

I wrote this guide to assist other users who may have had difficulty getting acclimated to the mod. KSPI has a lot of useful features but to the new user this can be rather intimidating at first. The goal of this guide is to attempt to ease the transition from Stock KSP's more casual gameplay and into KSPI's more involved and self-rewarding environment.

- **Basic Functionality**

- All KSPI parts support TweakScale and it should be used to resize the parts to your needs. Please note that many parts have maximum and minimum size limits. Nuclear reactors are complicated machinery and require many parts to function at peak efficiency. Smaller reactors produce less power and are less efficient at energy production than larger reactors.

- **Reactors**

- Reactors are the heart and soul of any KSPI spacecraft. The Reactor provides resources in the form of thermal power to be harvested by various generators and propulsion components.
- Reactors come in many varieties and the charts on the front page provide the details on each reactor type as well as the fuel modes (fuel modes covered below). Let's go over a reactor entry from the main page and decipher the different capabilities it may have.

Reactor Family (2.5m)	Unlock Technology	Primary Upgrade Technology	Secondary Upgrade Technology	Reactor Cost	Core Temp. (Kelvin)	max ISP thermal	Max Power (GW)	thrust thermal (kN)	Empty Mass (t)	Max Fuel mass (t)	Base Power Req	Thermal Propulsion Efficiency	Thermal Power Efficiency	Heat Trans Effi	Min Util.	Leaks Product	Can Use Magnet Nozzle	Heat Thotling	Buoyancy effects	Tritium Breeding
Molten Salt	Nuclear Power	Nuclear Fuel Systems	Improved Nuclear Power	37,500	1633 / 2285 / 3200	848s / 1003s / 1187s	0.612 / 0.856 / 1.2	242 / 309	6	5		100%	100%	95%	10%	no	no	no	no	yes

- **Reactor Family** - This field describes the technology behind the reactor. The technologies used in KSPI are based closely on real life reactors or scientific theories. You can use regular Wiki/Google searches to find out more about the real life counterparts.
- **Unlock Technology/Upgrade Technologies** - Reactors are high tech equipment that is not available to Kerbals right away and must be unlocked through the tech tree. Reactors have the ability to be upgraded to provide increased capabilities when the prerequisite upgrade technologies are researched. The numbers in the Core Temp, max ISP thermal, max Power, and thermal thrust show the base values as well as the upgraded values split by a '/'. For example the *Molten Salt* produces .612 GW of power when it is first unlocked but after researching the technology 'Nuclear Fuel Systems' the output increases to .856 GW of power.
- **Reactor Cost** - This is the cost of the reactor at the 2.5 M size, the cost of the reactor can also be greatly impacted by the cost of the fuel the reactor uses. Fuels like Uranium can actually be more expensive than the reactor itself! Due to the complex nature of reactors, smaller sized reactors can have the same cost as larger reactors, cost and performance are not necessarily related.
- **Core Temperature (Kelvin)** - This is operating temperature of the reactor. Reactors with a higher core temperature typically allow for higher ISP (Specific Impulse) values than cooler reactors which can be seen by comparing the Molten Salt and Gas Core reactors. A higher temperature reactor also plays a

factor in the fuel selection process since higher core temperatures allow fuels to go through a thermal decomposition process which provides more thrust for a given fuel. The power output of the *Dusty Plasma* and *Pebble Bed* reactors is dependant on the core temperature of the reactor, as the temperature increases the power output will also decrease. These reactors are also passively safe since their power output will decrease with increased core temperatures, but as a side effect they are not very good at producing electric power since all WasteHeat needs to be expelled from the vessel using radiators.

