LORDS OF THE EARTH

The Space Age

A Future Rules Supplement

"A few people laughed, a few people cried. Most were silent. There floated into my mind, a line from the Bhagavad-Gita*…'I am become death, the destroyer of worlds.'"*
Robert Oppenheimer, Trinity, July 16, 1945

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1. INTRODUCTION

1.1 THE SPACE AGE

This booklet is a supplement to the **Lords of the Earth** Basic and Modern Age Rulebooks, which are required for play.

The title of this supplement uses the very broad definition of the "Space Age" to describe a period from roughly the middle of the twentieth to the middle (perhaps) of the twenty first century. The main foci of these rules are new culture types: Industrial Two (**I2**) and Industrial Three (**I3**).

In **Lord of the Earth,** the 'arrival' of nations at Industrial culture status and the levels of Technology prevalent in these periods is governed by their accumulation of Tech Points during the previous periods. During the Industrial it is very likely that there will be a mix of national types — Nomadic, Civilized, Barbarian, Renaissance, Industrial One, Seafaring, possibly even pre-Columbian. As things progress, however, the nations less well endowed with technological prowess will find themselves facing a stiff struggle to survive in the face of nations that will gain the capability to span the seas, field armies of hi-tech infantry and tanks backed by air and later space power. This trend becomes even more pronounced during the Industrial period, as nations with access to internal combustion and nuclear technology will have a dramatic advantage over their less advanced brethren.

These are times of tremendous change; of the birth of world-girdling trade empires, the dramatic development of colonialism, of empires that initially span continents and then encounter difficulties in ruling over vast polyglot peoples. Warfare and economics change, banking changes — becoming international in scope. A worldwide web of interconnected economies form, develop and metastasize, eventually to expand beyond the bounds of Earth itself.

It is a time of new dreams, hopes, nightmares and disasters. New technologies appear, to be exploited and misused, bringing new challenges and new catastrophes. Players will have the opportunity to exploit these changes or may fall victim to them.

The survivors may inherit the stars or a blasted post-apocalyptic world.

1.2 THE NEW MAPS

With the introduction of spaceflight, the new high frontier also requires a map of the Earth-Moon system, linking to the rest of the solar system. At Industrial Two and Three satellites and space stations can orbit the Earth, and the first missions be made to Moon and even to Mars.

Human exploration of the Earth itself extends to the poles and a map of Antarctica is required.

See Section 4 for the new maps.

1.3 DESIGNER NOTES

The Lords of the Earth strategic environment expands to include both near space as satellites and space installations become possible, and the ocean depths. Earth orbit becomes the new high ground, whilst nuclear submarines lurk in the oceans waiting to unleash their deadly cargo. Energy production and dependence become a new factor limiting or increasing national economies.

With the expansion of the game world into the ocean beds, Antarctica, Earth orbit, Earth-Moon space and eventually towards the other planets of the Inner Solar System game play is liable to become increasingly complex. This is offset to some degree by the decreasing Years per Turn, down to a period of one month by TL20. Ultimately, it may be necessary to shrink the Lords Earth Map as the scale of play expands into the Solar System.

The projects and technologies at each Tech Level up to TL20 are either based on real world applications or applications that could have been developed. Beyond TL20 projects are extrapolations of proposed technologies and enter the realms of science fiction.

The GM of a campaign can move certain projects from one TL to another, delete projects entirely or add new campaign-specific projects. Not all project paths are linear; there are a number that can be obtained through different routes.

In the areas of ships, aircraft and AFVs, development appears to end with TL16. In writing this supplement it has been assumed that improving QRs represent the majority of improvements and innovations in these fields. Some specific enhanced capabilities are applied through projects such as Command and Control, Naval and Land Point-Defense and Battlesuit. Projects mostly represent entirely new technologies or significant technological steps.

Given the expense and variety of developing technologies it is unlikely that any but the richest and most powerful nations could practically consider investing and achieving most of the project paths. This means that there is liable to be a divergence between national capabilities and a growing importance in the sharing and export of technologies. The gulf between nations will increase, as some enjoy the benefits of Industrial Two or Three, whilst others remain mired in Industrial One.

This supplement introduces one-use units. These include nuclear bombs and warheads, and the majority of rockets. These units are expensive to develop and build and once deployed are lost. Some units, such as ICBMs, SLBMs, MIRVs and cruise missiles implicitly include a nuclear warhead. Others, such as the various types of early rocket are dual purpose; they can be used to deliver a separate nuclear warhead or a cargo into orbit, to emulate the history of rocketry.

