

HIGH FRONTIER

A game of space exploration for 1 - 5 players

includes Expanded Game

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HIGH FRONTIER

A GAME OF EXOGLOBALIZATION

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Exoglobalization: "The elimination of government-enforced restrictions on exchanges across the Earth as extended to extraterrestrial resources and facilities, creating an interglobal marketplace."

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1.0 INTRODUCTION

In the near future, nanofabricating techniques will allow incredible new materials, such as carbon buckytube whiskers, to be built atom by atom. But they can only be built in the zero-gravity and high-vacuum conditions in space. Various private and government enterprises race to establish a buckytube mechanosynthesis factory on a suitable carbonaceous asteroid. To do so, they accumulate tanks of water in orbiting fuel depots, to be used as rocket propellant. Also needed are remote-controlled robonauts to do the grunt work.

The key to success is water in LEO (low Earth orbit). At first, water will be expensively "upported" out of the deep gravity well of Earth. Eventually, it will be mined and transported from Luna, the moons of Mars, or other nearby hydrated objects at about half the velocity increment (or 2.7x less fuel). Extracting resources at the work site is called "In-Situ Resource Utilization" (ISRU). Whoever develops ISRU technology able to glean water from space rather than Earth will gain the strategic high ground to make money through exoglobalization.

Note: Terms being defined are listed in **bold**. Terms that are defined elsewhere in the rules are *italicized*. **Easily missed rules have a black backdrop.**

— The **rocket bullet** indicates a rule used in the expanded game only.

HIGH FRONTIER SUMMARY. Design and build rockets, *prospect* and *industrialize* promising sites in the inner solar system. Your rocket must be *researched*, *boosted*, and loaded with fuel. For "fuel" (actually propellant), a rocket uses *water tanks* (WT), which also serves as the game's currency. Each rocket has a thruster card specifying its *thrust* (number of burn spaces you may enter each turn) and *fuel consumption* (fuel steps per burn). Fuel is also spent to land/lift off of worlds. You *may commission* your rocket in space, which frees you to build a new one in LEO.

OBJECTIVE. To win, send crews or robonauts to prospect sites on the map. Then build *extraterrestrial* (ET) factory by transporting a *robonaut* and *refinery* to a successfully prospected site. Each ET factory awards *factory points* (VP) according to its Resource Exploitation Track. The game ends when a player who has built *ET factories* or *2 space ventures* pays 5 WT, or when a specified number of ET factories are built. The winner is the player who has the most VP.

Note: While this is a competitive game, there is great freedom on the deals that can be made with other players. See 5.9.

CONTENTS Sections 1 - 7 describe **basic game**. Section 8 adds the **expanded game**, purchased separately. Section 9 is background science and technology behind the cards.

NUMBER OF PLAYERS Two to five players, each representing a political entity.

2.0 COMPONENTS

2.1 COMPONENTS LIST (Basic Game)

1 This rulebook

1 Basic game map (inner solar system)

1 Placeholder Sheet (2.5)

5 Crew cards (2.6B) [must be cut out of the Placeholder Sheet].

5 Player Mats (2.4).

52 Transparent Disks (clear, red, & blue) for water tanks (WT) & indicators.

30 Opaque Disks (in five colors) for claims and outposts.

19 Black Disks for failed mines.

30 Cubes (in five colors) for ET factories, colonies and freighters.

10 Rockets (in five colors). Rocket's location and fuel level (5.4B).

24 Cards. Patent blueprints (2.6A) for Ibrusters, robonauts, & refineries.

1 Six-sided die (1d6), for prospecting (5.6) and bazards (6.4E, F).

2.2 MAP FEATURES

There are 3 kinds of **spaces**: *burns*, *intersections*, and *site hexes*.

A. BURNS. A red circle is called a **burn**. It costs fuel per 6.2B to enter it.

B. INTERSECTIONS. There are two kinds of intersections: **Hohmann** (cross) and **1-Point** (circular). These represent interplanetary elliptical orbits and Lagrange points respectively. Turning at a Hohmann intersection costs fuel per 6.3.

C. SITE HEX. A black hexagon is called a **site hex**. A rocket enters here per 6.4A to land on a world.

D. HELIOCENTRIC ZONES. The maps are divided into concentric **zones**, centered on Sol. Each is named after a planet: Mercury, Venus, Earth, Mars, Ceres, Jupiter, and [expanded map] Saturn. Each zone lists *thrust modifiers* for *solar-powered* rockets (6.1A).

E. ROUTES. The lines between burns indicate the **routes**. Seven of these routes have special colors and are marked with a *signpost* (5.4E). These routes are suggestions only, and have no special rules.

2.3 PLAYER FACTIONS

A. FACTIONS. Each player is a distinct "basal societal unit" (BSU): world organization (purple), national government (white), socialist regime (red), worker union (green), and private entrepreneur (orange).

B. FACTION PRIVILEGE. Each faction has a special **privilege**:
 • NASA Launch Fee (white player). Receive a 1 WT bonus after any player (including self) boosts one or more cards.
 • Shimizu Research (orange player). You may participate in a *Research Operation* regardless of your hand size (5.2A).

- ESA Powersat (green player). A power-beaming satellite in GEO allows you to increase the thrust of any rocket by 1 for the turn, during its *thrust modification* phase (6.1).

- Chinese Territorial Claims (red player). You may perform actions designated as **felonious**: *claim jumping* (6.4B), *crew decommission* (6.7B), and *water theft* (5.5C).

☞ Chinese War Declaration. You are allowed to move the politics from *anarchy* to *war* per 8.6.

Note: *If a crew is present at a site, the PRC cannot claim jump or steal water there.*

- UN Taxes (purple player). Receive a 1 WT bonus from the pool after any player (including self) places a *claim disk* (5.6B) or establishes an *ET factory* (5.7A).

☞ UN Cycler.*You may [expanded game] grant passage of any spacecraft through the *radiation belts* of Earth without a *radiation roll* (8.3C).

2.4 PLAYER MATS

A. ACCELERATION TRACK AND ROCKET DIAGRAM. The row labeled from 1 to 12 is the **Acceleration Track**. The field of spots is the **Rocket Diagram**, used to track fuel supply (5.4B).

B. WATER TANK ORBITAL DEPOT. This area stores your WT (clear disks). Each is a 40-ton water tank in **low Earth orbit** (LEO).

- Fuel Tank Liquidation. Each fuel tank = 1 WT. As part ~~of any~~ *operation*, you may freely convert fuel tanks in your rocket at LEO into WT, or vice versa. Adjust *fuel figure* (5.4B) accordingly.

2.5 CARD PLACEHOLDER SHEET

A. PATENT SLOTS. This sheet holds slots for three patent decks. The top card of each deck may be examined but not removed (to see the other side or the next card), until you put it up for *auction* (5.2).