- **Max ISP thermal** - This describes the reactors maximum ISP it is based directly on core temperature. As the core temperature increases through new reactor technology or fuel modes, the ISP will also increase. Fuel selection and Reactor technology also play a major role in the ISP of a propulsion system.
- **Max Power (GW)** - This describes the maximum power output in terms of heat generated. The heat is used by KSPI systems to generate thrust or power. Also note that it is affected by Reactor Technology upgrades.
- **Thermal Thrust (GW)** - The thermal thrust is the maximum amount of thrust a reactor can generate when combined with a thermal engine. The engines section shows the method in which it uses to generate thrust and engines with the 'Thermal' identifier use this value. Thrust has a direct correlation with Isp and Power, In general, the higher the isp, the lower the thrust.
- **Empty Mass (t)** - This is the mass or weight of the reactor when no fuel is present.
- **Max Fuel mass (t)** - This describes the maximum amount of fuel that can be held in the reactor in terms of weight. For Molten Salt reactors this also determines how fast the reactor will become poisoned by Actinides . Even though only a fraction of the nuclear fuel is used, it can become effectively useless due to Actinides buildup which prevent Fission from happening.
- **Base Power Req** - This value describes the amount of energy required to start and maintain a fusion reaction. This only applies to fusion based reactors. More advanced fusion reactions require increased amounts of power to start and sustain the reaction. Note that the amount of required power can be higher than the amount of produced power if you don't have sufficient electric generators (both Thermal and Direct energy converters). This is covered in more detail in the reactor fuel section. Electric Energy technology or Wasteheat processing reduces the need for thermoelectric power generators.
- **Thermal Propulsion Efficiency** - The thermal efficiency determines how efficient a thermal reactor is at converting energy into thrust. Lower values here will mean the reactor will produce less thrust for its provided power (GW).
- **Thermal Power Efficiency** - This value describes how efficiently a power generator uses the provided power (GW). Lower values indicate a less efficient conversion and increased WasteHeat production.
- **Heat Transfer Effectiveness** - This is the efficiency of heat transfer from a reactor to other parts. Some reactors are much more efficient at transferring heat due to the type of reaction materials used. This is relevant for engines which are not required to be connected directly to the Reactor. For every part the energy has to pass through some efficiency is lost. The final efficiency penalty is simply the sum of all parts (except the first one) it passes through. An exception to this is the non-androgynous docking port, which are optimised for thermal transfer.
- **Minimum Utilization** - The minimum utilization shows the lowest operating state for a reactor. If the reactor shows 10% minimum utilization then it can provide anywhere from 10% to 100% of the reactors output scaling depending on requested power.

- **Leaks Product - [Feature not yet implemented]** If a reactor shows that it leaks product, then the products of the resulting nuclear cannot be recovered and is said to be leaking. You will see a decreased mass of the reactor products over time.
- **Fuel can be pumped** - This explains if reactor fuel can be transferred from other parts of the ship while the reactor is operating.
- **Can use Magnetic Nozzle** - This explains if the reactor is capable of producing charged particles. Charged particles are a product of some types of nuclear reactions and can be used as propellant to provide thrust when paired with a magnetic nozzle. The highly energetic charged particles can also be efficiently converted into electrical power using the direct energy converter. Note that charged particles propulsion provide very high Isp and an often overlooked advantage is that the Magnetic Nozzles reduces WasteHeat and that charged particles can be transferred throughout the vessel without loss (except for 1% power cost).
- **Special:** Describes a unique feature of the reactor. We explain every characteristic in more detail:
 - **Heat Throttling** - The heat throttling of a reactor simply means that when the reactor temperature increases the power output decreases. Additional radiators can be used to offset the loss of power due to increased reactor core temperature. Thermal and Magnetic nozzles also reduce WasteHeat buildup, allowing heat throttled reactors to perform at maximum capacity.
 - **Buoyancy Effects** - This describes the reactors ability to provide thrust while under acceleration. The reactor buoyancy effect will decrease the power output when the reactor is subjected to G-forces.
- **Tritium Breeding** - This is a process that allows the reactor to produce Tritium which is used in a fusion reactor. Tritium breeding requires a compatible reactor as well as a supply of Lithium and a tank to store the Tritium which is created from the free neutrons. Tritium is the 3rd most valuable fuel in KSPI and is one of the required fuels to power the Vista Engine. Tritium will decay into Helium 3, which is the second most valuable resource in KSPI and can be used for efficient aneutronic Fusion.

● Propulsion/Engines

- Engines provide the thrust necessary to propel a vessel. Engines in KSPI can use many different types of energy or propellants to function.
- Let's go over an engine entry from the main page and decipher the different capabilities it may have.

Type	Method	ISP (LqdHydrogen)	Efficiency	Variable ISP	Gimbal	Functions in Atmosphere	Functions in Vacuum	Propellant	Electric Power Need	Special	Thermal Thrust Bonus	Wasteheat effect	Operating Cost
Thermal Nozzle	Thermal	813s- 8000s	100%	no	yes	partial	yes	any NTR propellant + Oxygen as afterburner	none	Can overheat when exchangers get clogged with soot	full	Consumes	low

- **Type** - This field describes the technology behind the engine. The technologies used in KSPI are based closely on real life engines or scientific theories. Note the distinction between Thermal and Magnetic. Thermal engines have limited Isp but benefit from thermal decomposition, giving it extra thrust and improved Isp. Magnetic engines first need to Ionise the propellant. Some engines like the Vasimr and Atilla engine use a combination of the 2 techniques.