A number of highly destructive units are introduced. In the event of a limited or major nuclear exchange it is likely that significant damage to the game world will result, up and including an end game scenario. Even in a limited nuclear war, it is possible that a nation may be obliterated or suffer serious consequences including loss of bureaucracy, infrastructure, reduced population, agricultural and energy production and reduced Tech Level.

1.4 GLOSSARY OF TERMS

The following terms are pertinent to this Supplement. A further list of more general terms and concepts is found at the beginning of the **Basic** and **Modern Era Rulebooks**.

- **Aerostat:** A lighter than air craft, usually tethered.

- **Anti-Ballistic Missile:** Any antimissile system designed to counter ballistic missiles. However the term is more commonly used for ABM systems designed to counter long range, nuclear-armed intercontinental ballistic missiles (ICBMs).
- **Antipodal:** A location on the opposite side of the globe.
- **Arcology:** A massive city built in three dimensions reducing urban sprawl and the ecological footprint of the city.
- **Asteroid:** A large piece of space debris. The greatest concentration are found in the Asteroid Belt beyond Mars, but a significant number orbit the sun closer in and include a number of families of Near Earth asteroids.
- **Asteroid Fortress:** An asteroid moved to a useful location and converted into a fortress. These have the benefit of intrinsic 'wall points' derived from the rock itself.
- **Asteroid Habitat:** An asteroid moved to a useful location and modified to allow the core to be used as a space colony.
- **Ballistic Missile**: A ballistic missile follows a prescribed course that cannot be altered after the missile has burned its fuel, its course is governed by the laws of ballistics. In order to cover large distances ballistic missiles must be launched very high into the air or in space, in a sub-orbital spaceflight; for intercontinental missiles the altitude halfway is ca. 1200 km. When in space and no more thrust is provided, the missiles are freefalling.
- **Battlesuit**: A battlesuit is an advanced armored suit with mechanical and electronic mechanisms designed to augment the wearer's abilities.
- **Biological Warfare:** The use of bacteria, viruses or other disease-causing organism as a weapon. Also known as germ warfare.
- **Bioweapon:** See Biological Warfare.
- **Cargo Mass Points:** The size/mass of asteroids and material mined from the Moon or an asteroid.
- **Chemical Warfare:** Warfare employing the toxic properties of chemical substances to kill or incapacitate an enemy.
- **cNFP:** Space construction NFP derived from processed asteroid and lunar material.
- **Combat Leader**: The Leader of an Army, a Fleet, Air Wing or Flight based on an Army Operations Point, a Naval Operations point or an Air Operations point.
- **Cybernetics**: The study of systems and control – and in the context of this supplement Artificial Intelligence.
- **Cycler**: A space station that follows a resonant or near resonant trajectory between the orbits of two celestial bodies.
- **Delta-V:** Change in velocity, the amount of "effort" needed to carry out an orbital maneuver, provided by a propulsion system.
- **Disinformation:** Deliberately false information provided to mislead an enemy. It may distort true information in such a way as to render it useless.
- **Electromagnetic Pulse**: (EMP) The electromagnetic radiation from a nuclear explosion.
- **Engineering**: The ability of Industrialized nations to use Siege Engineer units to assist in the construction of various national projects.
- **Exoatmospheric**: Outside the Earth's atmosphere.
- **Factories** and **Yards:** The facilities that enable Industrialized nations to build modern steam and diesel powered air, warship and submarine units as well as nuclear warheads and rockets.
- **Farside:** The lunar hemisphere that is permanently turned away from the Earth. This face is not visible because the rotation of the Moon about its axis is synchronized with its orbital period.
- **Geostationary Orbit:** A circular orbit directly above the Earth's equator (0º latitude).
- **Geosynchronous Orbit:** A geocentric orbit that has the same orbital period as the sidereal rotation period of the Earth. It has a semi-major axis of 42,164 km (26,200 miles). In the special case of the geostationary orbit, an observer on the ground would not perceive the satellite as moving and would see it as a fixed point in the sky.
- **Gravitational Sling-Shot:** A mechanism for transferring energy from the orbit of a planet to a passing spacecraft. Some of the planet's momentum is transferred to the spacecraft as it passes by during a close approach.
- **Helium3:** a light, non-radioactive isotope of helium; rare on Earth and sought-after for use in nuclear fusion. More abundant helium-3 is thought to exist on the Moon (embedded in the upper layer of regolith by the solar wind over billions of years). This resource becomes important at Industrial Four.
- **High Earth Orbit:** (HEO) in these rules is an orbit beyond Geosynchronous Orbit. (In normal usage it is an orbit above LEO.)
- **Hohmann Orbit:** An orbital maneuver moving a spacecraft from one circular orbit to another using two engine impulses.
- **Icebreaker:** a special purpose ship designed to move and navigate through ice-covered waters.
- **Intercontinental Ballistic Missile:** (ICBM), a very-long-range (greater than 5,500 km or 3,500 miles) ballistic missile typically designed for nuclear weapons delivery, i.e., delivering one or more nuclear warheads. It uses a ballistic trajectory involving a significant ascent and descent, including sub-orbital flight.
- **Interplanetary Transport Network**: A set of transfer orbits between various planets and moons in the solar system. These transfers have particularly low delta-v requirements, and appear to be the lowest energy transfers.
- **Kinetic Energy Weapon**: (KEW) Usually an inert projectile launched either from a lunar mass-driver, an orbital coilgun or from Earth orbit, where the destructive force comes from the kinetic energy of the projectile impacting at very high velocity. The largest releases energy on impact with the ground comparable to a small nuclear weapon (without the radioactive fallout) or very large conventional bomb.
- **Lagrange Points:** Five positions in interplanetary space where a small object affected only by gravity can theoretically be stationary relative to two larger objects

