

## High Efficiency Plasma Recombustion Fusion Rocket (HePlaR)

The HePlaR adds heat exchangers and a recombustion chamber that magnetically accelerates a stream of hydrogen that has been converted to plasma by a fusion plant. A fusion plant must be on a vessel that intends to use this drive, it's output must be at least as great as the rockets power input requirements.

**Thrust:** 940

**Mass:** 4

**Cost:** 0.04

**Output:** --

**Power:** 0.02

**RMC:** 0.7H

**ISP:** 690,000,000

**Heat:** RRA of 1 per 4 spaces of drive.

### X-200 High Performance Drive Testbed

The X-200 is a small deep research vessel, the first of its class to use the experimental high-efficiency plasma recombustion engines that replaced semi-liquid metallic hydrogen rockets for high-G acceleration.

The HePlaR designed proved incredibly effective with small missiles, allowing the creation of autonomous kill vehicles with accelerations as high as 14 G for several days. Shortly afterwards all life in the solar system was obliterated as terrorists used HePlaR powered craft to ram every colony with 2,000 ton craft at over 150,000 miles per second.

The basic design for the X-200 is a cylinder 150' long and 35' wide. The ship was unarmed but had a large space dock for its size. The hull was heavily armored to resist impacts at high speeds but unfortunately it proved not to be enough. As it was largely a testbed vessel half of the interior space was left empty and unpressurized. Typical payload was 13.7 tons with no craft in the space dock.

**Crew:** Commander (Leadership, Tactics), Pilot (Piloting (High-Performance Spacecraft)), Navigator (Astrogation, Electronics Operation (Communications), Electronics Operation (Sensors)), 12 Engineers (Mechanic (Fusion Drive), Mechanic (Robotics), other Mechanics skills as appropriate), Medic (Diagnosis, Physician, Surgeon). Most of the engineering crew was composed of cyberswarms and cybershells.

**Design:** Cylinder hull (294 spaces, diamandoid, extra-heavy frame, smart); cDR/cPF 50/10F, 10/2S, 2/1B (diamandoid). Hull radiators (2 ksf). Liquid-crystal skin.

**Modules:** New command bridge; large PESA; large radar; large ladar; 10 HePlaR; 50 tanks (ultralight, hydrogen); 8.5 new fusion reactor (48 MW); 8 cabins; passenger seat; large entry module; medium robot arm; 2 labs; minifac workshop; light storm shelter (1 space; covers passenger seat, cPF 100); hall; space dock hangar (45' long, 20' wide, 25' high: 45 spaces); surgery; 2 cargo (10 tons).

**Statistics:** EMass 1,299; CMass 1,338; LMass 1,363. Cost M\$618.44. cHP: 1,126. Size Modifier +5/+9. HT 12, Maintenance Interval: 1.61 hours. RRA 2.

**Performance:** sAccel: 7.02 G, Burn Endurance: 1,000 hours, Burn Points: 2,527,200, Delta-V: 77,358 mps. No air performance.

## Farnsworth Fusor Torch

An engine design based on:

<http://torsatron.tripod.com/fusor/>

[http://www.ibiblio.org/lunar/school/InterStellar/Explorer\\_Class/Bussard\\_Fusion\\_systems.HTML](http://www.ibiblio.org/lunar/school/InterStellar/Explorer_Class/Bussard_Fusion_systems.HTML)

### Space Drives Table

Space Drive	Thrust	Mass	Cost	Output	Power	RMC	ISP
Farnsworth Fusion Torch:							

-- high-impulse (HI)	1	4	1	10	0	0.03H	120,000
-- high-thrust (HT)	2	4	1	10	0	0.12H	60,000

*Alternate Reaction Mass:* Farnsworth fusor drives can use the same alternate reaction mass as conventional fusion drives (p. TS00).

*Heat:* RRA of 1 per two spaces of drive.

### ***Farnsworth-class USV***

The *Farnsworth's* hull is a cylinder 150' long by 40' wide. Usual payload is 504.5 tons.

**Crew:** Commander/Pilot (Leadership, Piloting (Low-Performance Spacecraft)); Navigator (Astrogation, Electronics Operation (Communications), Electronics Operation (Sensors), Gunner (Beams)); 4 Engineers (Mechanic (Fusion Drive), Mechanic (Robotics), other Mechanic as appropriate); Medic (Diagnosis, Physician, Surgeon); Cargomaster (Administration, Freight Handling).

