a particular sector on it, 4 hexes apart.

All of the ships on the +0 line are in Close Combat range with *all* the ships on the +4 line.

They are *not* directly opposite them, and do not move diagonally on this map. It is simply an abstract reference to the group of my ships closing to a group of your ships. However, if you intend to declare ramming or boarding, your ships with that intent need to be directly opposite their intended targets, and you *may* have more than one ship per hex if this is the case.

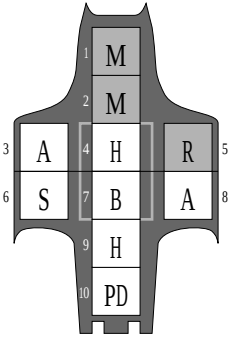
The +0 row indicates when you are just outside Close Combat range. The dog-fight is broken down into separate move/fire subphases. Only ships that declared close combat may move, since their superior mobility is what will set the range. On each subphase, each of the closing ships must either move closer or further away by *exactly* 1 hex, and can only change direction *once* (i.e. you can't sit still). If you decide to retreat, you *must* continue retreating until you reach the +0 line, at which point you stop. You may stop at the +0 line as your first move, which indicates that is where you hold position, or you may stop at the +4 line, which means you end the turn within boarding party or ramming range.

After each submove, fire resolves in order of Sensor Ratings. If equal ratings, the players put a spare counter under their hand for each ship, face up indicating “fire” and face down “no fire”. If you declare “no fire”, you *do not* fire weapons on that submove except in point defense, *regardless* of what your opponent does. If you declare “fire”, you *must* fire at least 1 weapon at one other ship in Close Combat, using the modifier for the line you are on instead of the default +4. Ranges are short enough that all hits resolve each subphase (including missiles).

Once all ships have reached the +4 or +0 line (or been blown to smithereens), normal combat resumes. This means that if you want to fire at a retreating ship in close combat, you have to declare it by the time they reach the +0 line. Ships involved in the dogfight combat *may not* fire at each other after the dogfight phase. Boarding parties that survive both close and normal combat, and are still eligible for boarding may do so if their carrier is at the +4 line with regard to the ship opposite them in close combat.

Random hit location

Instead of having the owner of the damaged ship always pick the initial hit location. Try the following. A player picks target location as normal, based on the weapon attack. The other player chooses clockwise or counter-clockwise, rolls a six-sided die and subtracts 1. The result is the number of valid locations the aim point is moved before the hit is actually applied.



Example - The ship to the left is hit with a particle beam that does 3 points of damage to it. The ship owner chooses the front Missile as the hit location, and the attacking player chooses “clockwise” and rolls 1d6 for 4 and subtracts 1, for 3. The hit is 3 locations clockwise from the front Missile, which is the other Missile (it is external and adjacent), to the Railgun to the Armor. Since Armor is not a valid initial target, the attacking player chooses an adjacent location, in this case the rear Hull. Now the ship owner chooses the second location as the Sensor, and the last point of damage exits into space.

Slow missiles

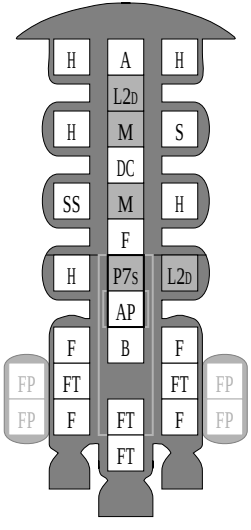
Missiles have high accelerations, but don't always make it to the target in the same turn. You can use (Size+2) counters to represent Missiles rather than counting them as a form of direct fire weapon. Missiles may move half their thrust when launched, and up to full thrust during ship movement afterwards. They have a thrust of 4 at Very Low, 6 at Low, 8 at Medium and 10 at High Tech. Missiles may only be shot down when they enter a ship's sector. During their flight to a target, they move as ships, based on their Thrust rating. Missiles are assumed to automatically hit if they enter the same hex as their target (even if they are less maneuverable, you *did* make a decision to let them get close).

Example - A Medium Tech Size 4 ship fires two Missile systems at a distant enemy ship. This results in 12 Missile counters being placed on the map. The owning player may move these any way they wish, up to 4 hexes the first turn and 8 hexes each turn after that. Even if the firing ship is destroyed, control may be passed to any other friendly ship, or adjustments made by on-board tactical analysis programs.

This makes Missiles the longest range weapon system in the game, and generates extra tactical subtleties as the Missiles can be timed to match fleet tactics, perform flanking maneuvers, and so on. On the other hand, it makes it harder to overwhelm a ship with Missile attacks unless you can make them all arrive on the same turn.

CAM 117 Destroyer
(V.Low Tech)

Size (systems/5)-1, round up	4(5)
Dmg. mod. -(Size/2), round towards 0	-2
Ship cost	17.4(.6)
Sensors	3(5)
Thrust	4(3)
Armor/Shields	1/0



Very Low Tech Combat

Ships at Very Low Tech are pretty much floating targets. They can't carry enough fuel to run for more than 2-3 turns at full power, their sensors suck and their weapons are limited and low-power. However, if you want to do combat where *all* the ships are Very Low or Low Tech, you can have some fun.

Basically, you divide the turn scale by a factor of 5. That is, a terrestrial planet is 5 hexes across, a moon is 3 hexes and an asteroid field is 5 hexes across. The turns are shorter, and Fuel for Fusion Torches or Orion Drives is used up each *five* turns of use (put a pencil dot next to a Fuel for each turn used). All other combat rules remain the same. Close Combat is just “closer”, for instance. Since planets are three dimensional, you can move all across the surface of a planet, and just need to specify “top” or “bottom” and “in atmosphere” or “in space”. Ships on opposite sides of a planet can't hit each other at all, while those on the same side simply take the regular Sensor penalties. To take gravity into account, all ships, free-flying missiles, drones or mines within 10 hexes of a planet or 5 hexes of a moon will be drawn one hex towards it per turn, in the direction they are moving if there are two equally likely choices. Items and bases can be declared “in orbit” when placed into play. Items in orbit move one hex clockwise around the gravitational body each number of turns equal to their altitude+1.

Example - A Sensor Drone orbiting two hexes outside the planetary edge would move one hex clockwise around the planet each three turns, like a drifting ship.

Money cost for ships

If you are using **Slag!** in a role-playing game (which we do not recommend, by the way), here is a way to generate ship cost in Credits or other convenient economic units. Take the number of systems the ship has, square it and multiply by 1 million credits. The apply any Tech Level cost modifier.

Example - A Size 2 Low Tech ship has 15 systems, so it has a base cost of 15 x 15 = 225 million credits, times x.8 for Low Tech is 180 million credits. A Size 5 High Tech ship would be 1.26 billion credits.

Civilian ships would cost half as much, but are limited to whatever is culturally allowed in that game world. Replacement cost of damaged or expended systems is equal to the pro-rated cost per system. Systems that any ship can have are half cost, while systems restricted to military vessels are double cost, and consumables (Cargo, Fuel, Fuel Pods) are one-tenth cost.

Example - Replacing a damaged Plasma Drive on the Size 2 Low Tech ship would cost 180 million credits divided by 15 systems, divided by 2 for a “civilian” technology is 6 million credits. Refueling a Fuel system on this ship would be 1.2 million credits.

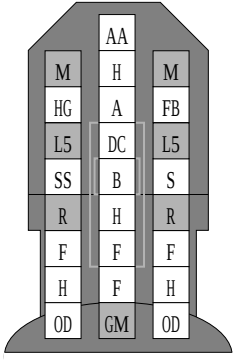
Optional Ship Systems

The basic rules include most of the standard technologies that we can rationalize or expect to see. This means that if you are playing a total stranger, you can expect them to have ships with these systems and no others. However, other people's vision of space combat may differ, and **Slag!** endeavors to be compatible with any space combat model that at least attempts to be realistic. To that end, there are some optional **Engines**, **General Systems**, **Defenses** and **Weapons** that you can use for your own ideas, recreate battles from books, television or movies or play "what if?" scenarios. The following systems are optional, and can be used by mutual consent of all players.

Michael(V.Low Tech)
Derived from "footfall"
by L.Niven and J.Pournelle

Size (systems/5)-1, round up	4
Dmg. mod. -(Size/5, round towards 0	-2
Ship cost	15.0(.6)
Sensors	3(5)
Thrust	2
Armor/Shields	3/0

OD



Orion Drive (Very Low tech only)

This particular engine is usable at very low tech only. It is the crudest form of plasma drive, using nuclear warheads detonated behind the ship to violently propel it through space. More advanced plasma drives might use controlled detonation of deuterium pellets, with the small explosions occurring at greater frequency and buffered by magnetic fields behind the ship. Each Orion Drive automatically counts as two extra points of Armor for any attack coming into the side or rear arc of the ship, and as long as the drive was used during a turn, the ship is also immune to all missile hits from the rear arc. This "armor rating" will be in addition to any normal Armor ths ship has, and may allow the ship to have a higher Armor rating from the side and rear than is normally possible.

An Orion Drive provides 3 points of thrust per system, and can only be used by ships of Size 3 or greater (smaller ones don't have the mass for the buffer plates and shock absorbers needed to withstand close proximity nuclear blasts). Orion Drives require a separate Fuel system. This Fuel may *not* be used to gain a temporary Armor bonus, since it is a stockpile of nuclear warheads rather than inert reaction mass. Any number of Orion Drives can draw from a single Fuel system, but that Fuel system is expended in any turn in which *any* Orion Drive is used.

BD **Burp Drive (High tech only)**

This is a high tech Jump Drive variant. It allows the ship to make very short jumps in conditions that prevent normal hyperspatial travel (usually, anywhere within 30 sectors of a planet, asteroid belt or gravity well). By itself, a Burp Drive will allow a ship to jump a distance of 1 sector during movement without crossing the intervening space, ending ending the jump with the same facing. Each **APU** declared as dedicated to the Burp Drive at the start of movement adds 1 sector to the jump distance. You cannot jump into or out of atmosphere using this drive. For sequencing purposes only, ships with Burp Drives have an apparent Thrust rating of 6. Use of this drive *does not* confer any acceleration or movement on the ship, and Burp Drive and regular engines may not be used for moving from sector to sector on the same turn. Regular engines *may* however be used to maneuver a ship *within* its destination sector to make it harder to hit or to change its facing after a jump. A ship jumping into a sector with Space Mines is treated as though it moved into the sector only if it uses regular engines as well.

PA **Plasma Accelerator (Medium tech+)**
This acts like a plasma drive, but with additional magnetic containment and directing fields. It operates as both a drive and a *rear-facing* spine mounted Particle Beam system. It provides 1 point of thrust per system, and has a damage of the ship's Size, minus the Damage Modifier of the defending ship, with a minimum of zero. Add 2 to the base damage if the target is in **Close Combat**. This effect may only be fired at targets in the same sector (which is still a range of a few thousand kilometers). It must be an internal or core system on any ship or base station it is mounted on (its damage assumes this), and can only be mounted on a base station that is on a moon, planet or asteroid. It may have dedicated Auxiliary Power Units, which increase its thrust as well as its damage.

The massive amount of energy in the Plasma Accelerator is diffuse, with a small central core doing most of the damage. The total energy one delivers over a turn is close to that of a proximity nuclear blast, and a hit by a Plasma Accelerator on a Force Screen being used as armor will drop 1 Force Screen for the turn, *if* the hit penetrates the total active Force Screen rating. Each Plasma Accelerator can only drop 1 Force Screen per turn, regardless of how many times it hits. Plasma Accelerators have no effect on Force Screens being used to negate Missile hits.

AI **Artificial Intelligence (Medium tech+)**
This system is a computer that completely runs the ship. Such a ship has no actual crew. As a result, only half the normal Damage Control (round down) is allowed (representing repair robots), and the ship may only have Intruder Defense systems, not Boarding Parties. However, an AI ship automatically counts as having one point of Electronic Countermeasures for evading attacks, since it can maneuver more violently and make tactical decisions faster.

This EC rating is in addition to the normal amount allowed with EC systems, and so an AI controlled ship can have a higher EC rating than a crewed ship. This extra EC bonus is lost if the AI controlled ship no longer has an effective thrust of 1 or more. The AI system is required *in addition* to the bridge. If a ship's last AI system is destroyed and cannot be repaired, the ship loses any AI benefits and is treated as a ship without a Bridge (it runs off local backup programs, but not nearly as well). A ship may have multiple AI systems, but this provides no benefit except redundancy.

BK **Breakaway (Very Low tech+)**
This is a system of bulkheads and explosive bolts that detaches one portion of a ship from another. This is declared *before* that ship moves. After separation, the ship is treated as two separate ships, one in front of the Breakaway, and the other behind it. The Breakaway itself is destroyed when used, cannot be repaired, and is not considered to be a system on *either* of the two ships.

The two ships *cannot* be rejoined during the normal scale of the game. Each "ship" has a Size based on the number of remaining systems, with thrust based on engines and this Size. This system is not common, but might prove useful on occasion. For instance, a ship with 4 Missile systems at the front and a Breakaway could fire the Missiles, and then use the Breakaway the following turn to discard the launchers, decreasing the Size and increasing the thrust of the ship. If targeted by hostile Boarding Parties, its destruction can *either* trigger a breakaway, *or* prevent it from being used, at the *attacker's* option.

JG **Jump Gate (Medium tech+)**

This is a system only usable on base stations that are in open space (not on any planet, moon or asteroid). The Jump Gate provides partial power and navigation for ships passing through it, and allows interstellar jumps by smaller ships. The base station will require both 1 Jump Gate *and* 1 Auxiliary Power Unit functioning for each point of ship Size the Jump Gate can pass in a given turn (minimum of 1). Needless to say, this tends to make large Jump Gate installations more fragile than other types.

A ship only requires a Bridge or Auxiliary Control system to use a Jump Gate. No Auxiliary Power Units are required. A ship may use a Jump Gate during the movement phase of any turn in which the ship started in the same sector as the Jump Gate. For any sort of campaign play, assume a ship using a Jump Gate has to appear at another Jump Gate.

RS **Redundant Systems (Medium tech+)**
Redundant systems are just that, backups, extra wiring, fault tolerant systems, etc. Whenever a ship takes damage for any reason, the owner of the ship may elect to take a system's worth of damage to a Redundant System. The game effect is similar to Damage Control, but it is pro-active instead of reactive. You have to use it when a given system takes damage, rather than waiting until later to see what you want to repair. The advantage is that you can protect a system you really need at sometime *before* damage control takes place. For instance, it could represent backup circuits on your antimatter containment fields, instead of the antimatter engine itself. No more than one Redundant System can be used vs. a particular weapon hit, and the system that was *originally* targeted for damage is treated as though it *had* been hit for purposes of further damage from particle beams, grasers, and other weapons that strike multiple systems. The maximum number of RS systems a ship can have is its Size-2.

