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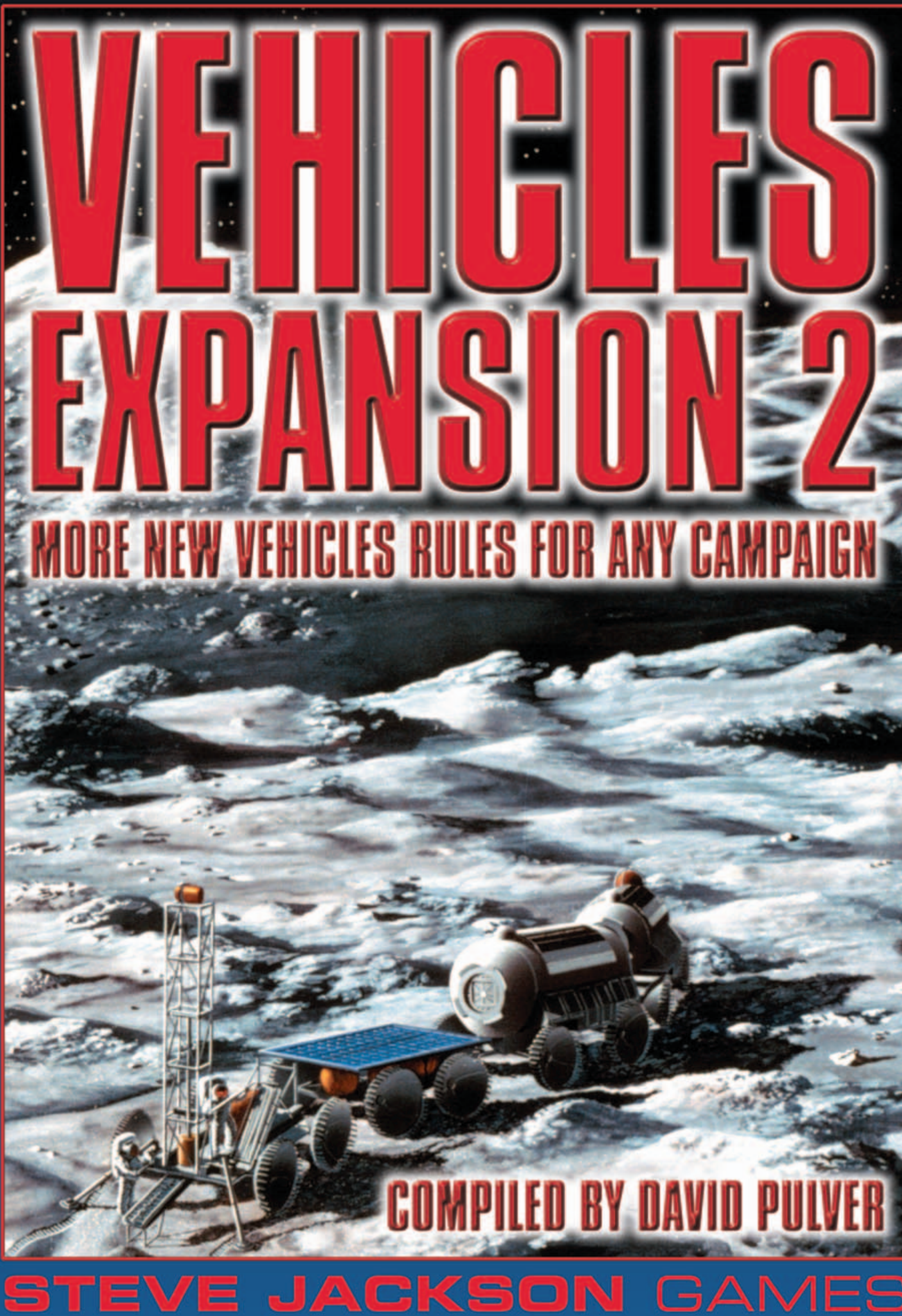

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This second set of new design components for ***GURPS Vehicles*** adds dozens of options to the GM's toolbox, collecting devices published in many other books and adding plenty of new ones. Now you can:

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GURPS Basic Set, *Third Edition, Revised* and ***GURPS Vehicles,*** *Second Edition,* are *required* to use this supplement in a ***GURPS*** campaign. The ideas in ***GURPS Vehicles Expansion 2*** can be used with *any* roleplaying system.