(such as a satellite with respect to the Earth and Moon). They are analogous to geosynchronous orbits in that they allow an object to be in a "fixed" position in space rather than an orbit in which its relative position changes continuously.

- **Lander:** Type of spacecraft which descends to come to rest on the surface of an astronomical body. In the context of this rulebook a space vehicle used to descend and ascend from the Moon or to dock with an asteroid.
- **Line of Communication**: A series of contiguous, controlled land regions or Sea Zones reaching from the national Capital to an outlying province. If the LOC is traced by sea, then it must go through a controlled, un-blockaded Port City before it may enter/exit a Sea Zone.
- **Low Earth Orbit:** (LEO), an orbit around Earth between the atmosphere and the Van Allen radiation belt, with a low angle of inclination. These boundaries are not firmly defined but are typically around 200 - 1200 km (124 - 726 miles) above the Earth's surface. This is far below geostationary orbit.
- **Lunar Outpost:** a small installation on the Moon, equivalent to a port fortress.
- **Mag-Lev**: Magnetic levitation, the process by which an object is suspended above another object by magnetic fields. The electromagnetic force is used to counteract the effects of the gravitational force. Mag-Lev systems are particularly attractive for use on the Moon as there is no atmosphere on the surface to slow down the train.
- **Maria:** The lightly cratered basaltic plains of the Moon concentrated on the Nearside.
- **Mass-Driver:** A magnetically accelerated mag-lev rail used to accelerate cargo from the Lunar surface to be picked up from orbit or elsewhere in Earth-Moon space. A mass-driver can also be used as a cheap way of moving an asteroid to a useful location by using the dust and rock of the asteroid itself as reaction mass.
- **Misinformation:** Information that is incorrect, but not because of any intentional attempt to mislead.
- **Moon Base:** A large permanent habitat on the Moon, usually at least part dug into the lunar regolith. Effectively a port city on the Moon, the base can host lunar mass-drivers.
- **Multiple Independently targetable Re-entry Vehicle:** (MIRV) A re-entry vehicle which is a collection of nuclear warheads carried on a single ICBM. Using a MIRV warhead, a single launched missile can strike several targets, or fewer targets redundantly.
- **National Force Points (NFP)**: A representation of the manpower. One NFP roughly equals 400 men.
- **NBC:** Nuclear, Chemical and Biological warfare.
- **Nearside**: The lunar hemisphere that is permanently turned towards the Earth, dominated by the large dark maria.
- **Nuclear**: A new class of weapons deployed by ship, aircraft or rocket.
- **Nuclear Weapon**: A nuclear bomb delivered usually by aircraft or a nuclear warhead delivered by rocket or cruise missile.
- **Powered Armor**: **Battlesuit**: A battlesuit is an armored artificial powered exoskeleton with mechanical and electronic mechanisms designed to augment the wearer's abilities.
- **Regolith**: A layer of loose, heterogeneous material covering solid rock. On the Moon, regolith has been formed by the action of micro-meteroids breaking down surface rocks into a powder.
- **Research Projects** A form of investment for Industrial nations, allowing them to develop new kinds of units, factories and capabilities (once they have achieved certain pre-requisites, particularly minimum tech level). Research projects are measured in numbers of "Advances", and are governed by an investment die roll, much like Quality Ratings.
- **Rocketplane:** In the context of this rulebook an aircraft that uses a rocket for propulsion designed to be carried aloft under the wing of a larger conventional aircraft.
- **Rockets:** A new class of units – long range weapons propelled by the reaction of gases produced by a fast-burning fuel.
- **Satellite:** An *artificial satellite* - a man-made object that orbits the Earth, usually a reconaissance satellite.
- **Shuttle:** In the context of this rulebook a partially reusable space vehicle, including vertical rocket launch and return to earth as an aircraft. A link between conventional rockets and spaceplanes.
- **Slingshot:** See Gravitational Sling-Shot.
- **Solar Power Satellite:** (SPS) A satellite built in GEO orbit that uses low-level microwave power transmission to beam solar power to a rectanna on Earth or the Moon, where it can be used in place of conventional power sources.
- **Soletta:** A gigantic space-based mirror used to reflect light to the Earth or Moon, or a specialized power plant.
- **Space Based Lasers:** Complex and sophisticated anti-ballistic missile using the reaction of hydrogen and fluorine gas and an optical resonator to extract energy from the HF molecules and produce a powerful beam focused on enemy missiles using a large mirror.
- **Space Elevator:** Also known as a beanstalk, orbital tower, space bridge or lift. A space elevator descends from geosynchronous orbit to a location at the Earth's equator and can be used to transport people and cargo up into space without the use of rockets or spaceplanes.
- **Spaceplane:** A rocket plane designed to pass the edge of space. It combines some of the features of an aircraft and some of a spacecraft. In the context of this rulebook it is a fully reusable single stage to orbit vehicle.
- **Space Platform:** a low-gravity habitat usually built as a number of modules. Space platforms are relatively small and act as port fortresses in space.
- **Spaceport**: A new Monolithic Construction that permits the launching of larger rockets.
- **Space Station**: a classic 'wheel in space' rotating to provide gravity. Effectively a port city in space which can provide industrial capacity and be used to host Rocket Factories.
- **'Specialized' NFP**: National Force Points that are "recruited" by Industrialized nations to assist in non-unit construction.