B. RESOURCE EXPLOITATION TRACKS. The four disks here track the victory point (VP) value of each *ET factory*.

2.6 CARDS

A. PATENT CARDS. There are three types of **Patent cards**: **Thruster**, **Robonaut**, & **Refinery**.

- White and Black Sides. The white side of a patent shows a product built on Earth; the black side shows an improved product built in space. A card won in a research auction goes into your *hand* (2.7A) on its white side, and is flipped over only after you build your first ET factory (5.7B).

B. CREW CARD. Your **crew card** identifies your color and faction *privilege*. This card follows all the rules of patent cards.

Remember: *Since the NASA, PRC, and ESA crew cards have a thruster triangle (2.6D), they may be used as a thruster.*

C. CARD DATA. The data in the white box (left) are for the *basic game*, and in the red box (right) are for the *expanded game*.

- **Mass.** [basic and expanded game]
- **Product letter.** (5.7B).
- **Radiation-hardness (expanded game).** Resistance to combat damage, solar flares, or radiation belt passages.
- **Support Cards required (expanded game).** This card requires an "x" reactor, plus one *therm* of radiator cooling (8.2H).

D. THRUSTER TRIANGLE. Cards with this icon act as a rocket motor.

- Afterburner. (See 6.1A).
- Solar-Power (See 6.1A)
- Thrust (See 6.1A)
- Fuel Consumption (See 6.2B)

E. PLATFORM & ISRU. These icons allow *refueling* and *prospecting*.

- Raygun. Prospect all adjacent nonatmospheric sites.
- Buggy. Re-roll a failed attempt, or prospect multiple sites along a road.
- Missile. May act as a thruster.

F. SOLAR POWER. If the **sun symbol** appears on any card used by the thruster, modify the thrust per 6.1A.

☞ **G. SUPPORT TRIANGLES** [expanded game].

Support cards (8.2) with one of these triangles, if used by a thruster that needs them, modify either the *thrust* or *fuel consumption*, as indicated.

☞ **H. RADIATOR ORIENTATION** [expanded game]. Each

radiator (8.2A) lists a different mass on each end of the card. During *boosting* (5.4) or *production* (5.8), play it on your mat in one of two **orientations**: with either the "heavy" or the "light" end uppermost. Once boosted, a heavy radiator can be freely reoriented into its light version, but not vice versa. Reorientation adjusts the *dry mass* (6.7A).

2.7 CARD HANDS AND STACKS

A. HANDS. Patent and crew cards are initially held in your **hand**. These cards are placed face-up on the table to the right of your mat. They are open for all to examine. There is no hand limit (but see 5.2A).

B. STACKS. Cards in play are kept in the three **stack slots** on your mat. The first, the **LEO stack**, contains cards at LEO. The second, your **outpost stack**, is for cards stored somewhere on the map. The last, your **freighter stack**, is for returning crews (6.7B) or shipments of factory product from an ET factory (5.7B).

- **Rocket Stack.** Your fourth stack, the **rocket stack**, is kept face-up to the left of your mat. All the cards in your active rocket are held here.

- **Limits.** You may only have one of each type of stack. **If you boost or build a second rocket stack, you must decommission (6.7) your old rocket stack, or convert it into an outpost per 6.7D.**

3.0 SET-UP

3.1 BASIC GAME SET-UP

A. ASSIGNING FACTIONS. Each player chooses, or is assigned randomly, one *crew card*. Your beginning *hand* (2.7A) is this single card. Unused crew cards are set aside.

- First Player. Randomly assign one player to go first.

B. PLAYER MATS. Each player faction receives a *Player Mat*.

- Starting Funds. Place four clear disks (WT) in your *Water Tank Orbital Depot* (2.4B), the hex area on your Player Mat. Each clear disk = 1 WT (water tank), the game's currency.
- Faction Cubes, Disks, and Rockets. Put the 6 cubes, 6 disks, and 2 rockets of your color anywhere on your Player Mat.

Note: You are limited to this number of cubes, disks, and rockets.

Important: Your WT, hand cards, and stacks are free for anyone to examine.

C. PLACEHOLDER. The 24 patents are separated into 3 categories (thrusters, robonauts, and refineries). Shuffle each category and stack them white-side up in the three slots indicated on the *Placeholder Sheet* (2.5A).

- Resource Exploitation Tracks. Place a blue disk in the "start" slot of each of the four *Resource Exploitation Tracks* (2.5B).

D. DISK POOLS. The disks and cylinders are placed into pools for easy access. WT are gained and discarded into these pools.

3.2 EXPANDED GAME SET-UP

The expanded game uses the basic game set-up, plus:

A. POLITICAL & SUNSPOT DISKS. One blue disk starts on the "Start" dot (center) in the *Space Politics*, and another starts on the "Start" dot (uppermost) in the *Sunspot Cycle* (8.5). Both diagrams are on the expanded map.

B. SUPPORT DECKS. The expanded game has three extra patent decks (generator, reactor, and radiator), which are shuffled and placed white-side up in the slots provided on the expanded map.

C. BUSTED MINES. If playing with fewer than 5 players, roll a 1d6 a number of times = $[5 - \mathbf{x}]$, where \mathbf{x} = the number of players, and consult the following table. If a site is rolled one or more times, place a black disk on its site hex, showing it is off-limits: 1 = Mercury, 2 = Venus, 3 = Luna, 4 = Mars (all three sites), 5 = Ceres, 6 = Hertha [all on the basic map].

3.3 SET-UP FOR A SHORTER GAME

For a shorter game, after set-up per 3.1 or 3.2, each player draws one card from each deck at random into his hand.

4.0 SEQUENCE OF PLAY

On your turn, calculate your dry mass and modified thrust and move your *rocket* and *freighter* (if any) per Section 6, and then select an *operation* per Section 5. Then proceed to the next player clockwise.

Note: It is helpful to have an object to pass around, so that everyone can tell whose turn it is. A cool rocket or celestial object would be nice.

5.0 OPERATIONS

During this phase, choose an **operation to perform**. The 8 choices are *Income*, *Research*, *Free Market*, *Boost*, *Prospect*, *Refuel*, *Industrialize*, or *ET Production*.

and

5.1 INCOME OPERATION

Draw 1 WT **income** from the pool. Each clear disk is 1 WT, each red disk is 5 WT, and (only if necessary) blue disks are 10 WT.

5.2 RESEARCH OPERATION (Auction)

This operation initiates an **auction** for a patent. The winner adds the card to his hand. Conceptually, he now owns the patent to build that product.

- Initiate Auction. Examine the top card of each deck and choose one to auction. This card is placed in the middle of the table so all can examine both sides and bid on it. (They can also examine the openly exposed top of the deck drawn from, to see which card is next in line for auction.)

- Auction Process. All players may openly bid WT for the card. They may freely increase (but not decrease) their bids. The minimum bid is zero.

- Auction Results. When no player is willing to increase his bid, the auction is closed. The card is awarded to the high bidder. If the high bidder is the phasing player, he pays his WT to the pool. **If the high bidder is another player, he pays the WT to the phasing player.**

- Ties. The phasing player wins ties if his bid is tied with another. If two non-phasing players are tied, the phasing player decides between them.