TB **Tractor Beams (High tech)**
This is a high-tech system that can be used to tow or anchor objects that are within docking or ramming distance. The strength of the system is the Size of the ship, and multiple systems on the same ship can add 1 to the strength per system after the first. It may be used to grab *an* object of a Size + thrust ≤ to its strength, if it hits (it is fired and used like a weapon). Missiles have a Size + thrust of 1, and only one may be “grabbed” per Tractor Beam. Tractor beams may *not* be defensively arrayed or spine mounted.

For towing purposes, if you can grab it, you can tow it, but items the same Size at the tractoring ship reduce its thrust by 1, and each point of Size greater than the tractoring ship reduces effective thrust by 1.

Example - A Size 1 ship with two Tractor Beams can “tow” a Size 2 ship, but its thrust will be reduced by 2 while doing so.

Tractored ships may still use their thrust for dodging attacks, but may not leave the proximity of the tractoring ship. Tractored missiles are destroyed if still held at the end of combat, otherwise it hits. If using counters for missiles, tractored missiles remain in play until destroyed, and will hit their intended target on the turn they are released, even if this is due to combat damage to the Tractor Beam.

AA **Ablative Armor (Very Low tech+)**

This system acts as double normal armor *effect*, but the total number of Armor *systems* the ship can have is unchanged. Ablative Armor coats the outer surface of the ship, and stops damage by sacrificing itself, ablating away into space and carrying the excess energy with it. This could be graphite plates, ceramic tiles, superconductors of heat, reactive armor or some combination of all of the above.

Example - A Size 1 ship could have 2 Ablative Armor systems, which would give it a total Armor Rating of 4.

Any turn in which the Ablative Armor is *breached* by *any* attack (inc. missiles), you *must* lose an Ablative Armor system. If this is not done as part of the damage from that weapon, then it is in addition to that damage. Each AA system *will* absorb 1 Missile hit and an AA system *is* destroyed in the process (no collateral damage). One AA system may be sacrificed to prevent *all* damage a ship would take in a turn due to lack of streamlining, like re-entry damage.

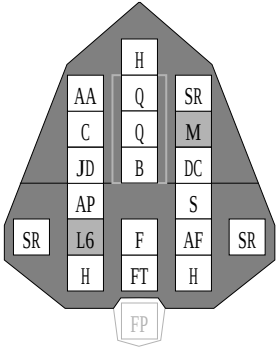
AF **Absorption Field (High tech)**

Also known as a Langston Field or black globe generator. Only one of these high-tech systems is allowed per ship. It generates a superconducting energy field at a distance around the ship, instantly spreading any energy over its entire surface and slowly dissipating it back into space. It can be locally modulated to provide “firing ports” and rocket exhaust exits, allowing normal firing and maneuverability.

An absorption field can negate *any* number of railgun, laser, graser or particle beam hits whose damage is *less than or equal* to the Size of the ship. Missile hits or hits by weapons whose damage is more than the ship's Size will begin to overload the field. The field can absorb a maximum number of such hits equal to twice the ship's (Size+1) before overloading, each non-missile hit counting as 1 hit, and each missile hit counting as 2 hits. If this maximum is *exceeded*, the field collapses, the field generator is destroyed, *and* all the energy it held is immediately applied as damage (in *addition* to the loss of the Absorption Field itself).

sinbad(High Tech)
from "The gripping hand"
by L.Niven and J.Pournel1E

Size (systems/5)-1, round up	3(4)
Dmg. mod. -(Size/2), round towards 0	-1
Ship cost	23.5(1.1)
Sensors	4
Thrust	1(0)
Armor/Shields	3/0



Example - If a Size 1 ship had an Absorption Field overload, it would immediately take 4 points of damage, since it holds twice the ship's (Size+1) in energy.

Overload damage is applied randomly throughout the external locations of the ship, and any internal locations that are adjacent to the field generator. Overload damage *does not* destroy normal armor, and the ship *does* get its Armor Rating, but not its Damage Modifier vs. this damage. The damage is not affected by the arc of the weapon that overloaded the field, and the *attacker* who overloaded the field gets to apply every other point of damage. In general, an overloaded field will pretty much ruin a ship because an attacker will get to put half the damage exactly where it will do the most harm.

Example - A Size 2 ship can have an Absorption Field that holds 6 points of energy. If this ship had an Armor rating of 2, and the field was overloaded, the ship would lose the Absorption Field and 4 other systems due to damage, of which the attacker would get to allot 2.

An Absorption Field *can* be turned off while it has energy stored in it. This occurs *after* damage control. Turning off a partially loaded field does *not* destroy the field generator, but the ship does take damage based on the energy currently stored in it. In this case, the ship *owner* allots *all* the damage. The field cannot be reactivated for a turn (at the start of the turn following a full turn of being off).

Absorption fields can radiate some of their stored energy back into space each turn. After damage control each turn, the ship subtracts its Size+1 from any energy stored in the field. This is done *before* turning the field off.

ND **Nuclear Dampers (High tech)**

These systems are field generators that inhibit some high-level nuclear reactions. The effect is that they prevent the detonation of nuclear warheads within a radius that would affect the ship. The conventional explosion that triggers most nuclear weapons will only have an effect if the target cannot maneuver, in which case the missile counts as a Size -1 ship ramming attack.

A side effect of Nuclear Dampers is that it prevents the use of nuclear reactors and propulsion systems while it is active. The field can rapidly be turned on and off as needed, but the net result is that the ship loses 1 thrust point from *each* engine on any turn in which dampers are on, and subtracts 1 from the total output provided by Auxiliary Power Units (i.e.a ship with three APU's would be counted as a ship with two APU's). If you do not declare that dampers are on before moving, they are assumed to be off. Antimatter engines or warheads are *not* affected by Nuclear Dampers.

Nuclear Dampers, Force Screens and Absorption Fields are mutually incompatible. While a ship *could* have all these systems, only one may be in operation at any given time.

M **Antimatter Missiles (High tech)**
These are substitutes for the normal nuclear warheads in missiles. They are no more destructive, but are unaffected by **Nuclear Dampers**. If a loaded missile rack is damaged, one or more of the missiles detonates, with catastrophic results. Treat as a Missile hit but *ignore* the **damage modifier** of the ship (since larger ships have more missiles to detonate).

R **Antimatter Railgun (High tech)**
Does normal railgun duty, but does more damage. It has damage of 2 and ignores Force Screens, but can't be used in an atmosphere. If damaged, it blows up like an **AM engine**. It may be voluntarily destroyed *before* combat to prevent this.

DM **Dogfight Missile (Very low tech+)**
These are short range missiles with their own sensors and guidance. While a normal missile in **Slag!** is about the size of an ICBM (Size 0 fighters only have 1 or 2 of them), dogfight missiles are about the size of a modern cruise missile, and can only be used against targets in **Close Combat**. Dogfight Missiles have an inherent Sensor Rating of 3 (2 at V.Low and Low Tech, 4 at High Tech), and are unaffected by the firing ship's Sensor Rating or modifications based on ship damage (lost Bridge, etc.). They do however, get any Close Combat bonus and are affected by enemy ship Size and Thrust. They are shot down like normal missiles, and do normal missile damage if they hit. Kinetic dogfight missiles are available (KM) and are treated as a Size -2 ship for collision purposes.

GM **Graser Mines (Very Low tech+)**
These are just like Space Mines, but they do not move to attack. Instead, they detonate a thermonuclear warhead that pumps a one-use gamma-ray laser. They do a 4 point **Graser** attack for each hit instead of a missile attack. They are available at all Tech Levels.

K **Kinetic Energy Missiles (Very Low tech+)**
These are missiles designed to hit a target and do damage based solely on their mass and velocity. For game purposes treat them as Size -1 ships that do collision damage with a target. They are shot down like Missiles, hits to the guidance system or engine altering their course enough that they miss. KE missiles are available at any Tech Level.

KK **Kinetic Kill Missile (Very Low tech+)**
These are effectively a “space claymore”, a dynamically adjusted directed fragmentation warhead that takes the place of a nuclear weapon. They generate hits like a normal missile, but do damage like a railgun with a damage of 4. That is, the weapon has a damage of 4, and ignores Force Screens. Since they are detonated further away, it takes 2 hits from a point defense weapon to take one out (or 4 hits from a friendly ship in the same sector that isn't the target of the attack). Space Mines can be loaded with fragmentation warheads instead of nuclear ones, and would be designated “FM”.

Strategic play

If you use **Slag!** for any sort of campaign, long-term or strategic play, here are some guidelines. Details are left to you. Strategic play is where you actually have some sort of rationale as to why you are trashing billions of credits worth of ships on a regular basis, where ships have to worry about supply, long-term fuel usage and so on.

A strategic turn is 10 days (≈1500 turns). Scenario generation is handled by random terrain generation and point cost of their fleets. Both sides decide and reveal terrain, and then figure out what ships they will bring. For instance, if one side reveals a planet, then the objective is to gain control of space around the planet. If it is all open space, then maybe it is a strategic jump point. If you have a star map to play with, assume Medium Tech ships can jump 1 parsec per 10 days, and High Tech ships can jump 2 parsecs per 10 days. Ships appear after a jump at 30 sectors from the strongest gravitational body on the map, and a defending player knows the direction the attack will come from (a particular map edge) If there are no gravitational bodies on the map, then ships appear within 10 hexes of the map edge. Ships appearing after a Jump do not move, but may use thrust normally and engage in combat normally. Ships waiting for incoming vessels may not move on the first turn, but may use thrust to evade and engage in combat normally.

Long term Fuel use
Fusion Torch engines use 1 Fuel per engine per 10 turns of use at Low Tech, per 20 turns at Medium Tech and per 50 turns at High tech.

Plasma Drives, Antimatter drives and Plasma Accelerators drives use up their internal fuel after 100 turns of use at Low tech, per 200 at Medium and per 500 at High tech. They need to have an additional Fuel per engine for use beyond this duration. If this Fuel is not available, mark the engine as deactivated. It is still there and can take damage, but is not available for thrust.

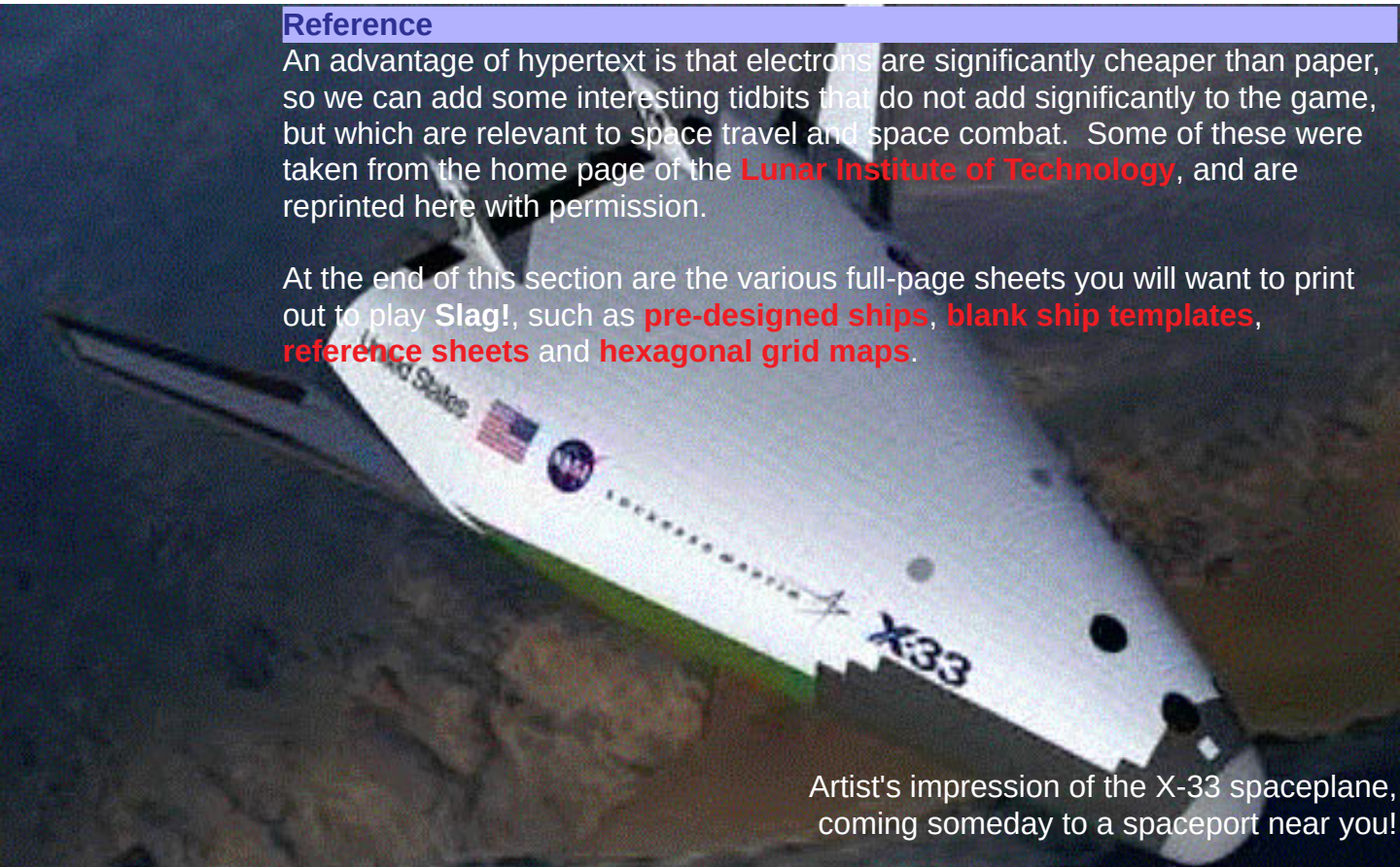
Ships need 1 Cargo or Damage Control per 50 days duration at Very Low and Low Tech, 1 per 100 days at Medium and 1 per 250 days at High Tech, rounding down. These systems are crossed off after the time elapses. If none is available, some other system must be destroyed (it breaks down and no parts are available to fix it). At Very Low and Low Tech, running out of supplies means life support failure. Cargo ships can resupply vessels, using 1 Cargo to replenish 1 Damage Control, Cargo, Missiles or Fuel on ships of the same Size. Supplying larger ships requires 1 extra Cargo per point of Size difference, and supplying smaller ships gives one extra Cargo per point of Size difference. Using Cargo to resupply Damage Control is how ship repairs will be handled in a strategic sense.