- **Submarines:** A new class of units for Industrial nations with the requisite technology. There are two types of submarine units: the petrol/electric *Submersible* (the *Holland,* for example), and early diesel/electric *Submarine* units themselves.
- **Submarine-Launched Ballistic Missile:** (SLBM) Ballistic missiles delivering nuclear weapons launched from submarines.
- **Tactical Ballistic Missile:** A short range missile with a nuclear warhead, fired from a mobile launcher.
- **Tech Level**: A numeric rating, ranging from one to twenty-five, that expresses the level of technological sophistication and industrial development of a given nation.
- **Tech Points**: An accumulated value that expresses the technological advancement and sophistication of the nation.
- **Terrae**: The heavily cratered highlands of the Moon.
- **Trans-atmospheric:** High-altitude, high-velocity aircraft.
- **Underwater Base:** A port city built underwater, possibly as an undersea dome.
- **Underwater Outpost:** A port fortress built underwater.
- **Warsat**: Space based weapons including sensors and interceptors housed in orbital weapons primarily for use against ICBMs. At higher Tech Levels laser and other exotic weapons may become available.
- **Yard Capacities:** A limit on the number of certain units and projects that can be built by a nation in any given turn. There are two different types of Yard Capacity: First, *Intrinsic*, which is based on cities and trade centers and represents the number of *Heavy*-type combat units that can be built at that location and apply to *all* culture types. Railroad, Mag-Lev Projects and other large construction projects by industrial cultures are also counted against this capacity. Dockyards are required to utilize the intrinsic yard capacity of Port Cities to build certain types of Renaissance ships. Second, *Specific Capacity* which is based on Factories and Yards built by Industrial cultures and apply to the construction of Steamship, Aircraft, Airship, Submarine and Rocket units.

2. THE STAT SHEET

2.1 TECH LEVELS

This statistic describes how advanced your nation is. At this point in time, pre-Colombians are (generally) at the lowest level of technology, Nomads and Barbarian are above that, Seafaring, Civilized, and Renaissance nations are at a middle level and Industrial nations are at the top of the heap.

As the game progresses, the level of technology will increase, and a nation will be able to exploit new opportunities. The advance of technology is the vehicle to change Culture Types and improve military capabilities.

Tech Level affects the following national statistics or ratings specific to the Renaissance and Industrial eras.

- It determines your maximum Trade Range and Conduit Limit ratings.
- It determines your maximum military Quality Ratings.
- It helps define the maximum number of Leaders that your nation can have.

2.1.1 Tech Level Bonus to Tax Rate (Optional)

This change adds the current Tech Level as a modifier to the Base Tax Rate for the nation according to the following formula

(Years per Turn % ×
TaxRateAdjustment × AgroModifier ×
InfraModifier × UW&M (if any) ×
(1.0 + TechLevel/100) = Tax Rate

So for a nation with a TL of 11 the base rate will be multiplied by 1.11 to get the final rate.