**Design:** Cylinder hull (384 spaces, carbon composite, heavy frame, smart); cDR/cPF 10/2F, 1/1S, 5/1B (carbon composite armor). Hull radiators (5 ksf), with two 71' by 71' radiator wings. Liquid-crystal skin.

**Modules:** Old basic bridge; medium ladar; medium radar; 50 HI Farnsworth fusor torch (hydrogen reaction mass); 200 tanks (ultralight, hydrogen); 2 2.5-MJ light laser tower [S]; 15 cabin; 1 passenger seats; light storm shelter (1-space: encloses passenger seats, cPF 100); medium robot arm; minifac workshop; 2 small entry module; large entry module; surgery; 100 cargo (500 tons).

**Statistics:** EMass 1,372; CMass 1,976; LMass 2,076. Cost M\$115.11. cHP 653. Size Modifiers +5/+9 [Hull], +7 [Radiators]. HT 12. Maintenance Interval: 3.73 hours. RRA 25.

**Performance:** sAccel: 0.03 G. Burn Endurance: 133.33 hours. Burn Points: 14,400. Delta-V: 44 mps. No air speed.

## **Stutterwarp Drive**

A stutterwarp drive uses a macroscopically scaled version of "quantum tunneling" exhibited by certain particles. A carefully managed pulse of energy is introduced to a field around the ship allowing it to instantly shift its relative location. The actual drive core consists of tantalum rings suspended magnetically horizontally aligned to the direction of travel. Minor alignment of the rings allows course adjustment over interstellar distances.

The actual distance traveled is quite small, about a hundred yards at a time for the most efficient drives, but the effect can be cycled very quickly. The effective travel time is largely dependent on the drives *efficiency* and the *charge buildup* of energetic particles in the core.

### **Efficiency**

The efficiency of a stutterwarp drive depends on many factors. In game terms it involves the manufacturing technology (which usually involves the amount and quality of tantalum used), input power, the size of the vessel being cycled, and the local gravity field.

*Technology:* Stutterwarps are available as *Old*, *New*, and *Advanced* systems. Old drives include the original designs dating back to the mid-22nd century and even some newer models with substandard coil and field generators. New drives are the standard for most civilian and many military vessels, they strike a balance

between cost (although they still cost into the millions) and cycle speed. Advanced designs are generally restricted to new military designs and their manufacturing secrets are not common knowledge outside of the largest corporations and nations.

Typically the technology level of the drive sets the base efficiency rating.

*Input Power:* Stutterwarp drives consume vast amounts of power. The drive core consumes a vast amount, but the majority actually goes into generating the actual tunneling field. The actual drive cores are largely standardized, but all vessels include associated support machinery such as condensers and field generators. Drives are usually rated in maximum input power since it neatly includes field energy rating, cycle times, and condenser capability.

*Mass:* The larger the vessel being cycled the lower the drives efficiency - typically this manifests as a reduced distance traveled per cycle.

*Gravity:* The stutterwarp field is easily disrupted by local gravitational effects. When in deep space the effect is largely inconsequential but in gravity wells the efficiency of a stutterwarp drops enormously. When the local gravity well reaches 0.0001 G (such as near a star) the drives efficiency falls to the point that it can no longer move faster than light. At 0.1 G the drive provides only token movement ability as each cycle only moves the vessel a few inches at best. Above 0.1 G the drive no longer functions except on a microscopic scale and become ineffective except as a means of reducing charge buildup.

### **Charge Buildup**

For unexplained reasons the nonzero time spent charging the stutterwarp field and actually cycling causes the tantalum coils to spontaneously begin to break down, emitting high-energy particles. Even after a single cycle the drives will begin producing this radiation, the more cycles that are conducted the faster the emissions increase. After a period of time the radiation reaches a critical threshold level and the drive becomes permanently unusable. This radiation poses a severe safety hazard, and limits most vessels to travelling less than 7 light-years.

*Radiation:* Every light-year traveled roll  $d6 \times 100$  to get the radiation output of the drive. Each hour after the first roll an additional die. Thus on the second hour the drive will produce  $2d6 \times 100$  cRads. Radiation shielding surrounding the drive core reduces exposure to the rest of the ship normally. However, despite shielding after 7.7 light years the drive experiences complete failure and releases a burst of intense radiation ( $3d6 \times 1000$  cRads).