Example - A Size 3 cargo ship could use 1 Cargo to replace 3 Missile systems on Size 1 ships, or 2 Cargo to replace one Damage Control on a Size 4 ship.

Reference

An advantage of hypertext is that electrons are significantly cheaper than paper, so we can add some interesting tidbits that do not add significantly to the game, but which are relevant to space travel and space combat. Some of these were taken from the home page of the **Lunar Institute of Technology**, and are reprinted here with permission.

At the end of this section are the various full-page sheets you will want to print out to play **Slag!**, such as **pre-designed ships**, **blank ship templates**, **reference sheets** and **hexagonal grid maps**.



Artist's impression of the X-33 spaceplane, coming someday to a spaceport near you!

A Primer on the Physics of Propulsion
by Eric Moore (moore@chem.cmu.edu)

This is a basic primer on the physics of conventional propulsion systems. It assumes some knowledge of physics, but not much at all. I'll try and keep everything as basic as possible, but this will be a technical treatment of the subject.

Terms - The letter "p" represents momentum, "m" represents mass, "v" represents velocity, "t" is time, "F" is force and "Δ" is "delta", or change, so "Δv" means "change in velocity".

The function of any propulsion system is to make something move forward. Due to the conservation of momentum, this can only be accomplished by making something else move backwards. (This article ignores "reactionless" drives, as none are known to exist, and postulating them is difficult.) The heavier the stuff going backwards is, and the faster it's going, the faster you go. Generally, in order to design a spacecraft it's easiest to base your calculations off the force the drive is capable of, so that's what we'll try and calculate.

The first drive we will work on is a standard reaction drive. This is a drive where you take some material, and squirt it out the back of your ship (a chemical drive, a fusion drive, ion drive, etc). The basic relation we will use is the the one between change in momentum and force:

$$F = \Delta p/\Delta t$$

In other words, the the force exerted by or on a body is equal to the rate of change in it's momentum (p) per unit time (t). This doesn't seem to help us much, but it's often easier to calculate the change in momentum than the force. Now all we need to know is how much mass (m) we're pushing out the back of the ship, and how fast it's moving away from us (v).

$$p = mv$$

$$\Delta p/\Delta t = (\Delta m/\Delta t) * v$$

we'll take $\Delta m/\Delta t$ as a paramater that describes the rate of reaction mass usage ("reaction mass" is a technical term for the stuff we make move backwards). We're assuming that we can use up stuff at any rate we want (not really fair from an engineering standpoint, you need pipes and stuff to get it into the drive, but that's irrelevant from a physics standpoint. So the only thing we need is the velocity the reaction mass is moving at relative to the vessel. Obviously for our spacecraft we're going to want this to be as fast as possible, so that we get the maximum amount of thrust out of each kilogram of reaction mass spent. How do we know what velocity the reaction mass is travelling at? The easiest kind of a drive to make is a rocket. Basically a rocket is where you make your stuff hot, and use the heat to propel it out.

In a gas (or any other material, but we're working with gasses here) , the molecules are in constant motion, and the speed at which they are travelling is determined by the temperature. In a thermally based drive, we put the reaction mass in a box that's open on only one side. Then any molecules that are travelling in the direction of the hole will leave the box, moving (relative to the box) at whatever velocity they're moving at due to temperature. In a gas, the average velocity of the molecules is detemined by:

v = square root of (kT/m)

where k is a constant (Boltzmanns constant = $1.38 * 10^{-23}$), T is the temperature in degrees above absolute zero, and m is the mass of the molecule. So in order to increase the thrust we get out of each gram of reaction mass, we can do one of two things, we can increase the temperature, or we can decrease the mass of the molecule we're using. This makes Hydrogen (the lightest element) an ideal choice for reaction mass (and is why the space shuttles main engines carry more hydrogen than is needed to combust with the oxygen, the extra hydrogen makes the exhaust lighter, and makes the engines more efficient). Since it's pretty hard reduce the mass of the molecules below that of hydrogen, all we can do to improve the efficiency of our drive is to increase the temperature. The problem is that the specific impulse (specific impulse is a technical term for how much force a given amount of propellant can produce) of a drive is proportional to the square root of the temperature.

So if we want to double the specific impulse, we need to quadruple the temperature. Quadrupling the temperature requires quadrupling the energy input. The reason we want a high specific impulse is because we have to carry all of our reaction mass with us until we use it. This means that in addition to accelerating the ship, our drive has to accelerate the reaction mass we haven't used yet. In some drives this isn't a problem (for example the ion drives on satelites), usually because they aren't expected to do much accelerating, and therefore carry a very small amount of reaction mass in comparison to their total mass. For these drives getting the most amount of thrust out of a given amount of energy is most important. So, if you give a particle a given amount of energy (for example by accelerating it with an electric field) it's energy is given by:

$$E = 1/2\ mV^2$$

and it's momentum by:

$$p = mv$$

$$p = \text{square root of } (2 * E * m)$$

So, once again, doubling the specific impulse requires quadrupling the energy, but you want as massive a particle as possible. The limiting factor in interstellar travel is usually reaction mass.

In order to get anywhere in a reasonable amount of time, you need to accelerate more or less all the way, however the longer you plan on accelerating, the more reaction mass you need, and the more reaction mass that you carry, the more massive your ship is, and the more reaction mass you need to accelerate the reaction mass you haven't used yet. It's a vicious cycle. So most interstellar starship propulsion system designs use some method for getting around this. For example the bussard ramjet collects interstellar hydrogen (which it did not have to accelerate) along it's path, rather than carrying its reaction mass with it. Another idea is to use light pressure to accelerate a remote vehicle (e.g. the star-wisp). With this design you do all the work at a stationary powerplant.

The Forward Antimatter Engine
by Ges Seger

Introduction
The Forward Antimatter Engine was first proposed in an article for the 1982 JBIS Interstellar Studies issue and as part of a study done for the Air Force Rocket Propulsion Laboratory in 1983. Instead of following the conventional science-fiction route of total annihilation of matter with antimatter, the Forward engine uses a small amount of antimatter to heat a large volume of normal matter. In addition to having higher theoretical energy storage densities than comparable fission or fusion systems, antimatter engines tend to be aneutronic and have simpler energy-release cycles to exploit. This article is intended as a summary of the basic theory, engineering, two possible applications for spacecraft, and a brief intro to antimatter management. The references at the end are good starting points for further, more technical research.

Theory
The notion that the annihilation of matter with antimatter creates gamma rays is correct - to a first approximation. The actual process is much more complex at shorter timescales, and the Forward Antimatter Engine takes advantage of this fact.

For particles heavier than electrons or positrons, the reaction sequence goes as follows:

proton + antiproton = 1.5(+pion) + 1.5(-pion) + 2(neutral pion)

(neutral pion) → 2 gammas (7×10^{-8} seconds)

(+/- pion) → (+/- muon) + neutrino (7×10^{-8} seconds),

(+/- muon) → (electron/positron) + 2 neutrinos (6.2×10^{-6} seconds)

(positron) + (electron) = 2 gammas

Numbers in parentheses list the lifetime of the particle involved in the reaction. Though short, the by-products can do a lot in the time they exist: at the reaction energies involved, pions will travel approximately 20 meters before decaying, and muons about 2000 meters. Exploiting the energies of these by-products is where we leave theory and enter engineering.

Engineering

The actual conversion of annihilation energy to propulsive energy can take several routes. Perhaps the simplest technique was developed by Bruno Augenstein, who surrounds the reactor with enough mass to thermalize the annihilation energy. The working fluid then flows under pressure through this mass, absorbing the thermalized energy.

If Augenstein's converter is treated as a particle-bed nuclear fission rocket for purposes of thermal and hydraulic modeling, power densities of 30 kw/cm^3 are possible. A variant developed by Cassenti, Howe, and Nordley uses a magnetic field to contain the charged annihilation byproducts within the working fluid, which heats and ionizes it. This technique has the advantages of capturing all energy from the reaction except for the neutrinos (the gammas are compton-scattered off the plasma electrons, which transfers their energy), and generating a plasma which can then be passed through a MHD generator for electricity.

Application (Direct-Thrust)

In the simplest application, the working fluid is exhasted out the back of the reactor after absorbing energy from the annihilation byproducts. The exhaust velocities will be very high, and very much dependent on how well the energy of the annihilation byproducts are coupled to the working fluid. For simple earth-orbital applications, mission delta-vees of 30 km/sec at mass ratios of 2 are achievable parameters. Direct-thrust drives have three advantages over other schemes based on the Forward Engine. First, thermal management becomes easier when you don't have to recirculate your working fluid. Second, thrust-to-weight ratios are higher. Lastly, delta-vee tends to scale as a function of antimatter consumed. Looking at the rocket equation:

$$\Delta v = v(\text{exhaust}) \times l_n(\text{initial mass/final mass})$$

we see Δv can be increased either by increasing the amount of working fluid you use or its exhaust velocity. Mathematically, it's more efficient to increase the exhaust velocity. Also, a spacecraft using a direct-thrust Forward Antimatter Engine will carry several tons of working fluid for each kilogram of antimatter. Looking at the spacecraft's mass budget, it's going to be more efficient to increase the antimatter load, which will result in a hotter exhaust velocity.

Application (Power Source for Ion Drive)

Nordley discusses a scheme for using an antimatter reactor to power a combined MHD/Brayton-cycle electrical generator. The working fluid through a reactor is passed first through the coils of an MHD power generator. After it extracts all the energy it can, the exhaust is then passed into a Brayton-cycle turbogenerator. Radiators will then be neccessary to remove the remaining (waste) heat from the working fluid and return it to the input temperature of the reactor. What is gained by all this? First, unlike the direct-thrust concepts, the working fluid is recirculated. Secondly, the electricity generated by the MHD and Brayton-cycle generators can be used to power an ion drive. Ion drives will typically have much higher exhaust velocities than a direct-thrust antimatter drive, and lower mass ratios as well (due unfortunately to the lower net thrust of the drive).

Antimatter Containment and Handling

Antimatter is currently created at accelerator facilities such as Fermilab and CERN for research purposes, and femto- to pico-gram quantities are routinely stored and handled. Scaling up to the kilogram quantities neccessary for inter-planetary spaceflight (and higher quantities for interstellar) will require further research into long-term antimatter management, and the associated problems involving thermal, vacuum, and radiation issues.

The main problem with thermal control in antimatter storage involves sublimation of the antimatter. For long-term containment, especially within electrostatic or magnetic fields, it is convenient to store the antimatter as a “snowball.” If this snowball can be kept at or below 2° Kelvin, virtually no antimatter will sublimate from it. Should it get much warmer, antimatter sublimates rapidly from the snow-ball, and you’ve gone from a temperature problem to a vacuum problem.For obvious reasons, the snowball should be kept in as good a vacuum as possible. However, no matter how successful you are at keeping the temperature of your antimatter snowball under control, you will always get a few stray anti-atoms leaving it. There will also be a few stray cosmic rays or hydrogen atoms which will manage to enter the storage container. You’ve now gone from a vacuum problem to a radiation problem. If sublimation is kept under control, the radiation (and energy coupling back into the snowball) is minimized to the point that the temperature increase of the snowball is negligible. Assuming you have safely stored your antimatter, how do you get it to your reactor?

The most common technique involves using ultraviolet lasers to ionize a local area of the snowball. Intense electrical fields can then be used to remove the ionized antimatter from the snowball and move it to the reactor. To insure the snowball's mass is not removed asymmetrically (which would tend to make containment difficult), it is usually spun during this process.Other (more speculative) schemes involve treating antiprotons as negative ions and storing them within normal matter crystal lattices, or storing antimatter as an exotic quark gas.

References:

Forward, Robert L. & Davis, Joel, "Mirror Matter," Wiley, 1988

Nordley, Gerald, "Application of Antimatter-Electric Power to Interstellar Propulsion," presented at 38th IAF Congress, Brighton, October 1987 (reprinted in JBIS vol 43)

Jackson, A. A., "Some Considerations on the Antimatter and Fusion Ram Augmented Interstellar Rocket," JBIS vol 43, p 117-120

Daedalus

Daedalus is a fusion powered starship massing 49,000 metric tonnes. Designed by the British Interplanetary Society in the early 1970s, the vehicle uses a fuel consisting of pellets of solid deuterium and helium-3. These fuel pellets are sent to a chamber where they are struck by a high-energy electron beam, beginning the fusion process. A super-hot plasma is created, and directed for thrust using magnetic fields generated by superconducting coils.

Daedalus was originally intended for a one-way trip to Barnard's Star. The vehicle would not be decelerated at the target system, and would continue flying through, making the encounter last for at most a few days, as the vehicle would be travelling at 15% the speed of light. Daedalus requires 27 thousand metric tonnes of helium-3, which is currently unavailable on the Earth. In order to produce a Daedalus-class vehicle, it is necessary to produce self-reproducing floating "atmosphere mining machines" which would be released in Jupiter's atmosphere. These probes would collect helium-3, and send it to Daedalus, in Jupiter orbit. Daedalus is an unmanned probe with a high degree of autonomy. As the trip to Barnard's star would take approximately 50 years, a number of sophisticated robots called wardens are stored on board for repair work. Daedalus also carries a large number of instruments and mini-probes which become active during the encounter phase of the mission.

Orion

Orion was developed during the 1960s by General Dynamics. The vehicle is a so-called nuclear pulse rocket. This means that over one quarter of a million atomic bombs are stored on board as fuel. These bombs are ejected from the aft end of the craft and exploded some distance behind it. A large physical barrier protects the vehicle's occupants, and acts as a pusher plate. As the explosions occur, the force of the explosion impacts upon the plate, pushing the entire craft forward. Enormous shock absorbers are used to cushion the "ride".

Orion could accellerate its 400,000 metric tonnes to 1.6% the speed of light in about a week. Actual tests of scale models were performed. The model vehicles did, indeed, propel themselves into the sky. The device was almost always unstable, however, and usually wound up exploding. Atmoic explosions in outer space were outlawed by the Nuclear Test Ban Treaty in 1963.