Table 2-1. Technology Levels

TechLevel	Culture Types
001	Pre-Columbian / Seafaring
002	Pre-Columbian / Barbarian / Nomadic / Seafaring
003	Civilized / Pre-Columbian / Barbarian / Nomadic / Seafaring
004	Civilized / Barbarian / Nomadic / Seafaring
005 – 007	Civilized / Seafaring
008 – 011	The Renaissance
012 – 015	Industrial Stage One
016 – 019	Industrial Stage Two
020 – 022	Industrial Stage Three

Table 2-2. Tech Level Table

TL	Culture	Notes
1	Precolumbian	Sticks
2	Nomadic	Horseback
2	Barbarian	Agriculture
3	Nomadic	Archery
3	Barbarian	Ironworking
4	Civilized	Literacy
5	Civilized	Medicine
6	Civilized	Crossbow
7	Civilized	Gunpowder
8	Renaissance	Navigation
9	Renaissance	Printing
10	Renaissance	Balloons
11	Renaissance	Steam Engine
12	Industrial 1	Railroads
13	Industrial 1	Combustion
14	Industrial 1	Electricity
15	Industrial 1	Valves
16	Industrial 2	Rocketry
17	Industrial 2	Atomics
18	Industrial 2	Computers
19	Industrial 2	Transistors
20	Industrial 3	Microchips
21	Industrial 3	Spaceplanes
22	Industrial 3	Genetic Engineering

2.2 ECONOMIC INFORMATION

2.2.1 International Trade Value

As in the Basic System, the ITV is calculated by totaling the City Trade Values of all of the cities in your nation. Each CTV is calculated according to the following formula:

City Trade Value (CTV) =
(City GPv / 3) ×
City Type Modifier ×
City Status Modifier ×
Regional Terrain Modifier ×
Cultural Modifier

Note that Renaissance and Industrial nations have a different Cultural Modifier, as noted in the following table:

Table 2-3. National Culture Modifiers

Cultural Type	Modifier
Industrial Four	1.4
Industrial Three	1.3
Industrial Two	1.2
Industrial One	1.1
Renaissance	1.0
Seafaring	0.9
Civilized	0.8
Barbarian	0.7
Nomadic	0.6
Pre-Columbian	0.5

Example:
The Frankish Commonwealth has a port city, Marseilles, which is worth 8 GPv. It is in an allied province, which is cultivated. The Commonwealth is Renaissance. The CTV of Marseilles, then, would be (8/3) = 2.6 × 1.5 × 1.0 × 1.0 × 1.0 = 3.9, rounded up to 4.

2.2.2 Regional Income

As in the Basic System, the formula for figuring out the regional income is as follows:

Regional Value =
Region's GPv × Status Multiple ×
Terrain Multiple

Regional Income (in GP) =
The Sum of Regional Values +
1 (for each Silk Road region controlled) +
2 (for each Fur Line region controlled)

Table 2-4. Terrain Type Tax Multiples

Terrain	Culture							
	I2/3	I1	R	C	B	N	S	P
c2	1.5	1.0	1.0	1.0	1.5	2.0	1.0	1.0
C	1.25	1.0	1.0	1.0	1.0	1.5	1.0	1.0
W	0.5	0.5	0.5	0.5	1.0	0.3	0.5	1.0
M	0.5	0.5	0.3	0.3	0.5	0.2	0.2	0.5
S	0.5	0.5	0.3	0.3	0.2	1.0	0.0	0.2
D	0.2	0.2	0.2	0.2	0.2	0.5	0.0	0.2
T	0.2	0.2	0.2	0.2	0.3	0.0	0.0	0.2
I	0.5	0.5	1.0	1.0	1.0	1.0	1.5	1.0
j	0.2	0.2	0.3	0.3	0.5	0.2	1.0	1.0
o	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
lp	1.0	1.0	-	-	-	-	-	-
lm	0.5	0.5	-	-	-	-	-	-
lt	0.75	0.75	-	-	-	-	-	-

Table 2-5. Terrain Troop Support Modifiers

Terr.	I2/3	I1	R	C	B	N	S	P
M	1.5	1.5	1.75	2.0	1.0	2.0	2.0	1.5
S	1.5	2.0	1.5	2.0	1.5	0.0	2.0	1.5
T	1.5	2.0	2.0	2.0	1.5	2.0	2.0	1.0
D	1.5	2.0	1.75	1.5	1.5	1.0	1.5	1.5
J	1.25	1.5	1.5	1.5	1.0	1.5	1.0	1.0
W	1.0	1.25	1.0	1.5	1.0	1.5	1.5	1.0
C	1.0	1.0	1.0	1.0	1.0	0.1	1.0	1.0
C2	1.0	1.0	1.0	1.0	0.5	0.1	1.0	1.0
I	1.0	1.0	1.0	1.0	1.0	1.0	0.5	1.0
O	2.0	2.0	2.0	2.0	2.0	1.0	2.0	1.5
ai	2.0	2.5	-	-	-	-	-	-
am	3.0	3.5	-	-	-	-	-	-
ap	2.0	2.5	-	-	-	-	-	-
lp	4.0	5.0	-	-	-	-	-	-
lm	2.0	3.0	-	-	-	-	-	-
lt	3.0	4.0	-	-	-	-	-	-