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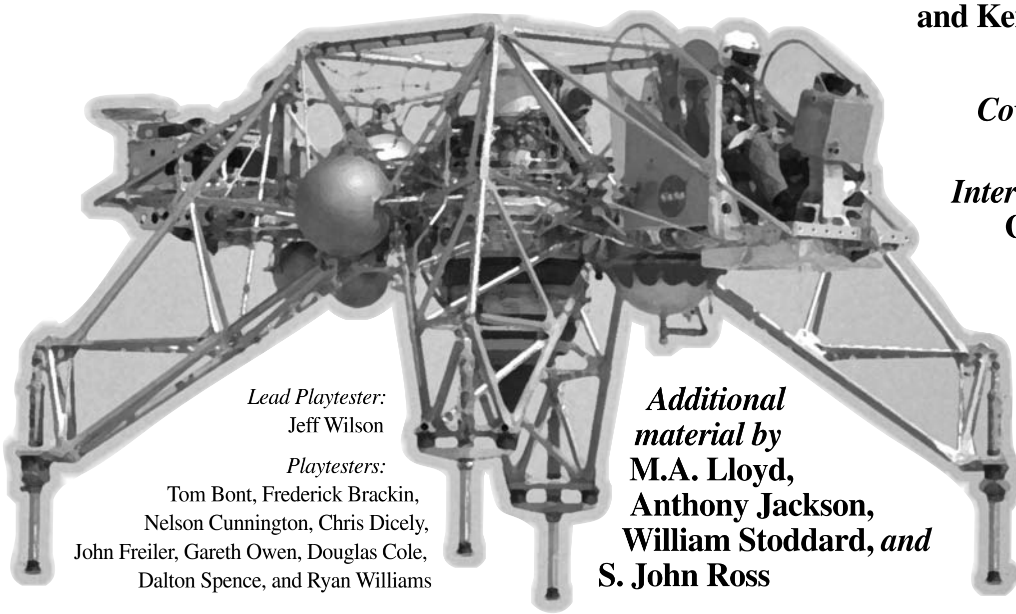

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INTRODUCTION

About GURPS

Steve Jackson Games is committed to full support of the ***GURPS*** system. Our address is SJ Games, Box 18957, Austin, TX 78760. Please include a self-addressed, stamped envelope (SASE) any time you write us! Resources include:

Pyramid (**www.sjgames.com/pyramid/**). Our online magazine includes new ***GURPS*** rules and articles. It also covers ***Dungeons and Dragons, Traveller, World of Darkness, Call of Cthulhu,*** and many more top games – and other Steve Jackson Games releases like ***In Nomine, INWO, Car Wars, Toon, Ogre Miniatures,*** and more. *Pyramid* subscribers also have access to playtest files online!

New supplements and adventures. ***GURPS*** continues to grow, and we'll be happy to let you know what's new. A current catalog is available for an SASE. Or check out our website (below).

Errata. Everyone makes mistakes, including us – but we do our best to fix our errors. Up-to-date errata sheets for all ***GURPS*** releases, including this book, are available from SJ Games; be sure to include an SASE. Or download them from the Web – see below.

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Internet. Visit us on the World Wide Web at **www.sjgames.com** for an online catalog, errata, updates, Q&A, and much more. ***GURPS*** has its own Usenet group, too: rec.games.frp.gurps.