➤ Support Cards [expanded game]. If the auctioned card lists *supports* (7.2), the winner gets the top card from each category deck (generator, reactor, or radiator) listed. **Support cards are free.**

Note: A player wins only the auctioned card plus its supports, not supports of the supports.

Example [expanded game]: The UN bid wins the cermet NERVA thruster in an auction. This card lists a support: a reactor n. The UN player takes the top reactor card. Unfortunately, this is a reactor x, which doesn't support the cermet NERVA. So he sells it next turn on the free market for 3 WT.

A. BID LIMITS. **A player with more than three hand cards (not counting crew cards or black cards) may not bid in or initiate a research auction.**

Exception : The Shimizu (orange) player may initiate or bid in an auction regardless of how many cards in his hand.

5.3 FREE MARKET OPERATION

This operation lets you pick a card in your hand to sell for 3 WT. Return the card to the bottom of its relevant deck.

- Sale of Space Products. Alternately, you may decommission (6.7) a black card in LEO to receive WT equal to the VP value of the card's product letter, as shown on the Exploitation Track (2.5B) (8, 5, or 4 WT).

5.4 BOOST OPERATION

This operation plays one or more crew or white cards from your hand to the *rocket or LEO stack* (2.7B) on your Player Mat by discarding 1 WT for each *mass point* (2.6C) boosted. This represents moving payloads into low Earth orbit (LEO).

- NASA Fees. If any player boosts one or more cards, the NASA (white) player earns 1 WT from the pool per 2.3B.
- Black cards. Black cards are built at ET factories, and can't be boosted to LEO.

➤ *Radiator Mass [expanded game]. When boosting radiators, see 2.5G.*

A. MAP FIGURE. If you are starting a *rocket stack*, place a rocket figure in "LEO start" (2.2B), and a second figure on your mat per the next paragraph.

B. DRY MASS. Set your **fuel figure** upright on the *Rocket Diagram* (2.4A) in the row corresponding to the rocket's **dry mass**. (the combined mass of all cards in the rocket stack). Set it in the far left spot of the row, marked with an exclamation point (!). This shows your rocket is **dry** (no fuel).

- Maximum Size. You are limited to a dry mass of 15.

Fuel does not count toward dry mass.

Important: If your dry mass changes, see 6.7A.

C. LEO FUELING. As part of any operation or move, you may fuel at LEO. Each WT discarded adds a tank of fuel per 2.3C. For each tank of fuel added, move the fuel figure to the right until it reaches the next jagged black column. These columns are labeled Tank #1, Tank #2, etc.

Note: Cards and WT may be freely interchanged between your rocket and LEO stacks.

Example: A rocket has a Hall Effect thruster (mass 2), a crew (mass 1), plus a Kuck mosquito robonaut (mass 0) in cargo. Its dry mass is 3. Loaded up with one fuel tank, it has 5 steps of fuel, as shown.

Remember: Refueling will often decrease your modified thrust indicator per 6.1A, since your wet mass is increasing.

D. TERRESTRIAL PRODUCTION. You may freely flip a **black card** in your hand over to its white side, so that you can boost it from Earth. If you later wish to build its black side again, *retool* your factory to add the product per 5.7D.

E. SIGNPOSTS. If taking the red, orange, yellow, green, blue, indigo, or violet routes, check the **signpost** to see how many impulses there are to arrive at your destination. This number multiplied with your *fuel consumption* (2.6D) equals the fuel steps you will need. Also indicated is the *lander fuel* possibly needed (6.4C).

- Gravity Assist. If the numbers of burns in the basic and expanded games differ (due to *slingshots* 8.3A), they are listed separated by a slash.

Note: The number of burns listed assumes a stop at every Hobmann intersection, to take advantage of the free rotation at the start of each move.

Example: A rocket with an output of 3 • 2 takes the orange route to Mercury. It will need $7 \times 2 = 14$ steps of fuel for the 7 impulses, plus 10 steps of lander fuel. No ship can carry more than 21 fuel steps, so this trip is doomed.

5.5 SITE REFUEL OPERATION

This operation extracts water from a site, and loads it into your rocket as fuel. This adjusts the *fuel figure* per 5.4C. **For fueling at LEO, see 5.4C.**

A. ISRU REFUEL. If you have a crew or robonaut at a site, gain a number of tanks of fuel equal to one plus the site's **hydration** (number of drops), minus your *ISRU rating* (2.6E). Sites never run out of water.

B. FACTORY REFUEL. As part of this operation, if your rocket is at a factory site, you may add as many tanks as the rocket will hold (up to 8 tanks). Factories never run out of water.

Example: An unfueled rocket with an ISRU of 3 and a dry mass of 3 sits on Mercury (hydration = 3). By performing a refuel operation, it gains $1 + 3 - 3 = 1$ fuel tank, which lowers its modified thrust by one. If a factory is present, it gains up to 8 tanks, lowering its modified thrust by two.

C. WATER THEFT. It is *felonious* (2.3B) to refuel from the factories of other players without their permission.

5.6 PROSPECT OPERATION

A. REQUIREMENTS. Your rocket stack must have a card with an *ISRU* (2.6E) less than or equal to the *hydration* (2.2C) of the site. The site must not have been previously prospected (indicated by the presence of a disk).

B. PROCEDURE. Roll 1d6. Prospecting is successful if your roll is less than or equal to the site *size* (2.2C). Therefore, it is always successful for sizes 6+.

- Claim Disk. If successful, place a red disk (to show **claim**). If unsuccessful, put a black disk on the site hex, which permanently prevents further *prospecting* or *industrialization*. (But rockets can still perform the *refuel* operation here.)

Remember: The UN (purple) player gains 1 WT per 2.3B if a claim disk is placed.

- Raygun Prospecting. If you are prospecting with a *raygun* (2.6E), you may prospect any number of adjacent site

hexes (where each intersection, burn, and site counts as a space). Exceptions: You may fire over *Hazard* spaces (i.e., L-points and burns with a *skull* (6.4E) may be skipped over). Your raygun can't fire into site hexes with *atmospheres* (Venus, Mars, Saturn, and Titan).**

Example: A raygun (ISRU =0) on the HEO for the Koronis Family may prospect ten asteroids in one operation! This includes the asteroids in the Karin Cluster.

- Buggy Prospecting. If you prospect with a *buggy* (2.6E), you are allowed two attempts for a successful prospecting roll with one prospect operation. Furthermore, if on Mars, Io, Europa, Ganymede, Callisto, or Titan, you may prospect all the site hexes connected by the dashed yellow arrow (indicating a "buggy road") with one prospect operation.

Example: A buggy prospects Dresda. The roll is a "3", which fails because Dresda is size 2. But a second roll of "2" succeeds and places a claim disk.