- **Method** - This describes the engine's power input used to generate thrust. Engines can use Thermal (GW) power from a reactor, magnetic types use charged particles, quantum vacuum uses the vacuum of space to produce thrust and Fusion uses an internal fusion reaction to produce thrust.
- **ISP (LqdHydrogen)** - This section shows the ISP (fuel efficiency) an engine produces when using LqdHydrogen as the propellant. Different types of propellants can provide different thrust values in an engine which is covered in more detail the Propellants section.
- **Efficiency** - The efficiency of an engine is how much of the thermal power (GW) is used to produce thrust and the remainder is expunged as Waste Heat. A low efficiency engine may require additional radiators to radiate the heat into the surrounding environment. The efficiency of electric engines is highly dependant on the efficiency of the propellant used.
- **Variable ISP** - In KSPI some engines can have a variable ISP when operating. The ISP of an engine decreases as it produces more thrust. Higher thrust values also decrease the energy conversion efficiency.
- **Gimbal** - This describes if the engine has gimbal capability. Gimballed engines can use thrust vectoring to control the attitude of a vessel. Note that RCS engines do not gimbal but are linked with KSP RCS system.
- **Functions in Atmosphere** - This is another self-describing value which explains if the engine can produce thrust when in an Atmosphere. Some engines rely on the vacuum of space or other methods to produce thrust and cannot be used in an Atmospheric environment. Many of the thrusters in KSPI are affected by static pressure. Which means the engine has to overcome the pressure of the atmosphere before producing usable thrust. Static pressure can be overcome by using a higher thrust propellant or by using a smaller nozzle.
- **Propellant** - The propellant section explains which propellants are compatible with a given engine. Note that some engines can be upgraded to allow for additional propellants than is initially unlocked.
- **Electric Power Need** - This section explains if Electrical Power (measured in MegaJoules) is required for the engine to operate. Engines can require partial or full electric power, as well as mixed types that also use charged particles. Some engines like the ResistoJet RCS, will switch to unpowered mode when insufficient power is available. These engines can therefore be used without KSPI reactors.
- **Special** - The special column covers any extra information about an engine that does not fit into a specific category on the chart.
- **Thermal Thrust Bonus** - This describes an engines ability to produce extra thrust depending on the propellant used. The temperature of the thermal engine also plays a factor on the thermal thrust bonus when factoring in thermal decomposition of a fuel. (More below in the Propellants section)
- **WasteHeat effect** - This explains how much Waste Heat is generated when firing a particular engine. Engines can both consume WasteHeat as well as produce WasteHeat depending on the engine technology used.
- **Operating cost** - This gives a general overview of the operating cost of running a engine. Electric engines are more expensive than thermal engines, since thermal engines have require less radiators. Vista Engines are very expensive to operate due to their high rate of consumption of Tritium.

- Generators

- Generators are electricity production parts in the KSPI mod. Generators come in 2 different types and function differently. Generators in KSPI generate both electric charge and MegaJoules. Generators must be directly connected to a reactor to generate electricity and can only use power from one reactor at a time. Generators require radiators to expel WasteHeat and will not function without them.
- **Thermal Generators** - These generators convert thermal power from a reactor into electrical power and waste heat. Their efficiency determines what percentage of that thermal power is converted into electricity. The rest becomes waste heat. Typical thermal generators in space use closed cycle Brayton gas turbines. For traditional molten salt-based fission reactors, this type of generator gives a maximum theoretical efficiency of 31%. Upgrading the electric generators changes them from Brayton Cycle Turbines to a KTEC Solid State Generator heat engine with no moving parts - this ups the theoretical efficiency to 60%!
- **Charged Particle Generators** - This type of generator produces power directly from the use of charged particles which are created in great quantities by fusion reactors. Charged particle generators can reach much higher efficiencies than their thermal counterparts. These generators will produce varying amounts of power depending on the reactor type and used reactor fuel mode.
- The Thermal Generator and Charged Particle generators can both be used at the same time on reactors that produce both charged particles and thermal power. This maximizes power potential and lower your utilization and therefore minimise WasteHeat production and reactor fuel consumption.