Alternately, the radiation can be based on time traveled rather than distance. This will tend to increase the effective range of smaller, more efficient vessels and decrease the usefulness of tugs and some types of large transports

*Charge Dissipation:* The only way to reduce or eliminate the radiation output from a stutterwarp core is to cycle the drive while in a gravity well of at least 0.1 G. Each hour spent cycling the drive in a gravity well reduces the radiation output by 10 cRads.

## **Faster-Than-Light Drives**

### ***Stutterwarp***

Technically known as the Jerome Drive after its discoverer Dr. Emile Francoise Jerome. It is an example of the *blink warp* drive listed on p. S31. In *Transhuman Space* it becomes available in 2180, with the first manned vessels in 2236.

Stutterwarps require only power to function - but the power must be continuous. Once a drive has been activated it is extremely difficult to shut down without damage. For this reason it is not recommended that they be powered by batteries or low-endurance fuel using systems. Typically fission and fusion reactors are used by stutterwarp vessels.

All stutterwarps are rated by their *input power* (in MW). This is the continuous power requirement for the drive. See *Stutterwarp Operation* for information on activating and shutting down a drive.

<b>Tech</b>	<b>Spc.</b>	<b>Mass</b>	<b>Cost</b>
Old	0.75	19	3.5
New	0.9	17	9.5
Advanced	1	17	15

*Spaces:* The stutterwarp drives final size in spaces is equal to *Spc.* multiplied by the cube root of the input power.

*Mass* and *Cost* are per *space* of drive.

*Efficiency:* Divide the input power of the stutterwarp drive by the EMass of the vessel. Take the cube root of the result and multiply it by 14.5 for *Old* drives, 16.05 for *New*, and 17.5 for *Advanced*.

*Heat:* Stutterwarp drives do not generate appreciable amounts of heat and thus do not have an RRA.

*For example, a typical stutterwarp used on a small SDV may be rated at 150MW. We'll assume it is an Advanced system. The cube root of 150 is approximately 5.3. Total spaces required for the drive is thus 5.3, mass is 90.1 tons, and cost is M\$79.5.*

### ***Stutterwarp Movement***

Objects travelling with stutterwarp only *appear* to have a velocity, but due to the nature of the tunneling phenomenon in actually this is purely illusory. There is no feeling of thrust and stopping the drive cycling causes the vessel to stop immediately with no deceleration. The exception is that a vessel retains its vector while stutterwarping, even if that movement is in opposite directions when the drive is disengaged! For this reason the tunneling requires small adjustments as the vessel travels to account for the small nonzero time that the vessel moves on its vector between cycles. Most vessels will also attempt to arrive at their destination in such a manner as to utilize the velocity it maintained before it began cycling.

The speed that a stutterwarp vessel travels at is dependent on the drives efficiency, this is measured in light-years per day. If the vessel enters a gravity well stronger than 0.0001 G then the drives efficiency is measured in AU/day. At 0.1 G the drives efficiency is measured as meters per second. At higher gravity the drive no longer provides any significant amount of movement.

### ***Stutterwarp Operations***

Operating a stutterwarp is a tricky business, and is as much an art as a science. The largest dangers in the operation of a stutterwarp drive occur at two critical periods of time: when the drive is activating and when it is taken off-line. As any active drive begins to emit hazardous radiation (see above) when the vessel is cycling many large vessels sometimes have backup drives that are brought on line later to extend the range beyond the typical 7.7 ly limit. Unfortunately any drive that is active begins to emit radiation when the vessel is cycling, even if it is not being used for propulsion.

*Drive Activation:* Bringing a inactive stutterwarp drive online requires an Engineering (Stutterwarp) roll at -12 and requires at least 30 minutes. On a critical failure the drive coils become misaligned and are destroyed in addition to causing 3d concussion damage to anyone in the engineering section.

*Deactivation:* Safely taking a drive offline requires an Engineering (Stutterwarp) roll at -8, plus an additional -2 for every hour the drive has been used if not fully discharged. In any case the process requires 1 hour and a critical failure results in the drives immediately destroying themselves and emitting 5d6 x 1000 cRads.