- Assaying Smelters. Certain refineries (as listed on the card) improve the ISRU rating or prospecting roll, if carried by the stack doing the prospecting.

5.7 INDUSTRIALIZE OPERATION

To build an **ET factory**, take a refinery and a robonaut card to a site with a claim disk and *decommission* them [plus their *supports* (8.2B) in the expanded game]. This adjusts the rocket's *dry mass* (6.7A). **Any refinery, regardless of its product letter, can industrialize a site.**

A. FACTORY CUBE. **Industrialization** places a cube of your color on the claim disk, to indicate the new *ET factory*.

Note: If you are out of cubes to build a factory, you can withdraw from your other cubes (colony, glory, space venture, or freighter).

Note: A claim can have 1 factory. Certain refineries, as listed on the card, add an extra cube if used to industrialize a claim. A claim with more than one cube is a space colony (6.7B). Each extra cube represents crew.

Remember: The UN (purple) player gains 1 WT per 2.3B if a factory is built.

B. CHOOSE FACTORY PRODUCT. As part of this operation, you may choose one card to be the **factory product**. It must have a *product letter* (2.6C) matching the *Spectral type* (2.2C) of the site. If this card is on your Player Mat, *decommission* it. Put it into your *band* (2.7A) so that its black side faces you.

C. LOWER EXPLOITATION TRACK. Find the *Resource Exploitation Track* (2.5B) with a *product letter* (C, M, S, or V) matching the Spectral type of the factory site. Decrease this track one step. If you industrialize a Type-D world, pick one of the four Exploitation tracks to decrease, and select a card with that *product letter* to be the factory product.

Example: The UN player decommissions a refinery and robonaut to build a factory on Luna. He adds a purple cube, lowers the S Resource Exploitation marker, and flips a band card of product type S to its black side.

D. RETOOLING. Industrialization can be used to change a *factory product* (5.7B) in your hand. Flip the previous product to its white side and flip the new product (must have the appropriate *product letter*) to its black side. This operation can also be used to flip over a card of the correct type for a factory that has no black card associated with it.

5.8 ET PRODUCTION OPERATION

This operation plays one black card from your hand into one of the *stack slots* (2.7B) on your mat. This builds the *factory product* (5.7B) at the factory. This card must have a *product letter* (2.6C) that matches the factory type (C, M, S, or V). If you have more than one such black card, choose one. This card is either added to the stack, or can initiate a stack:

- If a *rocket stack*: place a rocket of your color on the site hex of the factory.
- If an *outpost stack*: place a disk on the site hex (stacked on the claim disk).
- If a *freighter stack*: place a cube next to the claim disk at the site. Only one card is allowed in this stack, either a crew card per 6.7B or a black card.

Example: The UN player from the previous example decides to build and ship his first lunar product. He plays his S black card into his freighter stack slot, and places a purple freighter cube on the map.

5.9 DEAL-MAKING

You may exchange WT, cards in LEO (white side and crew only)*, or promises for future services or actions as terms of a deal. All cards for sale may be examined beforehand.

Important: WT (as fuel) may be transferred from your rocket to the stack of any cooperating player in the same space.

6.0 MOVES

During this phase, compute your *modified thrust*, and then move both your *rocket* and your *freighter* (if any) in any order.

6.1 ROCKET MODIFIED THRUST (Acceleration)

Your **modified thrust** ** sets how many *burns* you may enter per turn, and how big a world you can land on without *lander fuel* (6.4C). It is calculated before your rocket moves, and is applied for its entire move. Use a blue disk in your *Acceleration Track* (2.4A) to show your modified thrust for the turn.

A. THRUST MODIFIERS. Your rocket's **thrust** is the first number in the *thruster triangle* (2.6D). Add or subtract the **modifiers** listed below to obtain the modified thrust.

- Wet Mass Thrust Modifier. The modifier used is shown in the waterdrop icon in the top row of the *Rocket Diagram*, depending on your fuel figure position at the start of your move.

➔ Reactor Thrust Modifier [expanded game]. Some reactor cards have a thrust modifier in their *support triangle* (2.6G). This applies only if your thruster needs the reactor as a *support*.

- Solar Power Modifier. If your thruster or its support has the solar icon on its *triangle* (2.6D, F), your rocket loses thrust

the further from the sun it travels, according to the modifier listed on the *zone* (2.2D) it starts its move in. *(Apply this modifier only once, even with multiple solar components.)*

- ESA Beamed Power. If your rocket gets power from the green player, add one to your thrust for the turn per 2.3B.
- Open-cycle Cooling. The **afterburner** icon on many thrusters signifies that you can dump coolant into the exhaust to increase thrust and get rid of heat. This option increases your thrust by one for the turn, and [expanded game] satisfies one *therm* (8.2A) of cooling. This option costs fuel; decrease your fuel figure the number of steps listed on the icon. Immediately adjust your acceleration disk up one step, plus another step if your *wet mass modifier* improves due to the fuel burn.

Example [expanded game]: A rocket uses a vortex-confined thruster (1 therm) and a D-T Tokamak as a support (2 more therms). This rocket has but a single 2-therm radiator, however, and thus must use open-cycle cooling every move the thruster is used, to keep from melting down. This increases the thrust (from 6 to 7), at a cost of an extra fuel step.

B. MOVEMENT REQUIREMENTS. To move, a rocket stack must have a working thruster with a *modified thrust* of at least one.

Example: A rocket with a dry mass of 6 and one tank of fuel is transport class (wet mass thrust modifier of -1). Using a thruster with a thrust of 1, its modified thrust is 1 - 1 = 0. It can't move with zero thrust, so it jettisons one step of fuel to bring it to scout class [using expanded game rule 8.3D]. This class has a wet mass modifier of 0, allowing it to move.

- Dry Rocket. Except for *sails* (6.5) and *freighters* (6.6), a rocket with no fuel may not move any further. Exception: You may enter or leave an *aerobrake bazaar* (6.4F) with no fuel.

6.2 SPACECRAFT MOVE

A **rocket move** takes your rocket figure from space to space, along connected routes, until it lands, chooses to halt, runs out of fuel, or has insufficient fuel or acceleration to enter a burn.

A. PROCEDURE. In your rocket stack, choose one card with a *thruster triangle* (2.6D) to be your thruster for the turn. Compute its *modified thrust* per 6.1A. This is the maximum number of burns per move. Each burn costs fuel per 6.2B. **Intersections cost no fuel to enter.**

- Hohmann Pivots. If you move through a *Hohmann intersection* (2.2B), you must go straight through without turning, unless you pay the turning penalty specified in 6.3.

If you begin your move on a Hohmann, you may move in any direction, regardless of the direction moved last turn.

- Stacking Limits. You may freely pass and share a space with other rockets, freighters and outposts.

➤ **Advanced Maneuvers** [expanded game]. As part of your move, you may perform one *attack* (8.4) and one or more *advanced maneuvers* (8.3).

- No U Turn. You can't reverse direction during your move.