- ai: Ice Shelf
- am: polar mountains
- ap: polar plain
- lp: Lunar polar region
- lm: Lunar maria region
- lt: Lunar terrae region

2.2.3 Monetary Troop Support

This expenditure covers the minimum expenses required for the maintenance of the armed forces of the nation. If less is paid, then those units that are not supported disappear. The Troop Support cost is an easy calculation. Each unit type has a troop support cost defined for it. This much gold must be paid per unit that you have in your armies and garrisons at the *beginning* of the turn, *before* builds. This cost is further modified by the terrain of the region that the units ended the previous turn in, and whether they fought in a battle in the previous turn.

Units that were 'On Campaign' in the previous turn cost double to support. The effects of terrain upon troop support depend on the Society Type of the owning nation and the terrain type that the units ended the turn in.

Generally, Troop support is one-tenth the GPv purchase cost of the unit per turn.

$$\text{Troop Support} = \text{TSC} \times \text{TSM} \times \text{ASM}$$

TSC is the Troop Support Cost (from the Unit Build Chart, see Table 9-2 on page 79).

ASM is the Army Status modifier, from the following table.

Table 2-6. Army Status Troop Support Modifiers

Status	Description	Modifier
A	Administering	1.0
B	Being Besieged	2.0
C	On Campaign	2.0
E	Sneaking Around...	0.0
G	In Garrison	1.5
M	Mutinious!	0.0
N	Normal	1.0
P	Prisoner	0.0
R	Ruling	1.0
S	Besieging A City	2.0

Notes

- A Leader (and his army) has a Status of *On Campaign* if they have fought in ***any*** battle during the previous turn.
- A Leader (and his army) have a status of *In Garrison* if they are the sole units in a Pacified region, and are thus serving as its garrison.

- Leaders on Evade or in Prison cannot command troops. A Mutinous Leader is not counted for Troop Support.

TSM is the Terrain Support modifier, from the table above.

2.3 REGIONS AND CITIES

2.3.1 Regional Garrisons

As in the Basic System, the size of a regional garrison must equal or exceed the Modified Resistance Value of the region. The Modified Resistance Value can be calculated using the following equation:

Modified Resistance Value =
Regional Resistance ×
Terrain Multiple ×
Religion Modifier

Note that new Renaissance and Industrial nation terrain multiples have been added to the following table:

Table 2-7. Garrison Terrain Modifiers

Culture	*c*	*c2*	*w*	*s*	*j*	*i*	*d*	*m*	*t*	*o*
PreColumbian	1	1	1	2[c]	1	1	2[c]	1	2	1
Seafaring	1	1	2	2[c]	2	1	2[c]	2	2	1
Civilized	1	1	2	2[c]	2	1	2[c]	2	2	1
Barbarian	2	2	1	2[c]	1	1	2[c]	1	2	2
Nomadic	1	2	2	1[c]	2	1	1[c]	2	2	1
Rena./Indust1	1	1	2	2[c]	1	1	1.5[c]	1	2	1
Indust2/3	1	1	1.5	2[c]	1	1	1.5[c]	1	2	1

Culture	*ai*	*am*	*ap*	*lp*	*lm*	*lt*
Indust1	2	2.5	2	2	1.5	1.5
Indust2/3	2	2	2	2	1	1

Notes

- All regions requiring a cavalry garrison (those marked with a [c]) can be garrisoned with infantry or field forts in twice the cavalry amount. An exception to this applies in the case of regions where there is no Cavalry in use (pre-Cav Count America, or South Africa).
- All listed numbers are factors that are multiplied by the Region Resistance Value.

2.4 NEW OPERATIONS CAPACITIES

With the Industrial Era and the completion of the appropriate Research and Development projects, a Nation may acquire **Space** Operations capacity and the concomitant Bonus points.

See Section 6.4.2 for the Space action codes, modifiers and descriptions.

2.5 YEAR LENGTH CHANGE

As a campaign progresses, the number of years per turn is reduced to reflect the increasing tempo of events driven by the highest open position Tech Level in play. As the turn length decreases, so too does the Base Tax Rate as well as the costs for support. For example, If your nation is paying 100gp for its various support costs (Government, Troop and so on), then when the turn becomes four years long, you would only pay (100 × 0.80 = 80gp) in support.