GURPSnet. This e-mail list hosts much of the online discussion of ***GURPS.*** To join, e-mail majordomo@io.com with "subscribe GURPSnet-L" in the body, or point your web browser to **gurpsnet.sjgames.com**.

The ***GURPS Vehicles Expansion 2*** web page is at **www.sjgames.com/gurps/books/vehiclesx2/**.

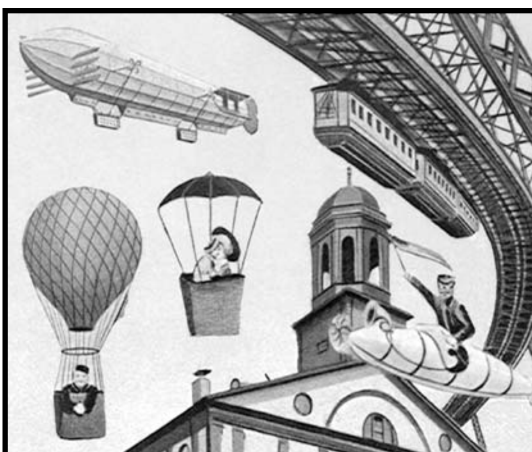
Page References

Rules and statistics in this book are specifically for the ***GURPS Basic Set,*** *Third Edition.* Any page reference that begins with a B refers to the ***GURPS Basic Set*** – e.g., p. B102 means p. 102 of the ***GURPS Basic Set,*** *Third Edition.* Page references that begin with CI indicate ***GURPS Compendium I.*** Other references are P for ***GURPS Psionics,*** S for ***GURPS Space,*** *Third Edition,* VE for ***GURPS Vehicles,*** *Second Edition,* and WT for ***GURPS Warehouse 23.*** For a full list of abbreviations, see p. CI181 or the updated web list at **www.sjgames.com/gurps/abbrevs.html**.

This book is the second supplement to ***GURPS Vehicles,*** *Second Edition.* Like the first volume, ***GURPS Vehicles Expansion 2*** adds a wide range of features for vehicles of all sorts, from powered turbosails for high-tech sailing ships to ley drives and disintegration screens for UFOs.

GMs should decide what technology is and isn't appropriate to a campaign, and mix and match to create memorable adventures. Feel free to decide that certain technologies don't exist in a particular setting, to make room for possibly more interesting inventions. Does contragravity make travel too easy? Replace grav vehicles with vacuum-filled airships or magnetic lifters. Is nuclear fusion too mundane for a weird-science future? Maybe everything runs on broadcast power or zero-point energy!

GURPS Vehicles Expansion 2 benefited immeasurably from the generous contributions of M.A. Lloyd (who provided a wide array of components and rules), Anthony Jackson (custom force fields), Bill Stoddard (for steampunk technology), and S. John Ross (for ***Warehouse 23*** weird science), among others.



About the Compiler

David L. Pulver is a prolific writer, game designer and editor living in Victoria, British Columbia. His credits include ***GURPS Vehicles, Transhuman Space,*** and ***BESM,*** *Second Edition.*

Design Options 1

This chapter describes alternative options for creating vehicle subassemblies, body features, structures, and armor, expanding on Chapter 1 of ***GURPS Vehicles.***

Divergent Tech Levels

Technology that represents a significant divergence from the normal technology path laid down in ***GURPS*** for TL7 and below is referred to as "divergent technology." This is indicated with a notation such as TL(5+1), the first number being the TL at which it diverged and the second the number of TLs since the divergence point. Use the sum of both numbers for most purposes, e.g., TL(5+1) is effectively TL6. However, it would be a *different* TL6. Engineers and scientists used to a normal (or differently diverging) TL will suffer an additional -2 familiarity penalty over and above any TL differences.

Divergent technology most often occurs in "alternative Earth" type settings, such as ***GURPS Steampunk.*** It sometimes, but not always, develops as a result of the existence of different prevailing physics. A divergent technology is only available if the GM specifically decides it exists.