B. FUEL CONSUMPTION. The right-hand number in the *triangle* (2.6D) is the thruster's **fuel consumption**. *This is the number of fuel steps expended for each burn entered, rounding up any fractions at the end of the move.

Example: The NASA crew has a (terrible) fuel consumption of 6, representing its SSME chemical engines. It must move its fuel figure 6 steps to enter each burn!

Example: An ion drive thruster (output 2 • 1/2) expends half a step for each burn entered. If it enters one burn in a turn, half a step is expended, which is rounded up to one step to the left.

➤ **Fuel Economy** [expanded game]. Some space-built reactors have a *triangle* (2.5G) that halves or quarters your fuel expenditure, if used in *support* of a thruster.

C. COASTING. You may continue to move after entering your maximum number of burns, if not *dry* (6.1B) and you don't *Hohmann pivot* or enter another burn. See examples on pg 24.

6.3 HOHMANN PIVOT (Brachistochrone)

If during your move you wish to make a **Hohmann pivot**, you must burn fuel equal to entering 2 burns. These burns count against *acceleration* (6.1). See the examples on pg 24. **Turning is free in circular spaces (L-points and burns).**

6.4 ROCKET LANDING AND BLAST-OFF

A. LANDING PREREQUISITES. Entering a site hex lands on a world. To do so, you must satisfy two conditions:

- You must spend enough *lander fuel* (6.4C).

➤ **Synodic Comets** [Expanded Game]. If the site has a *colored border* (2.2C), the Sunspot Cycle *sector* must be the same color per 8.5C.***

B. CLAIM JUMPING. To **claim jump**, land on the claim of another player, and immediately replace the claim disk with one of your color. Your rocket must have a crew, and the site must not have cubes or be defended by crew. Claim jumping is *felonious* (2.3B).

Note: It is not a felony to merely land on another player's claim or factory.

Example: Both NASA and PRC have an unmanned rocket on Enke's comet. NASA prospects successfully, placing a white claim disk. On his turn, the PRC feloniously decommissions his refinery and robonaut to industrialize the claim, replacing the NASA disk with a red disk and a red cube.

C. LANDER FUEL PENALTY. If you enter or leave a site hex, you must move your *fuel figure* to the left a number of spots equal to the site's *size*. This simulates fuel used by a chemical lander going to or from the surface. **This penalty costs fuel only, and does not count against your acceleration.**

- Direct landing. You may avoid burning lander fuel, for landings and lift-offs, if you have a *modified thrust* (6.1A) greater than the site's size.

- Signposts. The lander fuel required for a trip is shown on the *signposts* (5.4E). The number in the lander silhouette is the

number of fuel steps needed, assuming the thrust is too low for a direct landing.

Example: A rocket with a modified thrust of 3 lands on Nysa (size 3). Its fuel is decreased three steps. On its next turn, it reduces its dry mass (by dropping off a refinery on Nysa), which increases its modified thrust to 4 per 6.7A. It can blast-off without burning fuel.

D. LIFT OFF. A rocket on a site hex has three options for exit:

1. *Ascent Stage Lander Fuel. Burn lander fuel per 6.4C to exit and continue moving. (Lift off is free if modified thrust is greater than the site's size.)*

Note: You may not take an aerobrace path (6.4F) when lifting off.

2. *Suborbital Hop. If a world has sites joined by a dashed yellow line per 5.6B, you can hop to one of them if fueled. Unless your modified thrust is greater than the size, pay the lander fuel penalty (6.4C).*

3. *Decommission the rocket stack per 6.7.*

E. CRASH HAZARD. When entering a **crash hazard** L-point (marked with a skull), roll the die. A "1" = spacecraft **decommissioned** (6.7).

F. AEROBRAKE HAZARD. When entering an **aerobrace hazard** L-point (marked with a parachute), roll the die. A "1" = rocket **decommissioned**.

• Aerobraking. If you follow an aerobrace path to land on a site hex, you avoid burning any *lander fuel* (6.4C). (But still must burn fuel for entering burns.)

• Sails. A *sail* card entering an aerobrace hazard is **decommissioned**.

Example: A sail spends its 1 burn to enter the Mars HEO (highly eccentric orbit). It then coasts to the aerobrace hazard. The sail card is decommissioned, but the rest of the stack parachutes onto Mars.

• Atmosphere Scooping. A rocket carrying the Atmospheric ISRU Scoop refinery [plus its supports, in the expanded game] may perform aerobrakes without risk. It can also perform a **Refuel Operation** on an aerobrace space, which adds as many tanks of fuel as the rocket can carry. You are scooping and liquefying the atmosphere to use as propellant.

G. FAILURE IS NOT AN OPTION. You may avoid making a crash or aerobrace hazard roll by paying 4 WT **before the roll**. (Represents a software upload.)

6.5 SAIL MOVEMENT

Two thruster cards are **sails**, huge gossamer films propelled by the sun (solar photons, solar wind, or solar magnetic field). Sails move as a rocket with a fuel consumption of zero. The only fuel needed is *lander fuel* (6.4C).

Note: Sails modify their thrust per 6.1A. See the example on page 24.

Example: A sail with a mass of 1 takes on cargo with a mass of 6. The total dry mass is thus 1 + 6 = 7. Place the fuel figure in the empty position of the "7 dry" row (it's flying without any fuel). If it has a thrust of 1, it would be fully loaded, since it cannot take on any more mass or fuel without going into freighter class, which modifies its thrust to less than 1.

A. ATMOSPHERIC DRAG. If a sail **aerobrakes** (6.4F), **decommission** its sail card.

6.6 FREIGHTER MOVEMENT

A **freighter** is a cube representing a **factory product card** (5.8) or crew (6.7B) with a steam engine.* It moves as a rocket with a modified thrust of one and a fuel consumption of zero; see the example on page 24.

• A freighter can't land except at a factory. It can't **aerobrace** or **slingshot**. A freighter may only lift off a site hex of size 1 or a site hex with a factory.

• Freighter fuel is not tracked (assume it reaches its destination dry).

➤ A freighter rolls per 8.3C when entering a **radiation belt** [expanded game].

• A rocket may merge with a freighter if the rocket starts or ends its move on the freighter's space. Modify **dry mass** per 6.7A.

6.7 CARD DECOMMISSION

You may **decommission** (return to your hand) one or more cards freely as part of any operation. This includes crew. Decommissioning also occurs during free market, industrialization, hazards, flares, radiation belts, and combat. **Decommissioning returns cards to your hand, where they can be reused.**

A. DRY MASS ADJUSTMENT. If cards are added or subtracted from your **rocket stack**, the mass gained or lost affects your **dry mass** (5.4B). This takes effect on your next move. Move your fuel figure to the row corresponding to the new dry mass, keeping the number of tanks constant. If the fuel figure is on a spot that is between fuel tanks, it must follow the dashed line when moving to its new dry mass row as shown.