The costs to purchase discrete units (infantry points, Public Works, and so on) remain constant, however.

Table 2-8. Years per Turn

Tech Level	Years per Turn	Base Tax Rate
1-7	5	100%
8-9	4	80%
10-11	3	60%
12-13	2	40%
14-15	1	20%
16-17	6 months	10%
18-19	3 months	6%
20+	1 month	2%

2.6 ENERGY PRODUCTION AND CONSUMPTION

In addition to GP and Agro any Industrial position requires Energy (EN). Energy is an abstract of national power – oil, gas, hydroelectric, wind, wave, fission and ultimately fusion. EN surpluses can be traded just like Agro, or stored in national EN reserves.

EN can be traded like Agro – each unit representing oil tankers, pipelines, power cables – by any nations sharing trade routes. EN can only be moved by a Leader by sea, each unit requiring a modern transport, or by railroad.

Certain regions have an open Regional Bonus for energy production, representing coal, oil or gas reserves. Other regions may have a hidden bonus, which must be found by performing an IL action in the region specifically to find energy reserves. Any Regional Bonus may go up, or be reduced as the available resources are exhausted.

The polar regions become available for exploration, with the possibility of resources within the interior of Antarctica and Greenland.

Note that all Mountainous regions automatically have a regional bonus of 0.5 representing hydroelectric power, but only provide this bonus if a Power Plant (a hydroelectric dam) is built in the region.

2.6.1 Energy Production

EN is generated as a result of a new Monolithic Construction type, the Power Plant, see Section 3.10.1 Power Station. Power Stations can be built in controlled Cities and Regions. A Power Station represents a refinery, storage depot, coal or oil burning power station, and at higher TL a fission or fusion plant. The amount of EN generated by a Power Station is a factor of the position's TL.

At later TL solar power satellites can be built in GEO. These require the building of a terrestrial receiver plant.

2.6.2 Energy Consumption

The EN consumed is based on TL, Imperial Size, Infra and the size of the arny.

An EN famine is similar way to Agro shortages, reducing the tax rate as a result of the implications to industrial and commercial interests. (A shortage of EN does not affect Unit movement as it is assumed that the military always has stores and takes priority of any EN available).

Energy Expenditure is used in both determining the Energy consumed as a result of the size of the nation and by units, representing the level of mechanization in the Armed Forces.

$$EX = \int_{0.125}^{8.0} 2^{TL-X}$$

Where **X** = is the TL set in the campaign where Energy Consumption becomes a significant factor, usually TL16 at the start of Industrial Two.

The level of expenditure is then used to determine the energy consumption of the nation:

$$EC = \left(\frac{S}{10} + \frac{Infra}{3} \right) \times EX$$

Where **EC** is the energy consumed, **S** is the Imperial Size and **Infra** is the nation's Infra rating.

Armies consume energy equal to:

$$EC = \frac{NU}{50} \times TSM \times AECM \times EX$$

Where **EC** is the energy consumed, **NU** is the number of units, **TSM** is the Terrain Support Multiple (see Table 2-5. Terrain Troop Support Modifiers) and **AECM** is the Army Energy Consumption Status Modifier.

Table 2-9. Army Energy Consumption Status Modifiers

Code	*Description*	*Support Multiple*
M	Mutinous!	×0.0
P	Prisoner	×0.0
E	Sneaking Around...	×0.25
A	Administering	×0.5
N	Normal	×1.0
G	In Garrison	×0.5
C	On Campaign	×2.0
S	Besieging A City	×1.5
B	Being Besieged	×1.25

2.6.3 Powerplants

Each Power Plant generates Energy according to the following calculation:

$$EP = \left(\frac{TL}{10} \times Sm \right) + Rb$$

Where **EP** is the energy produced, **Sm** is the Status Production multiple of the city or region where the power plant is located, and **Rb** is the regional energy bonus if any.

Table 2-9. Regional Status Production Multiples

Status	Description	Production multiple
A	Full Ally	0.75
EA	Economic Ally	1.0
F	Friendly	1.0
HM	Homeland	1.0
P	Pacified	1.0
PT	Pacified Tributary	0.5
T	Tributary	0.25
(Others)	All Other Statuses	0.0

2.6.3.1 Capturing a Power Plant

If you capture an enemy location (region or city) containing a Power Plant, one-half (rounded down) of the Power Plants in the location are destroyed unless you capture the location by surprise[1].