In some cases, divergent technologies only function in alternative Earths (or other worlds) where different physical laws hold sway, e.g., a working theory of the ether instead of quantum physics. These are referred to as "weird science" technologies.

Subassemblies

Subassemblies are major components that are added to a vehicle, such as wheels or turrets. Two additional subassembly options are below.

Pontoons

Some light aircraft, notably seaplanes, are designed to land on pontoons and float. Build these as waterproof or sealed pods attached to the body or wings containing nothing but empty space. Each cubic foot of pontoon volume adds 37 lbs. flotation. A vehicle should generally have two pontoons (each the same size) as under-body pods, although other symmetrical arrangements may be permitted by the GM.

The combined volume of the pods is typically 10%-30% of body volume. If the flotation of the pontoons alone is higher than total loaded weight, the vehicle is treated as having fine hydrodynamic lines for all water performance except calculating draft (pp. VE130-132). Use combined pontoon volume, not body volume, when referring to the *wMR and wSR Table* (p. VE132).

A vehicle may have both retractable wheels and pontoons; use the statistics for "retractable wheels that retract into the wings," except that instead of adding 0.025 times body volume to each wing, use (0.05/number of pontoons) as an absolute minimum volume for each pontoon pod. Pontoons cost $4 × surface area.

Extra Detail – Wing Pontoons on Flying Boats

A winged aircraft with a hydrodynamic hull (a flying boat) normally requires two small underwing pontoons (one pod per wing) for stability when floating, even though most of the flotation is provided by the body. If the pods do not provide flotation equal to at least 5% of the vehicle's loaded weight, it usually tips over, preventing it from safely landing or taking off.

Rigid Sail Subassemblies

These are high-tech alternatives to conventional masts and sails. Rigid sails are potentially less vulnerable to damage than ordinary sails, and can be controlled by a single crew member regardless of the sail area. There are three types:

Flettner Rotors (TL6): These are tall rotating cylinders which produce thrust from the wind via the Magnus effect (see ***Vehicles Expansion 1***). They have a small power requirement.

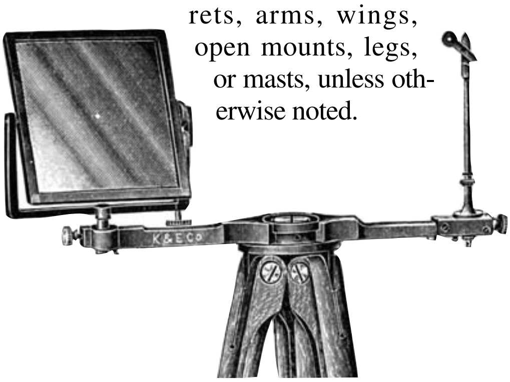
Wingsails (TL7): These rigid airfoils range from giant upright wings to forests of inch-wide slats. The advantages are simplified handling (no sailing crew is necessary), easier match to the wind direction (they travel at full speed in any wind except *Wind on the Bow*), and higher thrust.

OTHER COMPONENTS 3

This chapter describes other equipment that can be installed in a vehicle. It expands upon the components detailed in Chapters 4 through 8 of ***GURPS Vehicles,*** particularly sensors, power plants, and force fields.

INSTRUMENTS AND ELECTRONICS

A wide variety of gadgets can be installed in a vehicle for communication, navigation, and other purposes. Equipment in this section can be installed in the body, superstructures, pods, turrets, arms, wings, open mounts, legs, or masts, unless otherwise noted.



PRE-RADIO COMMUNICATIONS

These options are also available for pre-radio communications (p. VE47):

Mechanical Semaphore (late TL4): A pair of movable pointers mounted on a mast can be used to send any hand semaphore alphabet. Naked eye visibility is a mile. Transmission rate is operator's (Telegraphy skill -4) symbols/minute. Systems using single pointers, rotating colored disks, shutter arrangements, or more than two arms perform similarly, but don't use hand semaphore codes.