DROPPING OFF CARGO

Example: Your rocket, with an initial dry mass of 4, has a fuel figure positioned as shown. It drops off cargo with a mass of 2. The fuel figure moves up to the new dry mass of 2, following the dashed arrow, as shown.

B. CREW DECOMMISSION. It is **felonious** (2.3D) to voluntarily decommission crew anywhere except at your ET factory or LEO.

• Space Colony. Decommissioning crew at any factory adds an extra cube at the site to represent a **Space Colony**. Each cube is worth a VP per 7.1.

• Rescue Pod. If a stack is decommissioned except for crew, convert it instantly into a **freighter** (6.6). Move the crew card into the freighter slot (decommission any card there), and put a cube on its map location.

➤ C. RADIATOR DECOMMISSION. If a "heavy" radiator is decommissioned, reorient it to its light version per 2.6H instead of returning it to your hand. This rotates the card 180° and adjusts dry mass per 6.7A. "Light" radiators are decommissioned normally.

D. OUTPOST. You can convert your rocket or freighter into an **outpost** by exchanging its figure for a disk. All fuel is lost, and the cards are moved into the outpost slot. This frees you to build a new stack elsewhere. Outposts are also started by **boosting** (5.1) or **ET production** (5.8).

- Outpost Disk. Mark the outpost location with a disk of your color. If at a site, stack the disk on the claim disk.
- Coalescence. Collocated stacks can merge at the start or finish of a rocket's move. Replacing the outpost disk with a rocket figure converts the outpost back into a (dry) rocket.

7.0 WINNING THE GAME

7.1 VICTORY CONDITIONS

At the *end of the game*, every cube or disk of your color on a map site awards 1 **victory point** (VP), regardless if it's a claim, colony, or factory. (Remove all outposts and freighters prior to scoring.) Additional VP are awarded as follows:

- Each *ET factory* (1 or more of your cubes on your claim) awards the VP listed on its *Resource Exploitation Track* (2.4B).
- Each cube on a *Space Venture* (7.2) awards the VP indicated.
- Glory. The first to land a crew on Mars, Mercury, or any science site, and safely return them without using a *rescue pod* (6.7B), places a cube in the **Glory Arena** (+3 VP ea.). If you are the first to return crew from any site, additionally place a cube in the "any site" space.
- Science Sites. Each claim at a microscope icon (^) is +2 VP.
- Space Government [expanded game]. If the *political disk* (3.2A) is on a spot of a player color, it awards him the VP indicated.
- Tiebreaker. In case of ties, the one with the most WT wins.

7.2 SPACE VENTURES

The first player to claim three **S**, **V**, or **M** sites (and pay the WT listed), instantly places a cube in the corresponding zone in the map corner. You may remove *glory cubes* if necessary for this. **Space Tourism** allows you to perform two operations per turn instead of one. **Space Elevator** allows you to use the route marked "space elevator" between LEO and L2.**

Note: D worlds cannot be used for space ventures.

Endgame example: The red player ends with claims on the V worlds of Mercury, Vesta, and one of its moonlets. He also has a factory on Mercury, which is worth 8 VP on the Exploitation Track. He has 3 disks and 1 cube on the map, plus a cube (worth 7 VP) on Space Tourism. His total is 8 + 3 + 1 + 7 = 19 VP.

7.3 THE END OF THE GAME

- 2 Player Game. Game ends as soon as 4 factories are built.
- 3 Player Game. Game ends when 6 factories are built.
- 4 or 5 Player Game. Game ends when 7 factories are built.

A. PAVING TO END THE GAME. If a player has 3 ET factories built, or cubes in at least 2 *space ventures* (7.2), he may end the game by spending his turn paying 5 WT.

- B. FINAL REGIME. The phasing player automatically initiates an *election auction* (8.5B) at the end of the expanded game.

8.0 THE EXPANDED GAME

8.1 EXPANDED GAME COMPONENTS (purchased separately)

- 1 Expansion Map.
- 1 Thruster Patent Card (The touchy metastable helium rocket).
- 9 Generator Patent Cards. Two kinds: *electricity*, or *pulsed power*.
- 7 Reactor Cards. Three kinds: *neutronic*, *burst plasma*, or *exotic catalysts*.
- 7 Radiator Cards. Each provides one to three *therms* (<>) of cooling.

8.2 SUPPORT CARDS

Some cards list **support cards** (reactors, generators, and/or radiators) in their red *data field* (2.6C). The card can't be used (for movement, prospecting, refueling, industrialization, etc.) without these support cards. The support cards themselves also will often need supports.

Important: When industrializing a site in the expanded game, you will need to decommission not only the refinery and robonaut cards, but also all of their supports, and also all supports of those supports.

Exception: You never need to decommission radiators to industrialize a site (because the night side of the site itself acts as a radiator).

A. OVERHEATING. Some cards indicate a number of **therms** (the ^ icon) of radiator cooling required to keep from overheating. For instance, if your rocket stack altogether needs 3 therms of cooling, you will need one or more **radiators** that add up to at least 3 therms.

Important: Heat rejection is necessary only if the card is in use. If in a turn, a thruster system does not move, or a robonaut system does no prospecting or refueling, then they don't need radiators that turn.

Note: A radiator can be boosted in a light or heavy variant, per 2.5G.

Remember: Afterburning provides 1 therm of cooling per 6.1A.

Example: The Free Electron Laser robonaut needs the two supports shown. For its generator, it carries the In-Core Thermionic, which itself needs a reactor (either o or n) plus another three therms of radiators. The Pebble Bed Fission reactor is added to the stack, plus a heavy Ti/K heat pipe, and a heavy bubble membrane (each able to reject two therms of heat). The complete robonaut stack has these five cards: 1 robonaut, 1 generator, 1 reactor, and 2 radiators. Its dry mass is 8.

B. SHARING SUPPORTS. Thruster, robonaut, and refinery systems may share generators, reactors, or radiator supports. For instance, a single generator may serve **both a robonaut and a thruster.**

Example: A fuel cell generator (e output) can power an electric thruster during a move, and an electric robonaut during the subsequent prospect operation. If on the next turn, the robonaut

plus an electric refinery are consumed to industrialize the site, the fuel cell is decommissioned as well to power both of them.

C. FACTORY SUPPORTS. An ET factory provides e, , and ^^^ support to all collocated cards. (This is useful during combat.)

➤ 8.3 ADVANCED ROCKET MANEUVERS

A. SLINGSHOT A rocket or sail that enters a flyby L-point can perform a **slingshot** maneuver, giving it a number of free *Burns* (6.2A) up to the planet's **slingshot rating**. These are used during the remainder of its move. For instance, after entering the Earth flyby, you may go an extra two burns that do not count against your acceleration and cost no fuel. See example on page 24.

- The Venus flyby bonus may only be used during the blue *sector* (8.5B).