Selected abstracts

Below are abstracts and NASA reference numbers for some technical papers of relevance if you want to delve into the technical side of space travel and space combat.

Title:	Alien starship detectability - Bursters and skidmarks
Authors:	MATLOFF, GREGORY L. (Baruch College, NY); MALLOVE, EUGENE F. (MIT, Cambridge, MA)
Notes:	IAF, 39th International Astronautical Congress
Published:	October 1988
NASA Subject Category:	SPACE SCIENCES (General)
CASI Accession #:	88A55443
Pages:	5
Report Number:	IAF PAPER 88-552

Abstract:

All starships may utilize electromagnetic drag screens to decelerate to interplanetary velocities when approaching destination solar systems. Observable characteristics of exothermic starships and deceleration drag screens are reviewed. A preliminary theory for the detectability of ramjet or ram-augmented interstellar rocket or drag screen trails is developed. The applicability of planned astronomical telescopes to starship searches is briefly discussed.

Title: Design of orbital debris shields for oblique hypervelocity impact
Author: FAHRENTHOLD, ERIC P.
Published: February 1994
Source: Texas Universit., Austin, TX.
NASA Subject Category: SPACECRAFT DESIGN
CASI Accession #: 94N24828
Pages: 111
Report Number: NASA-CR-195152, NAS 1.26:195152

Abstract:
A new impact debris propagation code was written to link CTH simulations of space debris shield perforation to the Lagrangian finite element code DYNA3D, for space structure wall impact simulations. This software (DC3D) simulates debris cloud evolution using a nonlinear elastic-plastic deformable particle dynamics model, and renders computationally tractable the supercomputer simulation of oblique impacts on Whipple shield protected structures. Comparison of three dimensional, oblique impact simulations with experimental data shows good agreement over a range of velocities of interest in the design of orbital debris shielding. An abstract based on the work described was submitted to the 1994 Hypervelocity Impact Symposium.

Title: Debris impact on Earth-orbiting spacecraft
Author: SMITH, D.G.
Published: January 1985
Source: Tennessee Technological Univ., Cookeville, TN
NASA Subject Category: ASTRONAUTICS (General)
CASI Accession #: 85N22234
Pages: 15
Report Number: none

Abstract:
The accumulation of Earth-orbiting space debris leads to important new design considerations. Some 5,000 orbiting objects, many of them explosion fragments, are currently being tracked and future collision of these objects with each other is predicted. These collisions will occur at high velocities. Each collision will be explosive, ejecting thousands, of new orbiting objects, in turn increasing the frequency of future collisions. The debris population may thus become self-regenerative, and the future flux of orbiting debris will exceed that of meteoroids. As a result, a large space structure in Earth-orbit for several years has a significant probability of impact by debris objects. As a design problem, debris impact is significantly different from meteoroid impact. Protection against such large objects may require structural measures. The consideration of debris impact in the design of large, Earth-orbiting spacecraft is recommended.

Title: Structural Damage Prediction and Analysis for Hypervelocity Impact. Characteristics of Debris Clouds Produced by Hypervelocity Impact of Aluminum Spheres with Thin Aluminum Sheets

Author: PIEKUTOWSKI, ANDREW J.

Published: October 1995
Source: Dayton University Research Institute, OH.
NASA Subject Category: STRUCTURAL MECHANICS
CASI Accession #: 96N27666
Pages: 18
Report Number: NASA-CR-201003, NAS 1.26:201003, MAF/MMA-31-100(3/95), NIPS-96-48896

Abstract:
Debris clouds produced by the normal impact of aluminum spheres with aluminum bumper plates are shown to consist of an ejecta veil, an external bubble of debris, and a significant internal structure composed of three distinct elements. Effects of variations in bumper- plate thickness, sphere diameter, and impact velocity on the shape and velocity of the elements of the internal structure are described and compared. Three alloys of bumper material and several diameters of 2017-T4 aluminum spheres, ranging from 6.35mm to 12.7mm, were used in the tests described in this paper.

Test results were sorted into two sets. In the first set, impact velocity was held constant at 6.7 km/s and the bumper-thickness-to-projectile-diameter ratio, t/D, varied from 0.026 to 0.424. In the second set, t/D ratio was held constant at 0.049 and the impact velocity varied from 3.77 km/s to 7.23 km/s. In both sets of test results, debris-cloud properties are shown to scale with projectile diameter. Characteristics of the front element of the debris-cloud internal structure are shown to be sensitive to changes in t/D ratio and impact velocity. A model for the formation of this front element is presented and used to develop a description of a debris cloud consisting of material in the solid-liquid and/or liquid-vapor phases.

Title: Hypervelocity impact shield - Patent
Authors: COUR-PALAIS, BURTON G.; CREWS, JEANNE LEE
Published: November 1991
Source: National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
NASA Subject Category: SPACECRAFT DESIGN
CASI Accession #: 92N15114
Pages: 12
Report Number: NASA-CASE-MSC-21420-1, US-PATENT-5,067,388, US-PATENT-APPL-SN-516573, US-PATENT-CLASS-89-36.02, US-PATENT-CLASS-89-36.11, US-PATENT-CLASS-244-158R, INT-PATENT-CLASS-F41H-5/04

Abstract:
A hypervelocity impact shield and method for protecting a wall structure, such as a spacecraft wall, from impact with particles of debris having densities of about 2.7g/cm^3 and impact velocities up to 16km/s are disclosed. The shield comprises a stack of ultra thin sheets of impactor disrupting material supported and arranged by support means in spaced relationship to one another and mounted to cover the wall in a position for intercepting the particles. The sheets are of a number and spacing such that the impacting particle and the resulting particulates of the impacting particle and sheet material are successively impact-shocked to a thermal state of total melt and/or vaporization to a degree as precludes perforation of the wall. The ratio of individual sheet thickness to the theoretical diameter of particles of debris which may be of spherical form is in the range of 0.03 to 0.05. The spacing between adjacent sheets is such that the debris cloud plume of liquid and vapor resulting from an impacting particle penetrating a sheet does not puncture the next adjacent sheet prior to the arrival thereat of fragment particulates of sheet material and the debris particle produced by a previous impact.

Title: Advanced propulsion engine assessment based on a cermet reactor
Author: PARSLEY, RANDY C.
Published: 1993
Source: Pratt and Whitney Aircraft, West Palm Beach, FL.
NASA Subject Category: SPACECRAFT PROPULSION AND POWER
CASI Accession #: 93N26919
Pages: 67
Report Number: none

Abstract:
A preferred Pratt & Whitney conceptual Nuclear Thermal Rocket Engine (NTRE) has been designed based on the fundamental NASA priorities of safety, reliability, cost, and performance. The basic philosophy underlying the design of the XNR2000 is the utilization of the most reliable form of ultrahigh temperature nuclear fuel and development of a core configuration which is optimized for uniform power distribution, operational flexibility, power maneuverability, weight, and robustness. The P&W NTRE system employs a fast spectrum, cermet fueled reactor configured in an expander cycle to ensure maximum operational safety. The cermet fuel form provides retention of fuel and fission products as well as high strength. A high level of confidence is provided by benchmark analysis and independent evaluations.

Title: Mars manned fusion spaceship
Authors: HEDRICK, J.; BUCHHOLTZ, B.; WARD, P.; FREUH, J.
Published: 1991
Source: Wisconsin University, Madison, WI.
NASA Subject Category: SPACECRAFT PROPULSION AND POWER
CASI Accession #: 91N23232
Pages: 11
Report Number: NASA-CR-188215, NAS 1.26:188215

Abstract:
Fusion propulsion has an enormous potential for space exploration in the near future. In the 21st century, a usable and efficient fusion rocket will be developed and in use. Because of the great distance between other planets and Earth, efficient use of time, fuel, and payload is essential. A nuclear spaceship would provide greater fuel efficiency, less travel time, and a larger payload. Extended missions would give more time for research, experiments, and data acquisition. With the extended mission time, a need for an artificial environment exists. The topics of magnetic fusion propulsion, living modules, artificial gravity, mass distribution, space connection, and orbital transfer to Mars are discussed. The propulsion system is a magnetic fusion reactor based on a tandem mirror design. This allows a faster, shorter trip time and a large thrust to weight ratio. The fuel proposed is a mixture of deuterium and helium-3. Helium-3 can be obtained from lunar mining. There will be minimal external radiation from the reactor resulting in a safe, efficient propulsion system.

Title: Spaceship propulsion based on muon catalysed nuclear fusion

Author: PRIMEAU, G. (Aerocorp Tech., Lachine, Canada)

Notes: IAF, 42nd International Astronautical Congress
Published: October 1991
NASA Subject Category: SPACECRAFT PROPULSION AND POWER
CASI Accession #: 92A12589
Pages: 10
Report Number: IAF PAPER 91-247

Abstract:
A propulsion scheme is outlined that utilizes a nuclear fusion process in which the negative muon is the catalyst for the process. Muon-catalyzed fusion (MCF) replaces the lighter electron in light atoms thereby reducing the atomic radius and promoting spontaneous fusion. The unresolved technical issues regarding MCF are listed, and the potential of MCF for application to a space program is examined in terms of two modes of operation. An approximate nuclear power value of 36.7 GeV/muon is estimated using a conservative theoretical approach to the modes of operation based on the products of the nuclear fusion process. The estimate suggests that travel to Mars can be accomplished in about three days, and a global concept for the required spacecraft is presented. The ramifications of the MCF concept on the present aerospace scene are considered including the requirements to commence an MCF-propelled spacecraft program.

Title: Safe, compact nuclear propulsion: Solid core nuclear propulsion concept

Authors: RAMSTHALER, J.H.; FARBMAN, G.; HARRIS, P.; SULMEISTERS, T.

Published: October 1988

Source: Edgerton, Germeshausen and Grier, Inc., Idaho Falls, ID

NASA Subject Category: SPACECRAFT PROPULSION AND POWER

CASI Accession #: 89N19369

Pages: 310

Report Number: AD-A202339, EGG-ES-8093, AFAL-TR-88-033

Abstract:
The NERVA nuclear rocket engine was compared to an advanced nuclear electric engine as well as an advanced chemical engine for use in orbital transfer, and lunar and Mars missions. The NERVA stage had advantages over the chemical stage in payload, life cycle cost, and propellant consumption. The NERVA stage also had lower mission time requirements and life cycle cost compared to the nuclear electric stage. Fabrication of the NERVA stage does not require an extensive engine development program and demonstrated engine operating characteristics assure a reliable, flexible stage with a multiple mission capability. The single propellant used in nuclear engines eliminates the combustion hazards associated with the use of dual propellants in space.

Preliminary evaluations also indicated that varying the tankage used according to mission could reduce the cost of operating the nuclear engine. The open air engine tests used to develop the NERVA fuel and engine system are not environmentally acceptable today. A proposed alternate fuel development approach is to screen candidate fuel systems and conduct failure tests in test reactors. Such testing facilities are designed for testing of closed loop systems. Failure tests on full scale core segments could also be conducted closed loop in larger facilities. A full scale engine system qualification could be accomplished but the facility must be designed to shut down immediately at the first detection of fission product release. It is estimated that all non-nuclear components of the NERVA engine system could be qualified for engine testing within four years and depending on the problems encountered, cost could range from $55 to $180 million.

Title: Direct fission propulsion - Improvement of a series-staged starship from impulsive jettisoning policy

Author: VULPETTI, G. (Roma, Universita, Rome, Italy)

Notes: (British Interplanetary Society, 2nd Conference on Interstellar Travel and Communications, British Interplanetary Society, Journal (Interstellar Studies), vol. 31, Mar. 1978, p. 93-102.

Published: March 1978

NASA Subject Category: SPACECRAFT PROPULSION AND POWER

CASI Accession #: 78A26031

Pages: 10

Report Number: none

Abstract:

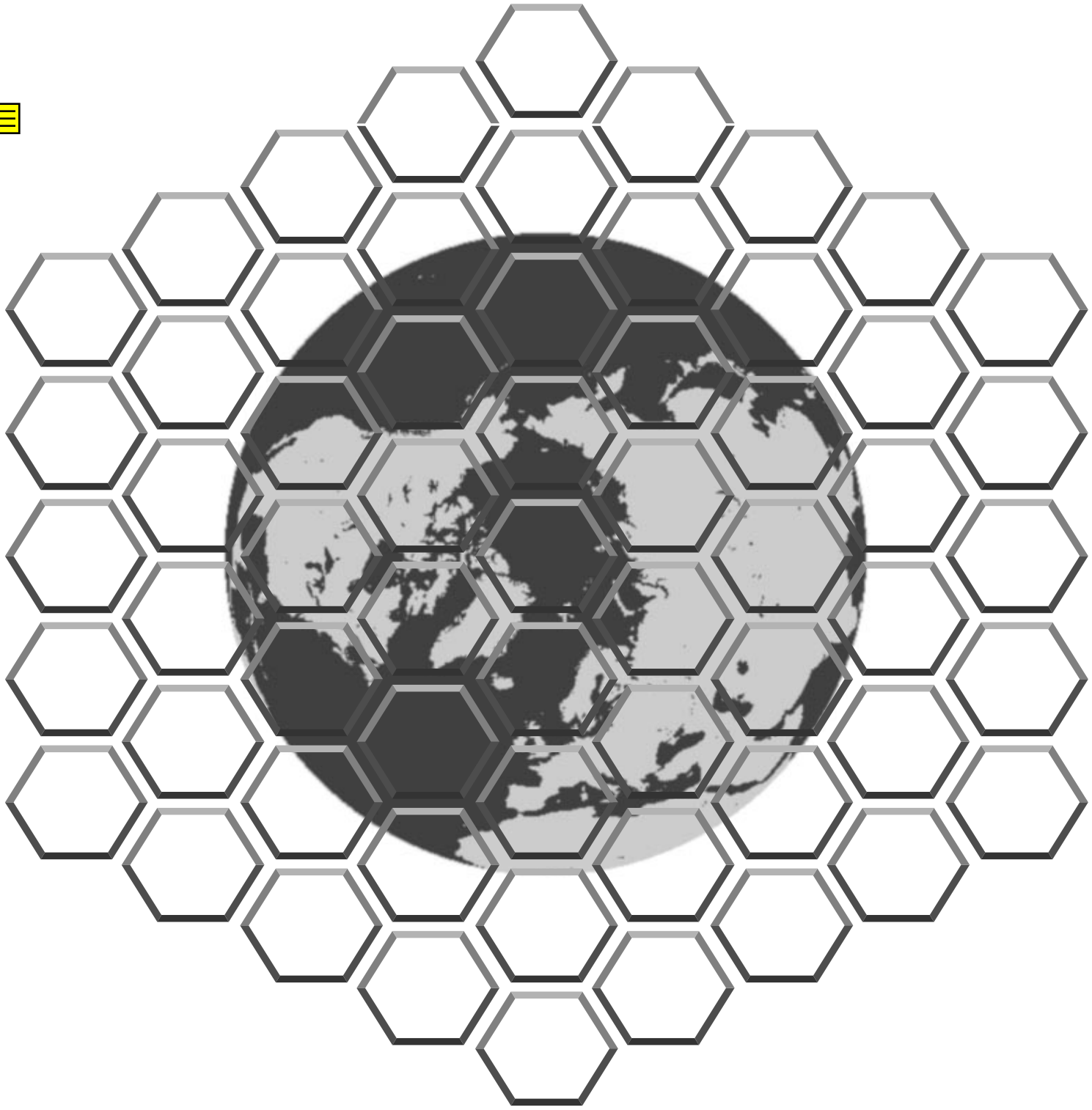
Plutonium 239 is proposed as a power source for an interstellar spacecraft. Impulsive jettisoning of non-reusable matter would furnish the specific thrust. Various design and operating parameters of the fission-drive are discussed, including: burning time, neutron generation, exhaust speed, number of jettisoning impulses, overall spacecraft weight to fuel weight ratios, and construction costs. Mission objectives are evaluated, ranging from unmanned probes to star-fareing space colonies involved in either very fast fly-bys to one or more star systems, or capture missions to a single system, in which the spacecraft will be able to search for (possibly earth-like) planets.