● Radiators & Waste Heat

- Radiators are used in KSPI to expel excess WasteHeat from a vessel. WasteHeat is produced by reactors, generators, microwave receivers, IRSU processes and hyperdrives and will build up over time. Once WasteHeat builds up in a vessel to 95% capacity than reactors, solar panels and microwave receivers will automatically power down. If WasteHeat is allowed to reach 100% then the parts may start being destroyed from too much heat.
- The Thermal Helper addon included with the KSPI installation can be used to estimate a reactor's WasteHeat output. The values in the addon will dynamically update depending on the connected components. The Thermal helper is only accessible from the VAB/SPH.

● Reactor Fuel Modes

- Reactor Fuel modes govern some of the capabilities of the reactor as seen on the chart. The specifics of how each fuel mode work are out of scope for this guide but can be researched on the web.
- Let's go over an engine entry from the main page and decipher the different capabilities it may have.

Fuel Mode	Type	Reactors	Additional Tech Requirement	Requires Science Lab	Core Temp Modifier	Power Multiplier	Fuel Efficiency	Power Requirement Multiplier	Fuel	Products	Charged Particles Ratio	Bremsstrahlung	Neutron Energy Ratio
Uranium	Fission	Molten Salt / Gas Core	Nuclear Power	no	100%	1	15%	n.a.	EnrichedUranium	DepletedUranium **	0	n.a	2%

- **Fuel Mode** - This field shows the types of Fuel Modes that are available for use in Reactors. Many types of reactors have alternative fuel modes which can referenced from this chart.

- **Type** - This describes the type of nuclear reaction used to produce energy. Fission fuel type reactors have a longer life but produce less power than their fusion counterparts. Antimatter reactors are incredibly powerful but require Antimatter which can be difficult to produce in large quantities.
- **Reactors** - This column displays which reactors can be used for a given Fuel Mode. MCF is an abbreviation for Magnetic Confinement Fusion. ICF is an abbreviation for Inertial Confinement Fusion.
- **Additional Tech Required** - This is a self-describing field which shows which tech tree node must be researched before the reactor fuel mode is unlocked for use.
- **Requires Science Lab** - If a fuel mode requires a Science Lab then it must be attached to the vessel to utilize these more advanced fuel modes.
- **Core Temp Modifier** - This section shows the effects of the Fuel mode on the reactor's core operating temperature. A percentage higher than 100% means the reactor will have a higher core temperature than with the standard fuel while values less than 100% indicate a decrease in thermal core temperature.
- **Power Multiplier** - This field is similar to the Core Temp Modifier above except in regards to power output of the reactor. A value higher than 1 means the reactor will have a higher core temperature than with the standard fuel while values less than 1 indicate a decrease in thermal power output.
- **Fuel Efficiency** - The fuel efficiency section displays how much of the fuels energy is able to be converted into useful power. Less efficient fuel modes will result in additional waste products which must be stored on the vessel.
- **Power Requirement Multiplier** - This value describes the change in power requirements for a given fuel type. Power requirements for a reactor are listed on the Reactor chart under the Base Power Req column. The more advanced fuel modes require additional power to start and maintain the nuclear reaction. Values higher than 1 indicate an increased need for Power to start and sustain the reaction.
- **Fuel** - This section lists the types of fuel required to use the respective Fuel Mode. Many of the reactor fuel modes listed require multiple fuel types to start and sustain a nuclear reaction.
- **Products** - This field displays which waste products are produced from running a given Fuel Mode. The waste products will build up over time while the reactor runs and must be stored in containers on the vessel.
- **Charged Particle Ratio** - The column shows what percentage of a reactor's energy output is converted into charged particles. Values of 0% indicate a reactor does not produce any charged particles.
- **Bremsstrahlung** - Bremsstrahlung (translation braking-radiation) is EM-radiation emitted when charged particles are forced to change speed vectors - this energy is probably lost for power generation. This correlates with fuel efficiency for fusion reactors. Not fully implemented yet but it becomes thermal energy which can be partially recovered with technological advances.
- **Neutron Energy Ratio** - How many neutrons are emitted in one second of active reactor. Lower values means slower degradation of reactor. Charged particle ratio + neutron energy ratio add up to 100% - this is the percentage of energy output available as thermal energy. It also has a big effect on the Tritium breeding rate which uses free neutrons to convert Lithium into Tritium.

- **Propellants**

- Propellants are used in KSPI for many of the engines and have a large effect on overall engine performance and reliability.

- Let's go over an propellant entry from the main page and decipher the different capabilities it may have.