B. MOON BOOST. Entering this flyby gives you one extra burn for no fuel or acceleration cost, just like a slingshot.

C. RADIATION BELT. Four worlds (Sol, Earth, Jupiter, and Saturn) are surrounded by a purple dashed line indicating a **radiation belt***. When entering a **radiation belt L-point**, find its **radiation level** by rolling 1d6 and subtracting the spacecraft *modified thrust* (6.1). All cards in the stack with a *rad-hardness* (2.6C) lower than this modified roll are *decommissioned*. This may halt the spacecraft on this spot; see example 8.9.

Example: The green route to Enceladus passes through 7 radiation belts.

- Solar Active Year. If the *sunspot disk* (3.2A) is in the red *sector*, add 2 to the radiation levels of all radiation belts.
- UN Cycler. The UN (purple) player may make any spacecraft he designates immune to the radiation effects of the Earth belt.
- Sail Bonuses. Sail cards are immune to damage from radiation belts and solar flares. The Mag Sail receives a +1 thrust bonus for each radiation belt it crosses in a move.

Example: A rocket with a modified thrust of 2 moves from LEO to GEO, crossing the Van Allen belt. A "3" is rolled, so the radiation level is 3 - 2 = 1. The rocket's solar panels (rad-hard = 1) are decommissioned, and without power, its electric thrusters stop working. Having failed to reach GEO, the stack may be left in HEO as an outpost, or else entirely decommissioned.

{Note: D and E below may be used in the Basic Game}

D. JETTISONS. By **jettisoning** fuel or cargo, your rocket decreases wet or dry mass and so improves its *modified thrust*.

- Cargo Jettison. If you jettison a card, it is *decommissioned*. Decrease the stack's *dry mass* by following the procedure of 5.6A.
- Propellant Jettison. You may jettison water by simply moving your rocket's fuel figure to the left the desired number of steps.

E. DIRT AS PROPELLANT. The "dirt bucket" icon on a thruster card allows a rocket to use **regolith** (space dirt) as propellant. A rocket with this icon can do the *refuel* operation at any site hex, adding as much fuel as it can carry, regardless of ISRU!

- Phileas Fogg Tactic. Besides regolith, these thrusters can use decommissioned cards as fuel (the machinery is ground up and fed into the engine hopper). Each mass point adds a tank of fuel.

Regolith collected by mass drivers and other "dirt rockets" is treated as water for all game purposes.

F. INITIATING COMBAT. If the political disk is in *war* (8.6), you (non-freighter) stacks may initiate combat per 8.4 at the end of your movement phase against other cohabitating stacks or factories.

- **Interception.** Also during war, your stacks or ET factories may initiate combat against any spacecraft which exit your space during their movement phase. If such spacecraft are operational after the combat, they may complete their move normally. See the example on page 11.

➤ 8.4 COMBAT PROCEDURE

Combat may be initiated per 8.3F, and proceeds as follows:

- (1) The defender attacks first with each of his rayguns per 8.4A.
- (2) Attacker attacks with each of his rayguns per .4A.
- (3) Defender may attack with any or all of his missiles per 8.4B.
- (4) Attacker may attack with any or all of his missiles per 8.4B.
- (5) The player with the higher modified thrust (if any) may attack with any or all of his buggies per 8.4C.

Note: A robonaut can't attack if any of its supports are decommissioned.

- LEO security zone. No combat is allowed in LEO.
- Crews in rescue pods (6.7B) can't attack and have a rad-hardness of 0.
- Certain cards, as noted on the card, have special combat rules. A rocket carrying the Project Orion reactor or the n-6Li microfission thruster is immune from missiles (it can launch fission bombs towards anything that approaches, and has a shield designed to survive nuclear blasts.) Mass driver or MPD T-Wave thrusters may attack as robonaut rayguns rolling 2d6 instead of 1d6.

A. RAYGUN ATTACK. Choose a single card in the defending stack, or factory cube, and roll 1d6. If the result is greater than its *rad-hardness*, it is *decommissioned*.

B. MISSILE ATTACK. Roll 2d6 and apply the sum against each card in the stack, or against each factory cube (see below). A sum greater than its *rad-hardness* (2.6C), will *decommission* cards or discard cubes. **Any missile card used to attack is decommissioned!**

- Kamikazes. A missile needs no lander fuel to attack a site hex, assuming it is entirely consumed in the attack. Missile crews are allowed to make suicide attacks; see Year 25 on page 11.

C. BUGGY ATTACK (Piracy). Roll 2d6. The buggy attack succeeds if the sum is greater than 8 if an opposing crew is present on the space, or 6 if an opposing robonaut is present or if the target is a factory, or 4 if there are no opposing crew or robonauts present. If the attack succeeds, choose a white card from the target stack to steal to your stack, or a black card or crew to decommission. If the target is a factory, remove one cube (see 8.4D).

Factories with more than one cube are considered crewed, see 6.7B.

Note: A buggy may not attack unless the modified thrust of its rocket stack is greater than the modified thrust of its opponent.

D. FACTORY COMBAT. Each (non-freighter) cube on a factory fights as a robonaut raygun with a rad-hardness of 8.

- **Factory Destruction.** If all factory cubes at a site are lost, the factory is destroyed, the associated factory product card is immediately re-inverted to its white side and placed into its owner's hand, and the appropriate Resource Exploitation Track is increased by one step.

Example: Project Orion lands on a 2-cube factory at an M site. The defending cubes fire first, targeting Orion's missiles. But one missile survives, rolling a 9 which removes both cubes (but not the claim). The M factory product reverts to its white side, and the M resource Exploitation Track is lowered one step.

Factory Capture. If a factory's last cube is removed by a buggy attack, re-invert its factory product card per the preceding bullet, but do not adjust the exploitation track. Instead, remove and replace its claim token and last cube with a disk and cube of your color (demonstrating that you have captured the factory). You may later perform an *industrialization* to establish a new factory product.

➤ 8.5 SUNSPOT CYCLE & EVENT TABLE [Expanded Game Map]

A. SUNSPOT CYCLE. This diagram (on the expanded map) is divided into three colored **sectors**. Immediately following each 1d6 **event roll**, **advance the sunspot disk (3.2H) one step clockwise.**

B. EVENT TABLE. If your rocket enters one or more triangle *burns* (2.2A), roll once on the following table after spacecraft move but before operations. Freighters do not trigger event rolls.

1 or 2. No Event.

3. Glitch. You must *decommission* one of your cards that is in a stack without a crew card, if any.

4. Pad Explosion/Space Debris. Every *LEO stack* decommissions its heaviest card. If a stack has ties, the victim chooses one.

5 or 6. Special Event. The event depends on what color *sector* the sunspot disk is in; see the Sunspot Cycle.

- **Blue:** Election Year. An **election auction** is held per 5.2, except that the winner always pays WT to the bowl (never to the auctioneer) and is allowed to move the *political disk* (3.2A) to an adjacent spot (8.6). The phasing player decides how ties are settled.

- **Yellow:** Budget Cuts. Each player (starting with the phasing player, then clockwise) discards a white hand card (if he has any) to the bottom of its corresponding deck.