Title: Heating and drag at relativistic speeds
Author: POWELL, C. (Tennessee University, Tullahoma, TN)
Notes: British Interplanetary Society, Journal, vol. 28, Aug. 1975, p.546-552.
Published: August 1975
NASA Subject Category: ASTRONAUTICS (General)
CASI Accession #: 75A38610
Pages: 7
Report Number: none

Abstract:
Equations are derived for the drag on a starship and for the forebody surface temperature, as functions of interstellar-medium density, flight speed, forebody half-angle, and forebody surface emissivity. Some numerical results are given, and some implications of interstellar heating for starship design are discussed. A possible solution to the problem of forebody shielding is suggested.

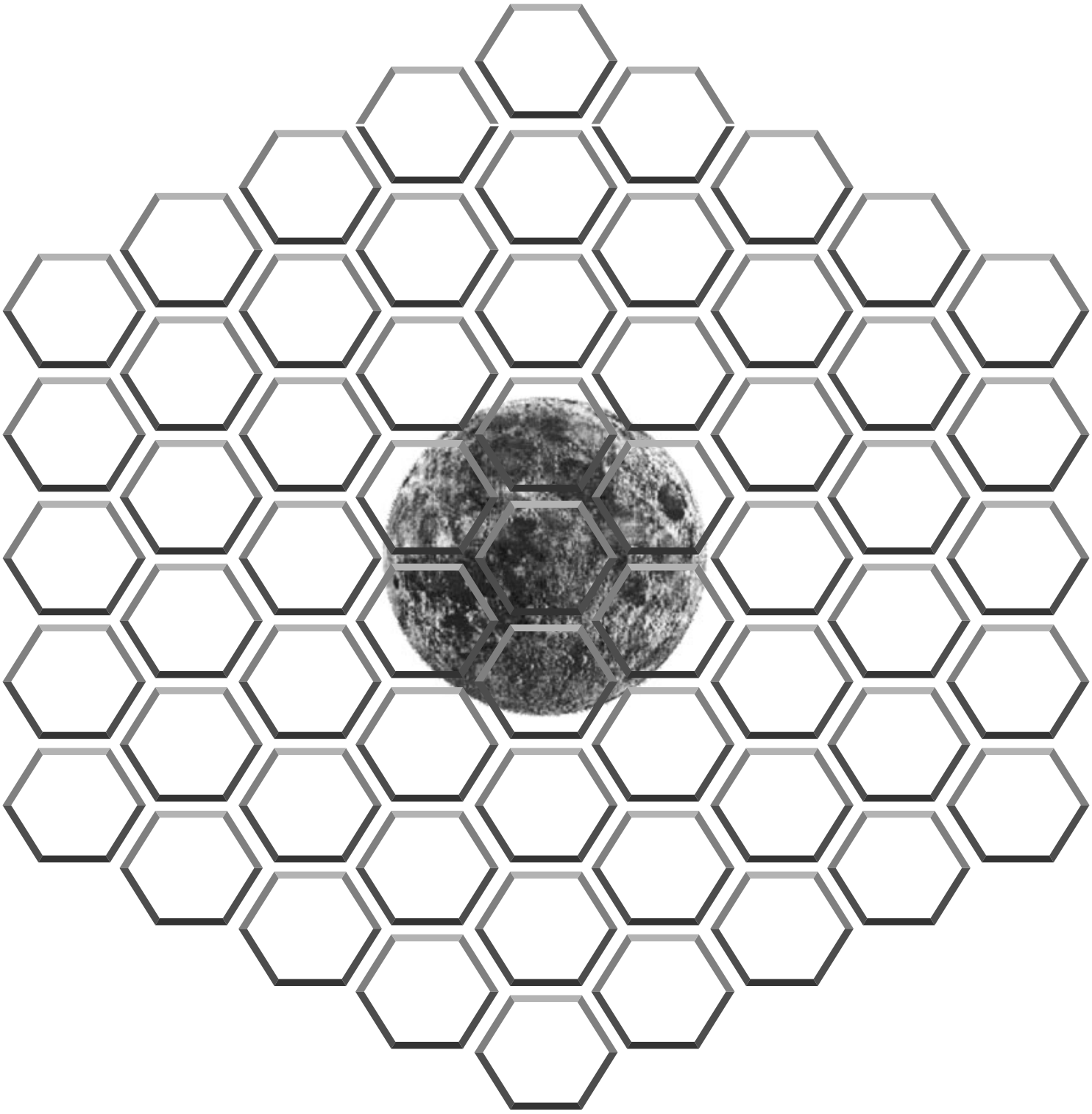
Earth map

This map is suitable for Very Low Tech conflicts around Earth. The Moon is on its own map, separated from this one by a number of empty space maps.



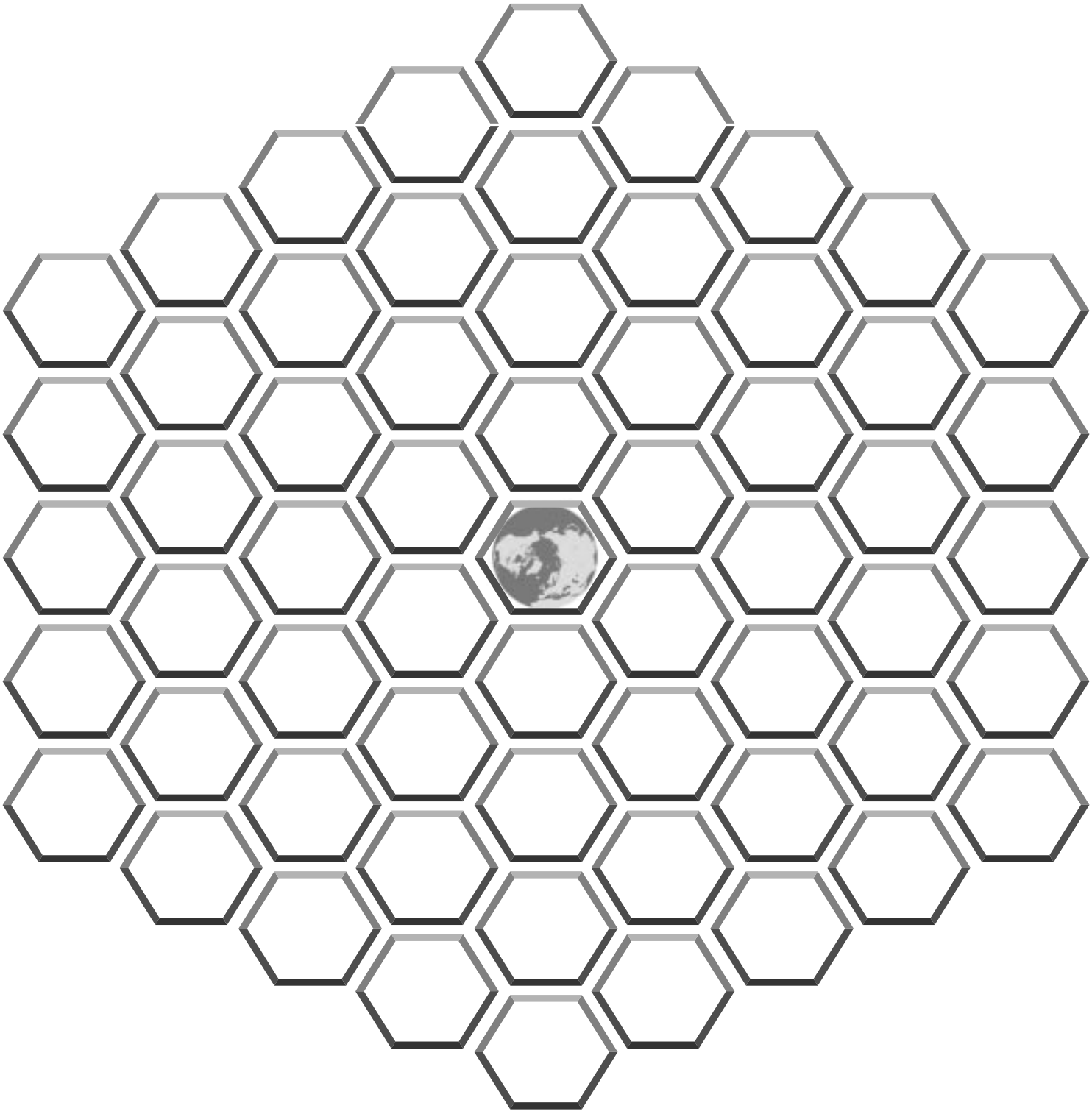
Moon map

This map is suitable for Very Low Tech conflicts around the Moon. The Earth is on its own map, separated from this one by a number of empty space maps.



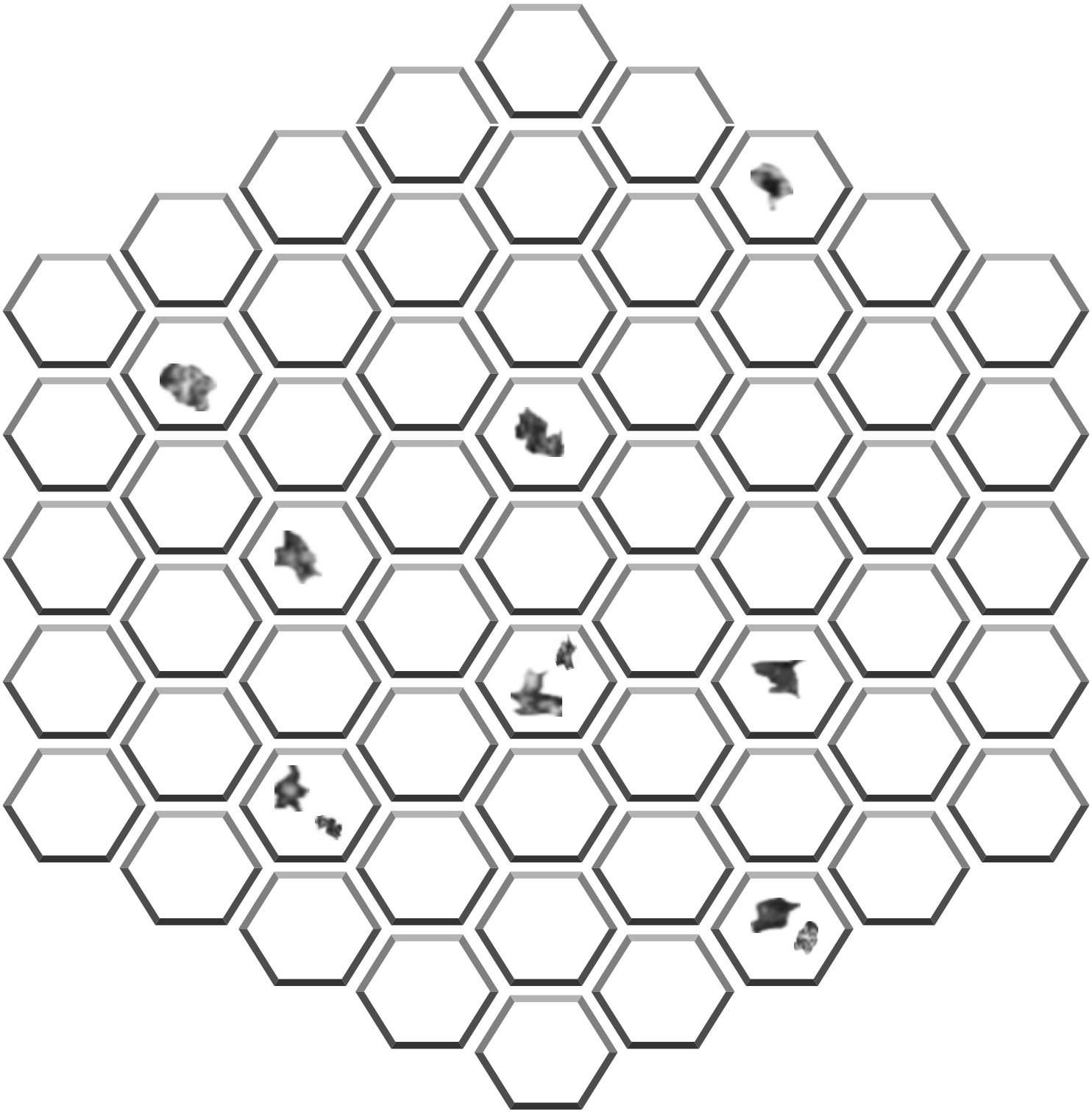
Earth map

This map is suitable for conflicts around Earth using the normal game scale. The Moon would be a similar map, separated by four empty space maps.