Heliograph (TL5): A heliograph consists of a mirror and a sighting device. Slight movements of the mirror send a pulse code by moving a reflected beam on or off the target. Only the target can read the signal properly, and messages can only be sent from a stable platform, not a ship or a moving vehicle, unless the heliograph is equipped with TL7+ Full Stabilization (p. VE45). Signal rate is (4 × Telegraphy skill) characters per minute. Range is limited by line of sight, and also depends on the light source; sunlight gives a maximum range of 30 miles and moonlight is 5 miles. If artificial sources are attached to the heliograph, range will vary depending on the light's intensity. Larger mirrors have better ranges, but may be slower – at one extreme, a square-mile lightsail in Earth orbit should be visible at 10 AU, and might send a few characters per hour.

Shape Telegraph (TL5): The standard Redl's Cone Telegraph consists of a mast with four fabric cones which can be opened like umbrellas. The 16 open and closed combinations are used to send coded signals. Variants may use different shapes or combinations, although symmetrical shapes are preferred, to ensure legibility when viewed from any direction. Signal rate is slow: 6 code groups per minute. Naked-eye visibility is 3 miles.

Light Telegraph (TL5): This is a shape telegraph with colored lamps replacing the shapes. Early systems changed signals by running up new lamps (0.5 characters per minute), but shutters (15 characters per minute) or electrical switches (60 characters per minute) are much faster. Naked eye range is 3 miles for typical systems – beyond that the lamps are too close to reliably make out signals.

Signal Lamp (TL5): This lamp (limelight or electrical) is fitted with a shutter allowing it to be used for Morse code. Effective range is 15 miles (or line of sight), and (4 × Telegraphy skill) characters can be sent per minute. Searchlights can be fitted with shutters for $50, and used as signal lamps at 20 × their range.

Early Communications Table

TL	*Type*	*Weight*	*Cost*	*Power*
4	Mechanical Semaphore	200	$500	0
5	Heliograph	15	$250	0
5	Shape Telegraph	200	$500	0
5	Light Telegraph	140	$800	neg.
5	Signal Lamp, limelight	175	$300	0
5	Signal Lamp, electric	30	$100	neg.

Location: Mechanical semaphores, light or shape telegraphs require a mast, which cannot be used for sailing at the same time as when signaling.

Performance and Operations 4

This chapter expands on Chapters 10 and 12 of ***GURPS Vehicles***, providing additional rules for specific situations and types of vehicles.

Aerial Performance – Gliders

A vehicle with wings, rotors (see *Auto-Rotation and Helicopters*, p. 31), or a lifting body but no functioning aerial propulsion system is a glider. The GM may wish to calculate glider performance for any aircraft with a stall speed, in the event of the craft losing power.

A glider has the same aerodynamic drag, Stall Speed, aMR, and aSR as any other aircraft, and it can fly if its speed exceeds its stall speed. A glider might reach its stall speed by using a powered propulsion system and then turning it off, or by being towed by another vehicle. The important statistics for a glider are its terminal velocity and top gliding speed, and its glide ratio.

Top Gliding Speed is the top speed the glider can theoretically reach in forward flight. It is calculated as follows:

Top glide speed = 0.4 × terminal velocity.

Terminal velocity is:

Square root of (7,500 × Loaded Weight/Aerodynamic Drag).

Glide Ratio is the critical statistic for a gliding aircraft. It is the forward distance the aircraft can travel before losing a unit of height. Glide ratio is calculated as:

(Top glide speed/stall speed) squared.

E.g., one with a top glide speed of 120 mph and stall speed of 20 mph has a glide ratio of (120/20 = 6) squared = 36, or 36:1. It could fly 36 yards horizontally before losing a yard of altitude, go 3.6 miles before losing 0.1 mile altitude, etc.