- **Red:** Solar Flare/Coronal Mass Ejection. Roll 1d6 for *radiation level*, which affects all stacks outside a planetary *radiation belt* (8.3C) or site hex. The radiation level is locally modified by adding the *heliocentric zone modifier* (2.2D), and

the result is compared to the *rad-hardness* (2.6C) of all cards in each stack. Any cards that have a rad-hardness less than the roll are *decommissioned*.

C. SYNODIC COMETS A site hex with a *border color* (2.2C) cannot be entered unless the Sunspot Cycle is in the same color. (This simulates synodic planetary alignment and launch windows.)

➤ 8.6 SPACE GOVERNMENT

The **Space Government** * (expanded map) is divided into the 14 spots listed below. With the exception of **anarchy** and **war**, all these spots reward VP to the player indicated, if the *political disk* (3.2A) is there at the *end of the game*.

Centrist. This is the start location, and has no special rules.

Anarchy (3 spots). All players are allowed to commit *felonious* actions (2.3B). **The PRC (red) player may move a political disk in anarchy into an adjacent war spot as a free action at the beginning of his move.**

War (3 spots). All players are allowed felonious actions and combat

Militarism. No players may perform the *free market operation* (5.3)

Egalitarianism. During an *income operation* (5.1), take 1 WT from a player who has more WT than you, instead of from the pool.

Antinuke. No reactor patents are allowed in the hands of any players. Discard them to the bottom of the reactor deck.

Nationalism. Only NASA (white) may perform the *income operation* (5.1).

Paleoconservatism. Only NASA (white) is allowed to initiate a research *auction* (5.2).

Capitalism. During an *income operation* (5.1), a player receives as many WT as the number of factories he owns.

Note: An election per 7.3B is automatically held at the end of the game.

➤ 8.7 EXPANSION SCENARIOS

A. SPACE RACE (2 to 5 players). The winner is the first to land a crew on Titan, and return them to LEO (in a rescue pod or rocket).

B. ALIEN INVASION (3 players). The red player is an alien race based on Titan. The two human players must find a way to cooperate against the vastly superior aliens.

- **Titans.** The Titan player has no crew card (thus is vulnerable to glitches).

- **Research.** Research auctions are conducted like *election auctions* (8.5B) with the winning bid always going into the pool. The Titans must use the black side of its cards researched.

- Titan Water tank orbital depot. Titan boost operations and WT start in the **LTO** (Low Titan Orbit) burn instead of LEO.
- War. All players can attack and perform *felonious* actions (2.3B).
- Factories. No factories allowed on **D** worlds or any of Saturn's moons.
- End of Game. The game ends if the Titan rocket enters LEO, or if the Earth rocket enters a site hex on Titan.
- Victory Conditions. Each player gets 1 VP for each **S** factory (military base) and 5 VP for an outpost with at least one operational robonaut in the Rabbit hole L3 point in the Mercury zone.

C. HERMES FALL SOLITAIRE GAME. The Earth is threatened by the binary asteroid Hermes [expanded map], which has been calculated to impact in 19 turns. You must decommission a refinery (or mass driver thruster) plus its supports on both of them, before the sunspot disk enters the yellow sector for the third time. (The refineries represent mass drivers that gradually deflect the path of the twin asteroids away from Earth.)

Revised Sequence of Play. Set-up per 3.2 as any faction.

1. Move your rocket or rockets. You may have up to two.
2. Pick one operation. For research, pay 2 WT to buy a card off the top (comes with *supports* per 5.2), or 1 WT to buy one unseen off the bottom (does not come with supports). Ignore *bid limits* (5.2A).
3. Make an *event roll* and then advance the sunspot disk one step.

- Election Event. Instead of *elections*, this event removes the top card of one of the six stacks from the game. Roll 1d6 to see which one.
- New Privileges. The Shimizu privilege is to pay an extra WT during a research operation to advance a hand card to its black side (which can be boosted at LEO in this variant.). The UN privilege is to start with 10 WT. He also has his *cyclers* (8.3C). The PRC starts with extra cards per 3.3. The other two privileges are unchanged (as per 2.3B).

9.3 GAME SCALE

- Every **turn** is one Earth year.
- Every **Crew card** is an eight-man crew with life-support. See *crew* glossary entry.
- Each **mass** point is a *quadecaton* (40-tonnes, or 40,000 kg).
- **Fuel consumption** is inversely proportional to a rocket's **specific impulse** in seconds as follows: 6 = 4.6 km/sec (460 sec Isp), 4 = 10 km/sec (1000 sec Isp), 2 = 20 km/sec (2000 sec Isp), 1 = 40 km/sec (4000 Isp), ½ = 80 km/sec (8000 sec Isp), ¼ = 160 km/sec (16,000 Isp).
- A **thrust** of one is 0.75 kN (750 Newtons, or 169 lbs., the weight of the game designer on Earth!). Each additional point doubles this.
- An **acceleration** of one is 0.38 milligees or 0.38 cm/sec², and each step more doubles this.
- A **size** one world has a surface gravity of 0.75 milligees, and each additional step doubles this. Size 1 worlds have the following diameters based upon density: comet nucleus 52 km (only Centaur comets approach this size), **S**-type asteroid 22 km, **M**-type asteroid 14 km.
- Beamed power emits a 60 MW laser beam. Generators produce 60 MW_e of electricity. Reactors produce from 650-

2000 MW_{th} of thermal energy, either in neutrons, pions, or plasma jets. Each therm generates 120 MW_{th} of heat. (Subscript e = electricity, th = thermal).

- Each **burn** requires a **delta-v** (velocity change) of 2.5 km/sec. Each **brachistochrone** is 5.0 km/sec.

➤ A solar flare die roll of 1 is an M1 flare with an X-ray power density of 10⁻⁵ Watts/m². Each point more is 4 times this. Thus, a die roll of 6 is a X95 (Carrington-class) flare with a power density of 10⁻² Watts/m².

➤ Equipment with a **rad-hardness** of 1 can withstand a total ionizing dose of 4 X 10⁻⁷ krad (Si) without failing. Each point more is 4 times this. For example, equipment with a rad-hardness of 5 can survive a Mrad of dosage. These numbers are actual industry ratings.

- Solar insolation is 1.38 kW/m² at 1 AU (1 AU = Earth-Sol average distance). Maximum sailing thrust is 12.2 N/km² from photon pressure at 1 AU, or 0.002 N/km² (2 nPa) from solar wind dynamic pressure. These values are in the Earth zone. Each zone closer to Sol doubles them.

- Each **water tank** (WT) is a 40-tonne bag with a diameter of 4.25 meters. Some rockets use hydrogen as propellant; 40-tonnes of LH₂ or slush hydrogen is held in a cryo-tank cylinder 7.5 meters in diameter and 16 meters long, including active refrigeration for zero boil-off.

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Sierra Madre Games, 2010