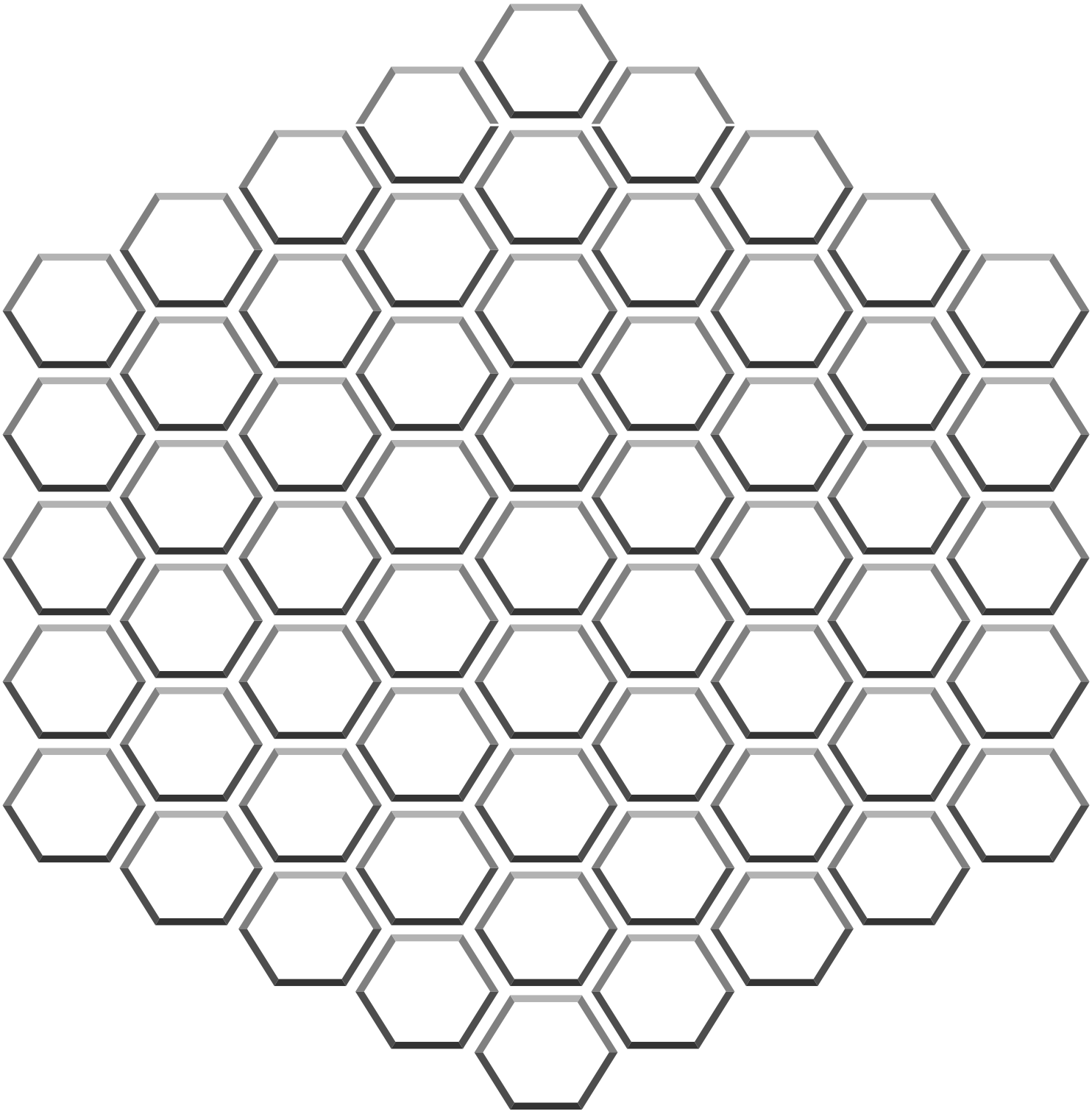
Asteroid map

This map is suitable for conflicts around a “movie style” asteroid belt. Each hex of this map with debris in it counts as an asteroid field counter.



Generic map

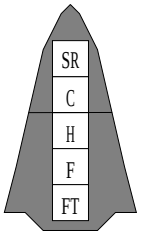
Cut out along outer border to generate maps of any size. Overlap hexes as needed for best fit.



Very Low and Low Tech Ships

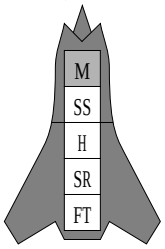
X-30 Space Plane (V.Low Tech)

Size (systems/5)-1, round up	0
Dmg. mod. -(Size/5), round towards 0	0
Ship cost	.6(.1)
Sensors	-3
Thrust	2
Armor/Shields	0/0



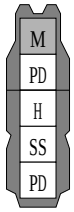
Air Interceptor (V.Low Tech)

Size (systems/5)-1, round up	0
Dmg. mod. -(Size/5), round towards 0	0
Ship cost	.6(.1)
Sensors	-3(1)
Thrust	2
Armor/Shields	0/0



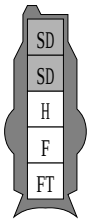
Space Interceptor

Size (systems/5)-1, round up	0
Dmg. mod. -(Size/5), round towards 0	0
Ship cost	.8(.2)
Sensors	-3(1)
Thrust	2
Armor/Shields	0/0



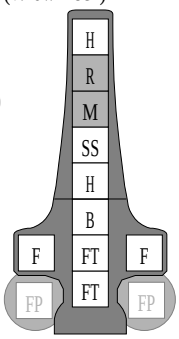
EW Escort

Size (systems/5)-1, round up	0
Dmg. mod. -(Size/5), round towards 0	0
Ship cost	.8(.2)
Sensors	-3
Thrust	2
Armor/Shields	0/0



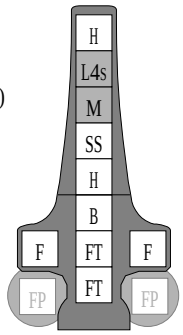
Heavy Interceptor (V.Low Tech)

Size (systems/5)-1, round up	1(2)
Dmg. mod. -(Size/5), round towards 0	0
Ship cost	2.8(.2)
Sensors	-2(2)
Thrust	3(2)
Armor/Shields	0/0



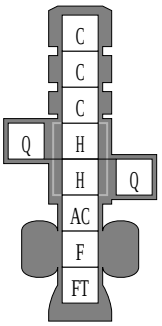
Heavy Interceptor

Size (systems/5)-1, round up	1(2)
Dmg. mod. -(Size/5), round towards 0	0
Ship cost	3.8(.3)
Sensors	-2(2)
Thrust	3(6)
Armor/Shields	0/0



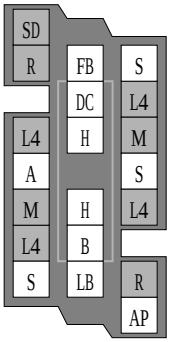
Sublight Frieghter

Size (systems/5)-1, round up	1
Dmg. mod. -(Size/5), round towards 0	0
Ship cost	3.2(.3)
Sensors	-3
Thrust	1
Armor/Shields	0/0



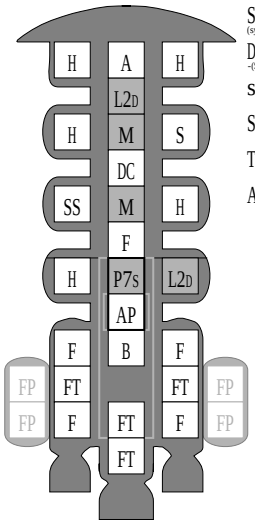
Sentinel Outpost (V.Low Tech)

Size (systems/5)-1, round up	3
Dmg. mod. -(Size/5), round towards 0	-1
ship cost	9.6(.5)
Sensors	3
Thrust	0
Armor/Shields	1/0



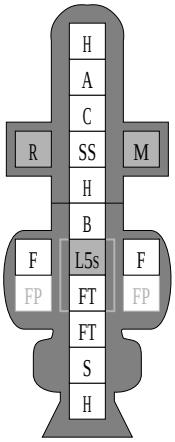
CAM 117 Destroyer (V.Low Tech)

Size (systems/5)-1, round up	4(5)
Dmg. mod. -(Size/5), round towards 0	-2
Ship cost	17.4(.6)
Sensors	3(5)
Thrust	4(3)
Armor/Shields	1/0



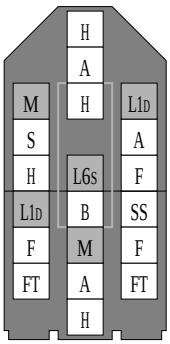
Customs Frigate

Size (systems/5)-1, round up	2(3)
Dmg. mod. -(Size/5), round towards 0	-1
ship cost	8.2(.5)
Sensors	1(3)
Thrust	2(5)
Armor/Shields	1/0



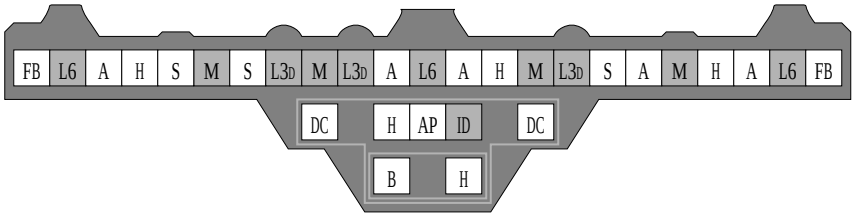
Planetary Defense Boat

Size (systems/5)-1, round up	3
Dmg. mod. -(Size/5), round towards 0	-1
Sys./Cost	12.8(.6)
Sensors	2(4)
Thrust	1(3)
Armor/Shields	3/0



Planetary Base (V.Low Tech)

Size (systems/5)-1, round up	5
Dmg. mod. -(Size/5), round towards 0	-2
Sys./Cost	21.6(.7)
Sensors	5
Thrust	0
Armor/Shields	5/0



Engines

AG	Antigrav Drive
AM	Antimatter Drive
FT	Fusion Torch
PD	Plasma Drive
JD	Jump Drive

General systems

A	Armor
AC	Aux. Control
AP	Aux. Power Unit
B	Bridge
C	Cargo
DC	Damage Control
F	Fuel
FB	Fighter Bay
FS	Force Screen
H	Hull
HG	Hangar
LP	Lifepods
Q	Quarters
S	Sensors
SR	Streamlining

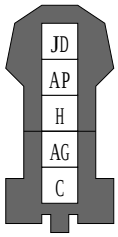
Weapons

BP	Boarding Parties
EC	Electr. Counterm.
G	Graser
ID	Intruder Defense
L	Laser Cannon
M	Missiles
P	Particle Beam
R	Railgun
SD	Sensor Drones
SM	Space Mines

Medium Tech Ships

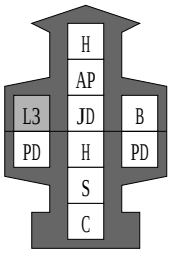
Free Trader

Size (systems/5)-1, round up	0
Dmg. mod. -(Size/5, round towards 0	0
Ship cost	1(.2)
Sensors	-2
Thrust	3
Armor/Shields	0/0



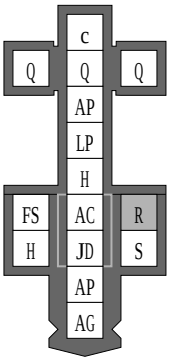
Commerce Raider

Size (systems/5)-1, round up	1
Dmg. mod. -(Size/5, round towards 0	0
Ship cost	4(.4)
Sensors	1
Thrust	3
Armor/Sh.	0/0



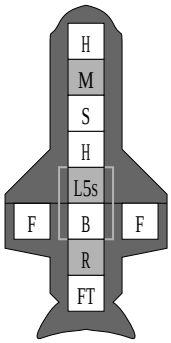
Small Passenger Liner

Size (systems/5)-1, round up	2
Dmg. mod. -(Size/5, round towards 0	-1
Ship cost	9(.6)
Sensors	1
Thrust	1(2)
Armor/Shields	0/1



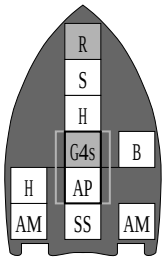
Escort Cutter

Size (systems/5)-1, round up	1
Dmg. mod. -(Size/5, round towards 0	0
Ship cost	4(.4)
Sensors	1
Thrust	2(5)
Armor/Shields	0/0



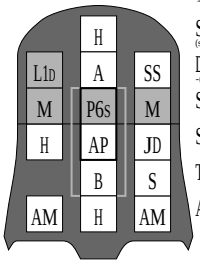
Wasp

Size (systems/5)-1, round up	1
Dmg. mod. -(Size/5, round towards 0	0
Ship cost	4(.4)
Sensors	1(3)
Thrust	5
Armor/Shields	0/0



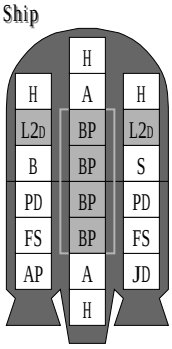
SSB28 Mako

Size (systems/5)-1, round up	2
Dmg. mod. -(Size/5, round towards 0	-1
Ship cost	9(.6)
Sensors	2(4)
Thrust	4
Armor/Shields	1/0



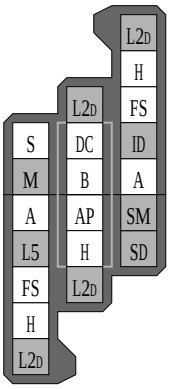
Planetary Assault Ship

Size (systems/5)-1, round up	3
Dmg. mod. -(Size/5, round towards 0	-1
Ship cost	16(.9)
Sensors	3
Thrust	1
Armor/Shields	2/2



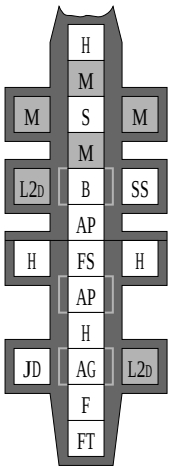
Border Outpost

Size (systems/5)-1, round up	3
Dmg. mod. -(Size/5, round towards 0	-1
Ship cost	16(.9)
Sensors	3
Thrust	0
Armor/Shields	2/2



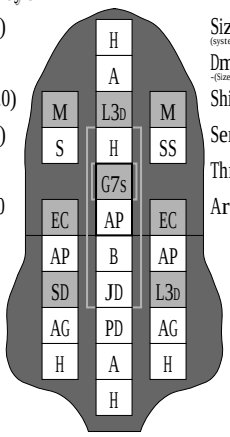
GMD Draconis

Size (systems/5)-1, round up	3
Dmg. mod. -(Size/5, round towards 0	-1
Ship cost	16(.8)
Sensors	3(5)
Thrust	3(5)
Armor/Shields	0/1