Propellant	Chemical	Thermal ISP multiplier	EngineThrust Multiplier	Thermal Decomposition	Full Decomposition Energy	Soot Effect	Toxic	Electric ISP multiplier	Density	ISRU
Liquid Hydrogen	H ₂	1	1			-0.01		1	--	++

- **Propellant** - This simply states the name of the propellant. All propellants in KSPI are based on real world fuels and have closely matched performance values.
 - **Chemical** - The Chemical value is the molecular makeup of a given propellant. H₂O is Water for example.
 - **Thermal ISP Multiplier** - This field shows the effect on ISP for a given propellant. A baseline value of 1 would give the maximum ISP while values less than 1 will decrease the ISP of an engine by the multiplier.
 - **Engine Thrust Multiplier** - This value like the ISP multiplier above effects the thrust value of the engine which is being fed the listed propellant. A thrust multiplier of 1 would give a baseline thrust while values higher than 1 increase the thrust and values lower than 1 decrease it.
 - **Thermal Decomposition** - Describes the effect of a propellant as it breaks down into basic chemicals when heated. This has the effect of increasing thrust and ISP of the engine depending on the core temperature of the reactor. This does come with a disadvantage where the extra byproducts of the thermal decomposition contribute to additional soot (carbon build up) in the engine which can clog and oxidize the reactor causing a reactor to leak nuclear fuel. Some propellants such as Hydrazine or Ammonia release all their combustion components at a low temperature so no thrust or ISP gain can be seen.
 - **Full Decomposition Energy** - Determines the maximum amount of power released by decomposition. The higher this number, the high the Isp and thrust boost.
 - **Soot Effect** - This shows how much soot buildup will occur for a given propellant. Positive values indicate a propellant will buildup soot deposits in the reactor while negative values have the effect of cleaning the reactor. Soot buildup decreases the thrust and ISP performance of an engine.
 - **Toxic** - This simply states if a propellant is toxic to Kerbals and will contaminate the environment. Using an engine with a Toxic propellant in the atmosphere will most certainly upset your Kerbal population.
 - **Electric ISP Multiplier** - Like other multipliers in the chart this value will effect the overall ISP of a engine and propellant pair. Engine effective Isp can depend on a combination of Ionisation efficiency and thermal efficiency.
 - **Density** - The density of a fuel shows how much fuel can be filled into a given volume. Denser fuels will typically allow you to get more delta-v out of the same sized fuel tanks. Denser propellants also will weigh more (wet mass) when compared with a less dense propellant given the same volume in tankage. A plus means it has a high density, a minus means it has a low density (might be replaced by an actual number).
 - **ISRU** - Is a broad classification of how difficult it is to collect and fabricate the propellant.
- **Building your first KSPI propulsion module/example propulsion modules**
 - **Example Propulsion Module** - This is a temporary addition until I get a chance to actually create a better guide with pictures and more examples. To create a propulsion module in KSPI adhere to the below guidelines. Details for each of these components is outlined above.

- The 6 basic components needed to create a working KSPI-E propulsion module are as follows
 - **Reactor** - A reactor is needed to produce heat energy or charged particles which is used by other KSPI components to convert it into useful energy. Pebble Bed is recommended for high thrust/atmospheric launches and Molten Salt is recommended for long term usage for upper stage/satellites. Your choices will change as you unlock more components
 - **Generator** - A generator is required to produce Electric Charge and MegaJoules, both resources are needed on almost any KSPI vessel. Megajoules are needed for KSPI engines which have 'Electric Power Needed' = Yes or Partial
 - **Radiators** - Radiators are required to expel WasteHeat from the reactor, generator or engines. Without a radiator you will not be able to generate any power!
 - **Engine** - Without an engine this wouldn't be much of a propulsion module. Most engines operate most effectively when directly connected to the reactor. The reactor heat transfer performance values will indicate how much of the original energy is available if an engine is not directly connected to the reactor. The Atilla and Arcjet RCS thrusters do not require any direct connection to function at 100%. I recommend starting with either the Thermal Turbojet or Thermal Rocket nozzle.
 - **Propellant/Fuel** - All Reactors and most Engines require propellant/fuel to operate. The Interstellar Fuel tanks are the standard containers that will be used to store the propellants. Hydrazine or LqdAmmonia are performance fuels and are be strongly recommended for Launch stages.
 - **Control** - A probe core or crewed command module is also needed to operate the vessel.
- **Common Issues**
 - All engines (except vacuum plasma thruster) must overcome the static pressure in the atmosphere and is better suited for vacuum usage and may not show any thrust in the atmosphere. Smaller thrusters will help overcome static pressure

- Atmospheric Scooping and ISRU
 - Work in Progress