Glider Flight

A glider flies like any other aircraft. It must be moving faster than its stall speed to stay in the air. The rule for aircraft deceleration (1 mph/s in forward flight; see *Change of Top Speed*, p. VE150) does not apply if using these glider rules, since the glider is always sinking. Even in forward flight, a glider will constantly lose altitude as determined by its glide ratio and forward speed.

Gliding speeds are relative to the air, not the ground, so any speed added from a tailwind (which adds to ground speed without increasing air speed) or subtracted from a headwind is not counted when determining altitude lost.

Thermals, downdrafts, and updrafts are also important, and increase or decrease altitude for a period of time, sometimes several minutes. A

Extra Detail – Aircraft Stall Speeds and Landing

For increased realism (and especially if using the glider rules) stall speeds should be calculated as follows:

Sl × Rs × square root of [(Lwt. - Static Lift)/Lift Area].

Sl is 7 for fair streamlining or worse, 7.35 for good, 7.7 for very good, 8.05 for superior, 8.4 for excellent, and 9.1 for radical streamlining.

Rs is 2 mph for most vehicles, but 1.5 mph if the vehicle has a responsive structure.

Lift Area is calculated as per p. VE133: Add the entire combined surface area of all the wings and rotors to 10% of the area of the body (30% for lifting bodies). Treat STOL wings as having 1.5 times their actual area and flarecraft as 3 times their area for this purpose.

Static Lift is the total pounds of lift from ornithopter wings, helicopter rotors, lifting gas, Magnus effect drivetrains, vectored thrust used for lift, lift fans or engines, contragravity, and levitation.

Lwt. is loaded weight.

Stall Speed and Glider Terminal Velocity in Alien Environments: Multiply it by the square root of the local gravity and divide by the square root of local air density.

Rough Field Landings: For landing and take off purposes, a vehicle with up to Very High ground pressure can treat a level grassy field or a smooth, straight dirt road as hard terrain.

To find the specific impulse of a space drive or rocket engine rated in ***GURPS Vehicles*** terms, use this formula:

$$\mathbf{Isp = 3{,}600 / (F \times W).}$$

F is the *Fuel Usage* value (in gph per pound of thrust) on space drive and rocket engine tables; see p. VE36). *W* is the weight of the fuel or reaction mass in lbs. per gallon: see p. VE90 and similar fuel tables.

For example, the Optimized Fusion engine on p. VE36 has a fuel usage of 0.004H (0.004 gallons of hydrogen) per hour per lb. of thrust. The table on p. VE90 shows that hydrogen weighs 0.58 lbs. per gallon. As such, the engine has an impressive Isp of 3,600/(0.004 × 0.58) = 1,551,724.

Realistic Delta-V

Specific impulse can be used to calculate a realistic delta-V, the total velocity change that a spacecraft can achieve using a particular load of fuel. Use this formula to find delta-V from specific impulse:

$$\mathbf{Realistic\ Delta\text{-}V = 21.8 \times Isp \times natural\ log\ (1 + [fuel\ weight/dry\ weight])\ mph.}$$

Fuel weight is the total weight of fuel carried for that engine. *Dry weight* is the loaded weight of the vehicle minus the weight of its fuel for that engine. Delta-V is often given in miles per second (e.g., in ***Transhuman Space***). To get mps, divide delta-V in mph by 3,600.

Simplified Delta-V

GMs who want a simpler system for calculating delta-V without working out Isp and using natural logarithm functions can use this formula:

$$\mathbf{Delta\text{-}V = (sAccel\ in\ G) \times endurance\ in\ hours \times 21.8\ mps.}$$

If doing this, calculate loaded mass as if the tanks carried only half the load of fuel. This will simulate the fact that the fuel load will be gradually burned away during flight.

Round Trips and Delta-V

A vehicle using a reaction drive (one that requires fuel) will usually accelerate to a speed equal to *half* its delta-V, burning just over half its fuel, travel for (miles to destination/speed) hours, then decelerate using the remainder of its fuel.

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