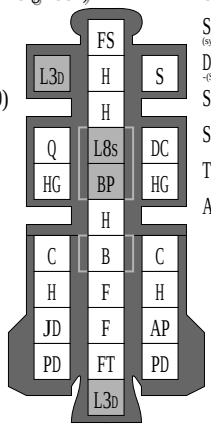
Orca-class Destroyer

Size (systems/5)-1, round up	4(2)
Dmg. mod. -(Size/5, round towards 0	-2
Ship cost	25(1.0)
Sensors	4(6)
Thrust	4
Armor/Shields	2/0



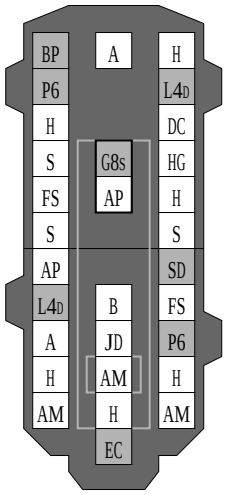
Privateer (conv. freighter)

Size (systems/5)-1, round up	4
Dmg. mod. -(Size/5, round towards 0	-2
Ship cost	25(1.0)
Sensors	4
Thrust	3(4)
Armor/Shields	0/1



Strike Cruiser

Size (systems/5)-1, round up	5(4)
Dmg. mod. -(Size/5, round towards 0	-2
Ship cost	36(1.2)
Sensors	6
Thrust	3
Armor/Shields	2/2



Engines

AG	Antigrav Drive
AM	Antimatter Drive
FT	Fusion Torch
PD	Plasma Drive
JD	Jump Drive

General systems

A	Armor
AC	Aux. Control
AP	Aux. Power Unit
B	Bridge
C	Cargo
DC	Damage Control
F	Fuel
FB	Fighter Bay
FS	Force Screen
H	Hull
HG	Hangar
LP	Lifepods
Q	Quarters
S	Sensors
SR	Streamlining

Weapons

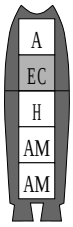
BP	Boarding Parties
EC	Electr. Counterm.
G	Graser
ID	Intruder Defense
L	Laser Cannon
M	Missiles
P	Particle Beam
R	Railgun
SD	Sensor Drones
SM	Space Mines

GZG

high Tech Ships

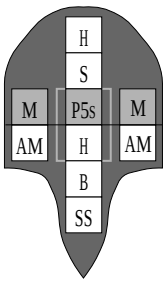
Kamikaze

Size (systems/5)-1, round up	0(-1)
Dmg. mod. -(Size/5, round towards 0	0
Ship cost	1.4(.3)
Sensors	-1
Thrust	8
Armor/Shields	2/0



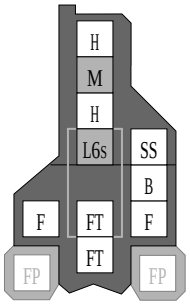
G2 interceptor

Size (systems/5)-1, round up	1
Dmg. mod. -(Size/5, round towards 0	0
Ship cost	5.6(.6)
Sensors	2(4)
Thrust	7
Armor/Shields	1/0



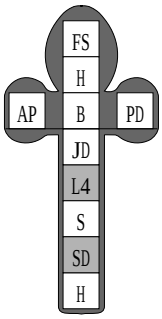
Blowtorch

Size (systems/5)-1, round up	1(2)
Dmg. mod. -(Size/5, round towards 0	0
Ship cost	6.8(.6)
Sensors	-1(4)
Thrust	7
Armor/Shields	1/0



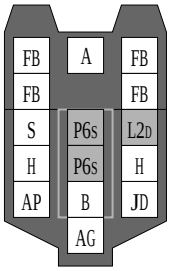
Long Range Scout

Size (systems/5)-1, round up	1
Dmg. mod. -(Size/5, round towards 0	0
Ship cost	5.6(.6)
Sensors	2
Thrust	2
Armor/Shields	1/1



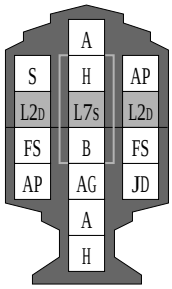
Heavy Drone Frigate

Size (systems/5)-1, round up	2
Dmg. mod. -(Size/5, round towards 0	-1
Ship cost	12.6(.8)
Sensors	3
Thrust	2
Armor/Shields	2/0



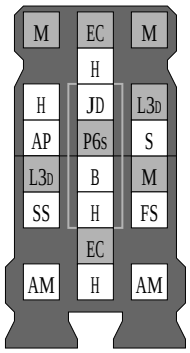
Armadillo

Size (systems/5)-1, round up	2
Dmg. mod. -(Size/5, round towards 0	-1
Ship cost	12.6(.8)
Sensors	3
Thrust	2
Armor/Shields	3/2



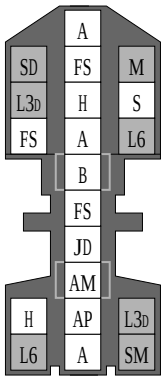
Hammerhead

Size (systems/5)-1, round up	3(1)
Dmg. mod. -(Size/5, round towards 0	-1
Ship cost	22.4(1.1)
Sensors	4(6)
Thrust	5
Armor/Shields	1/1



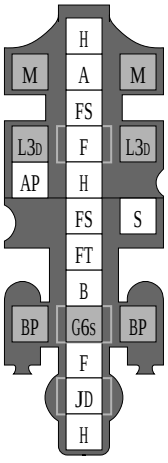
Space Control Ship

Size (systems/5)-1, round up	3
Dmg. mod. -(Size/5, round towards 0	-1
Ship cost	22.4(1.1)
Sensors	4
Thrust	1
Armor/Shields	4/2



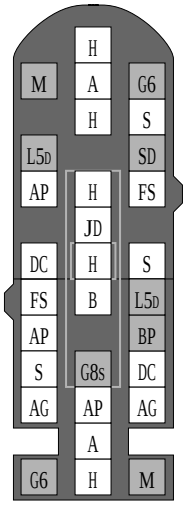
Porcupine

Size (systems/5)-1, round up	3
Dmg. mod. -(Size/5, round towards 0	-1
Ship cost	22.4(1.1)
Sensors	4
Thrust	1(5)
Armor/Shields	2/2



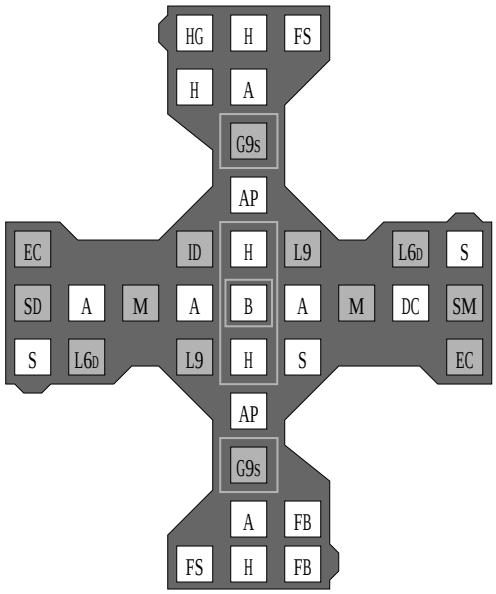
Name: **Command Cruiser**

Size (systems/5)-1, round up	5
Dmg. mod. -(Size/5, round towards 0	-2
Ship cost	50.4(1.7)
Sensors	7
Thrust	3
Armor/Shields	3/2



Starbase

Size (systems/5)-1, round up	6(4)
Dmg. mod. -(Size/5, round towards 0	-3
Ship cost	68.6(2.0)
Sensors	8
Thrust	0
Armor/Shields	6/2



Engines

AG	Antigrav Drive
AM	Antimatter Drive
FT	Fusion Torch
PD	Plasma Drive
JD	Jump Drive

General systems

A	Armor	DC	Damage Control	HG	Hangar
AC	Aux. Control	F	Fuel	LP	Lifepods
AP	Aux. Power Unit	FB	Fighter Bay	Q	Quarters
B	Bridge	FS	Force Screen	S	Sensors
C	Cargo	H	Hull	SR	Streamlining

Weapons

BP	Boarding Parties	M	Missiles
EC	Electr. Counterm.	P	Particle Beam
G	Graser	R	Railgun
ID	Intruder Defense	SD	Sensor Drones
L	Laser Cannon	SM	Space Mines

SHIP RECORD SHEET

Name: ____________________ (__)

Size ______ TeCH: ________
(systems/5)-1, round up

Dmg. mod. 0
-(Size/2), round towards 0

Ship cost ____(__)

Sensors ______

Thrust ______

Armor/Shields __/__

Name: ____________________ (__)

Size ______ TeCH: ________
(systems/5)-1, round up

Dmg. mod. 0
-(Size/2), round towards 0

Ship cost ____(__)

Sensors ______

Thrust ______

Armor/Shields __/__

Name: ____________________ (__)

Size ______ TeCH: ________
(systems/5)-1, round up

Dmg. mod. 0
-(Size/2), round towards 0

Ship cost ____(__)

Sensors ______

Thrust ______

Armor/Shields __/__

Name: ____________________ (__)

Size ______ TeCH: ________
(systems/5)-1, round up

Dmg. mod. 0
-(Size/2), round towards 0

Ship cost ____(__)

Sensors ______

Thrust ______

Armor/Shields __/__

Name: ____________________ (__)

Size ______ TeCH: ________
(systems/5)-1, round up

Dmg. mod. 0
-(Size/2), round towards 0

Ship cost ____(__)

Sensors ______

Thrust ______

Armor/Shields __/__

Name: ____________________ (__)

Size ______ TeCH: ________
(systems/5)-1, round up

Dmg. mod. 0
-(Size/2), round towards 0

Ship cost ____(__)

Sensors ______

Thrust ______

Armor/Shields __/__

Name: ____________________ (__)

Size ______ TeCH: ________
(systems/5)-1, round up

Dmg. mod. 0
-(Size/2), round towards 0

Ship cost ____(__)

Sensors ______

Thrust ______

Armor/Shields __/__

Name: ____________________ (__)

Size ______ TeCH: ________
(systems/5)-1, round up

Dmg. mod. 0
-(Size/2), round towards 0

Ship cost ____(__)

Sensors ______

Thrust ______

Armor/Shields __/__

Name: ____________________ (__)

Size ______ TeCH: ________
(systems/5)-1, round up

Dmg. mod. 0
-(Size/2), round towards 0

Ship cost ____(__)

Sensors ______

Thrust ______

Armor/Shields __/__

Name: ____________________ (__)

Size ______ TeCH: ________
(systems/5)-1, round up

Dmg. mod. 0
-(Size/2), round towards 0

Ship cost ____(__)

Sensors ______

Thrust ______

Armor/Shields __/__

Name: ____________________ (__)

Size ______ TeCH: ________
(systems/5)-1, round up

Dmg. mod. 0
-(Size/2), round towards 0

Ship cost ____(__)

Sensors ______

Thrust ______

Armor/Shields __/__

Name: ____________________ (__)

Size ______ TeCH: ________
(systems/5)-1, round up

Dmg. mod. 0
-(Size/2), round towards 0

Ship cost ____(__)

Sensors ______

Thrust ______

Armor/Shields __/__

Engines

AG	Antigrav Drive
AM	Antimatter Drive
FT	Fusion Torch
PD	Plasma Drive
JD	Jump Drive

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AP	Aux. Power Unit
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ID	Intruder Defense
L	Laser Cannon
M	Missiles
P	Particle Beam
R	Railgun
SD	Sensor Drones
SM	Space Mines

SHIP RECORD SHEET

Name: ______ ( )
Size ______ TeCH: ______
(systems/5)-1, round up
Dmg. mod. ______
-(Size/2), round towards 0
Ship cost ______ ( )
Sensors ______
Thrust ______
Armor/Shields ___/___

Name: ______ ( )
Size ______ TeCH: ______
(systems/5)-1, round up
Dmg. mod. ______
-(Size/2), round towards 0
Ship cost ______ ( )
Sensors ______
Thrust ______
Armor/Shields ___/___

Name: ______ ( )
Size ______ TeCH: ______
(systems/5)-1, round up
Dmg. mod. ______
-(Size/2), round towards 0
Ship cost ______ ( )
Sensors ______
Thrust ______
Armor/Shields ___/___

Name: ______ ( )
Size ______ TeCH: ______
(systems/5)-1, round up
Dmg. mod. ______
-(Size/2), round towards 0
Ship cost ______ ( )
Sensors ______
Thrust ______
Armor/Shields ___/___

Name: ______ ( )
Size ______ TeCH: ______
(systems/5)-1, round up
Dmg. mod. ______
-(Size/2), round towards 0
Ship cost ______ ( )
Sensors ______
Thrust ______
Armor/Shields ___/___

Name: ______ ( )
Size ______ TeCH: ______
(systems/5)-1, round up
Dmg. mod. ______
-(Size/2), round towards 0
Ship cost ______ ( )
Sensors ______
Thrust ______
Armor/Shields ___/___

Name: ______ ( )
Size ______ TeCH: ______
(systems/5)-1, round up
Dmg. mod. ______
-(Size/2), round towards 0
Ship cost ______ ( )
Sensors ______
Thrust ______
Armor/Shields ___/___

Name: ______ ( )
Size ______ TeCH: ______
(systems/5)-1, round up
Dmg. mod. ______
-(Size/2), round towards 0
Ship cost ______ ( )
Sensors ______
Thrust ______
Armor/Shields ___/___

Name: ______ ( )
Size ______ TeCH: ______
(systems/5)-1, round up
Dmg. mod. ______
-(Size/2), round towards 0
Ship cost ______ ( )
Sensors ______
Thrust ______
Armor/Shields ___/___

Engines		General systems						Weapons			
AG	Antigrav Drive	A	Armor	DC	Damage Control	HG	Hangar	BP	Boarding Parties	M	Missiles
AM	Antimatter Drive	AC	Aux. Control	F	Fuel	LP	Lifepods	EC	Electr. Counterm.	P	Particle Beam
FT	Fusion Torch	AP	Aux. Power Unit	FB	Fighter Bay	Q	Quarters	G	Graser	R	Railgun
PD	Plasma Drive	B	Bridge	FS	Force Screen	S	Sensors	ID	Intruder Defense	SD	Sensor Drones
JD	Jump Drive	C	Cargo	H	Hull	SR	Streamlining	L	Laser Cannon	SM	Space Mines

SHIP RECORD SHEET

Name: ______________________ (___)

Size ______ TeCH: ________
(systems/5)-1, round up

Dmg. mod. ______
-(Size/2), round towards 0

Ship cost ____(___)

Sensors ______

Thrust ______

Armor/Shields ___/___

Name: ______________________ (___)

Size ______ TeCH: ________
(systems/5)-1, round up

Dmg. mod. ______
-(Size/2), round towards 0

Ship cost ____(___)

Sensors ______

Thrust ______

Armor/Shields ___/___

Name: ______________________ (___)

Size ______ TeCH: ________
(systems/5)-1, round up

Dmg. mod. ______
-(Size/2), round towards 0

Ship cost ____(___)

Sensors ______

Thrust ______

Armor/Shields ___/___

Name: ______________________ (___)

Size ______ TeCH: ________
(systems/5)-1, round up

Dmg. mod. ______
-(Size/2), round towards 0

Ship cost ____(___)

Sensors ______

Thrust ______

Armor/Shields ___/___

Name: ______________________ (___)

Size ______ TeCH: ________
(systems/5)-1, round up

Dmg. mod. ______
-(Size/2), round towards 0

Ship cost ____(___)

Sensors ______

Thrust ______

Armor/Shields ___/___

Name: ______________________ (___)

Size ______ TeCH: ________
(systems/5)-1, round up

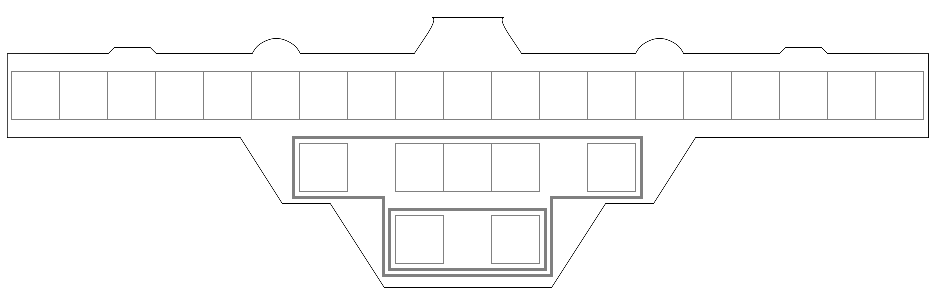
Dmg. mod. ______
-(Size/2), round towards 0

Ship cost ____(___)

Sensors ______

Thrust ______

Armor/Shields ___/___



Engines		General systems						Weapons			
AG	Antigrav Drive	A	Armor	DC	Damage Control	HG	Hangar	BP	Boarding Parties	M	Missiles
AM	Antimatter Drive	AC	Aux. Control	F	Fuel	LP	Lifepods	EC	Electr. Counterm.	P	Particle Beam
FT	Fusion Torch	AP	Aux. Power Unit	FB	Fighter Bay	Q	Quarters	G	Graser	R	Railgun
PD	Plasma Drive	B	Bridge	FS	Force Screen	S	Sensors	ID	Intruder Defense	SD	Sensor Drones
JD	Jump Drive	C	Cargo	H	Hull	SR	Streamlining	L	Laser Cannon	SM	Space Mines

SHIP RECORD SHEET

Name: ____________________ (__)

Size ______ TeCH: ________
(systems/5)-1, round up

Dmg. mod. ______
-(Size/2), round towards 0

Ship cost ____(__)

Sensors ______

Thrust ______

Armor/Shields __/__

Name: ____________________ (__)

Size ______ TeCH: ________
(systems/5)-1, round up

Dmg. mod. ______
-(Size/2), round towards 0

Ship cost ____(__)

Sensors ______

Thrust ______

Armor/Shields __/__

Name: ____________________ (__)

Size ______ TeCH: ________
(systems/5)-1, round up

Dmg. mod. ______
-(Size/2), round towards 0

Ship cost ____(__)

Sensors ______

Thrust ______

Armor/Shields __/__

Name: ____________________ (__)

Size ______ TeCH: ________
(systems/5)-1, round up

Dmg. mod. ______
-(Size/2), round towards 0

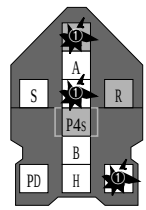
Ship cost ____(__)

Sensors ______

Thrust ______

Armor/Shields __/__

Engines		General systems						Weapons			
AG	Antigrav Drive	A	Armor	DC	Damage Control	HG	Hangar	BP	Boarding Parties	M	Missiles
AM	Antimatter Drive	AC	Aux. Control	F	Fuel	LP	Lifepods	EC	Electr. Counterm.	P	Particle Beam
FT	Fusion Torch	AP	Aux. Power Unit	FB	Fighter Bay	Q	Quarters	G	Graser	R	Railgun
PD	Plasma Drive	B	Bridge	FS	Force Screen	S	Sensors	ID	Intruder Defense	SD	Sensor Drones
JD	Jump Drive	C	Cargo	H	Hull	SR	Streamlining	L	Laser Cannon	SM	Space Mines



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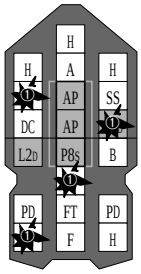
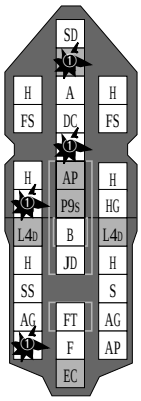
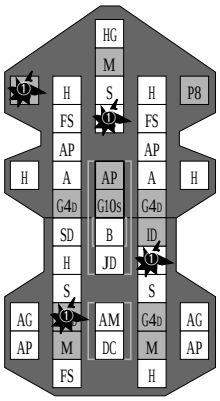


Size 2-3

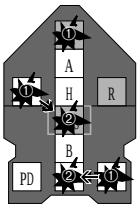
Typical Laser hits
All hit locations shown are valid for these ships



Size 4-5



Size 6-7



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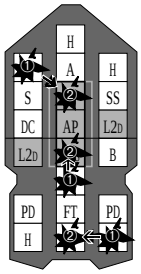
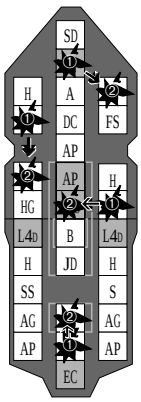


Size 2-3

Typical Graser hits
All hit locations and damage progressions shown are valid for these ships



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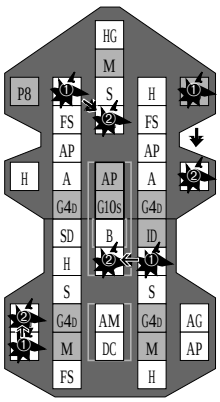

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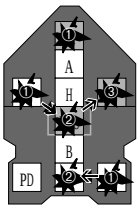

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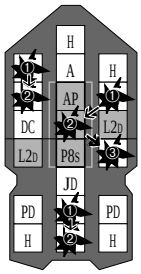
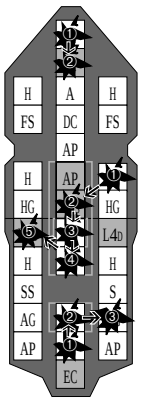


Size 2-3

Typical Particle Beam hits
All hit locations and damage progressions shown are valid for these ships



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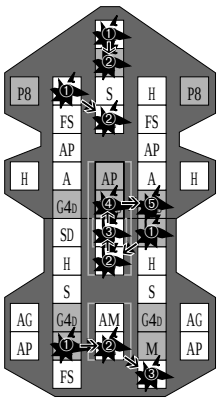

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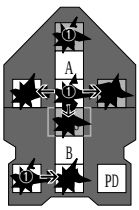

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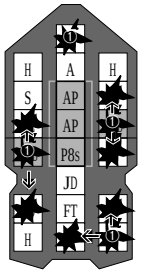
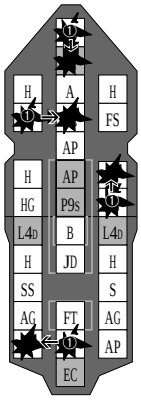


Size 2-3

Typical Missile or Mine hits
All hit locations and damage progressions shown are valid for these ships



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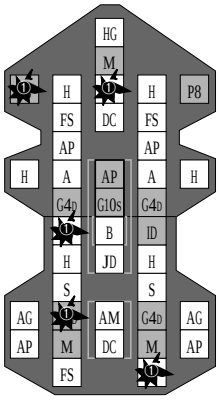


Size 6-7

Quick Reference Sheet

Movement

Ships may move a number of hexes equal to their Thrust Rating. No matter how many hexes a ship moves, it may always get its full thrust rating to subtract from the chance of being hit. A ship may change facing to any facing after each hex of movement, unless moving a number of hexes equal to its Thrust Rating, in which case it retains the facing it used to enter the final hex.

Turn Sequence

Ships move in order of lowest Thrust Rating to highest Thrust Rating, ties meaning the larger ship moves first, and further ties broken by Initiative for the turn. Ships fire in order of highest Sensor Rating to lowest, firing one weapon each, then repeating with any other weapons. Beam weapons do damage immediately. All Missiles resolve hits immediately, and damage after all beam weapons have resolved from all other ships.

Hit Determination

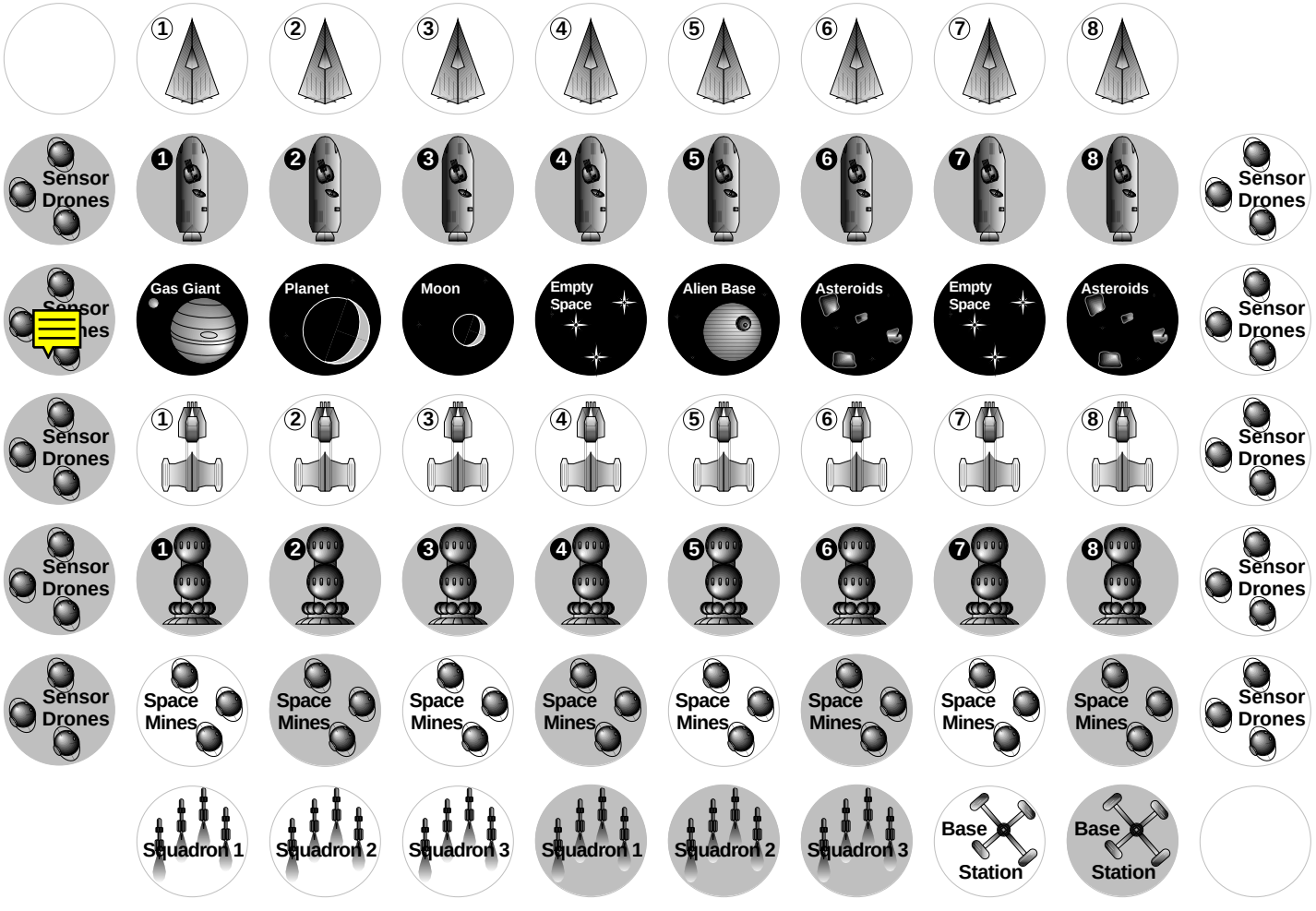
Start with zero hits, then add your Sensor Rating and the Size of the target ship, plus any bonus for weapon system type and Sensor Drones in the same or adjacent hexes. Then subtract the Thrust Rating of the target ship and the range, along with any ECM or terrain penalties that apply. The result is the number of hits gotten with that weapon system. If a weapon gets exactly zero hits, one hit may be added for each identical weapon system of that type in the same firing arc firing at the same target (i.e. three weapons that get zero hits can combine to get two hits). Size 0 or Size 1 ships with identical firing arcs and hit chances can combine weapon systems like this as well.

Damage

Systems are considered adjacent if either horizontally or vertically adjacent, or at roughly a 45° angle (one system over and one system up/down). Empty spaces between external systems do not keep them from being adjacent unless the midline of the ship or an internal or core system is between them. Empty spaces between internal or core systems keep internal or core systems from being adjacent.

Collisions and Boarding

To do either, a ship must be declared as entering close combat during movement, which is a +4 bonus to hit for both ships involved. After all other weapons resolve, if the attacking ship still has a higher Thrust Rating than the target, then the collision or boarding is successful and is resolved normally.


1
2
3
4
5
6
7
8
Sensor Drones
Gas Giant
Planet
Moon
Empty Space
Alien Base
Asteroids
Empty Space
Asteroids
Space Mines
Squadron 1
Squadron 2
Squadron 3
Base Station