2.6.3.2 Attacking a Power Plant

A Power Plant may also be attacked by airships, aircraft, artillery barrage (from either heavy artillery or ships offshore) or nuclear warhead. In this case, units attack with their Siege strength (and Siege QR), and the Power Plant has a Siege Strength of 20.

2.6.4 Stratospheric Aerostats

A giant aerostat can be built and launched in Industrial Two, beaming energy down to a rectenna on the surface. This massive airship resides in the stratosphere and cannot descend to lower altitudes or return to the surface.

Each Aerostat generates Energy according to the following equation:

$$EP = \frac{TL}{8} \times Rt$$

Where **EP** is the energy produced, **Rt** is the Region Terrain Modifier of the region where the rectenna is located. See Table 2-10 for Rectenna Regional effects.

2.6.4.1 Capturing an Aerostat

If you capture an enemy Aerostat it cannot be used unless moved to a location where it can beam energy down to a rectenna you own, or you have captured (intact) the terrestrial rectenna.

2.6.4.2 Attacking an Aerostat

An Aerostat is extremely fragile and vulnerable, but can sustain damage before it falls from the sky because it has thousands of gas cells and retains stability by pumping water between different tanks.

It has a Siege Strength of 20, but if damaged does not generate any energy until fully repaired. To be repaired NFP must be flown up to the ailing aerostat.

2.6.5 Solettas

These massive mirrors can be built in orbit or at a Lagrange point to enhance agricultural production or increase the energy provided by an aerostat or Solar Power Satellite. See Section 3.10.5.

A soletta is extremely fragile and has a Siege Strength of 5. Any sort of fighting in its vicinity will probably destroy it.

[1] And it's up to the GM to say whether a location is captured by surprise or not. In general, however, if a Combat roll is involved, then it's not a surprise capture.

However, solettas are also very useful, especially if manufactured from lunar or asteroid material.

2.6.6 Solar Power Satellites

Solar Power Satellites can be developed and built in Industrial Two, providing energy beamed down to the Earth from Space. See Section 5.3.72.

To be operational an SPS in Earth orbit must be associated with a working rectenna positioned below its GEO orbit unless the energy is relayed via an operational space elevator, see Section 3.21.1.3.

To provide energy to the Moon the SPS must be in L4 or L5 with a working rectanna on the Moon.

Each SPS generates Energy according to the following equation:

$$EP = \frac{TL}{5} \times Rt$$

Where **EP** is the energy produced, **Rt** is the Region Terrain Modifier of the region where the rectenna is located.

Table 2-10. Rectenna Region Terrain Modifiers

Region Terrain	*Modifier*
c2 / c / i/ w/ s	1.0
m / d/ t	0.75
j / m	0.5
Lunar Surface	1.25
Via a Space Elevator	1.2

2.6.6.1 Capturing a Solar Power Satellite

If you capture an enemy Solar Power Satellite it cannot be used unless moved to a location where it can beam energy down to a rectenna you own, or you have captured (intact) the terrestrial rectenna.

If you capture an enemy location (region or city) containing a Solar Power Rectenna, one-half (rounded down) of the rectennas in the location are destroyed unless you capture the location by surprise. You cannot use any surviving installations unless you have SPS of your own, or you have captured some of the associated enemy SPS in orbit.

2.6.6.2 Attacking a Solar Power Satellite

An SPS in orbit is relatively fragile. It will be attacked by units using their Siege strength (and Siege QR), and the SPS has a Siege Strength of 10. A nuclear detonation in proximity to the SPS will effectively destroy it.

A Solar Power Rectenna is comparatively more robust, being spread over many square kilometers. It may be attacked by airships, aircraft, artillery barrage (from either heavy artillery or ships offshore) or nuclear warhead. In this case, units attack with their Siege strength (and Siege QR), and the rectenna has a Siege Strength of 50. If a rectenna is damaged it will still generate a percentage of its normal energy according to the percentage damage to the installation.

2.7 Mining Asteroids and the Moon

With advancing Tech Levels and R&D projects Near Earth asteroids and the Moon can be mined to create cNFP for space construction. See Sections 3.14.7 and 3.18 for details.

2.7.1.1 Asteroid Mining

To commence mining asteroids the nation must have completed the R&D project Asteroid Mining and performed an asteroid mining mission, either in situ or moving the asteroid to the desired location.

Mining and processing an asteroid is a less complex operation than mining on the Earth or Moon. The various mining missions return units of asteroid material back as cargo. This raw material can be used to offset construction costs of facilities in orbit or on the Moon.

Early missions can only return the raw material. Later advances allow automated mining and the return of asteroid material using a mass-driver using the waste rock to propel the craft. See Section 3.18 for the use of asteroid and lunar material.

The production figures for asteroid mining can be calculated by the following formula:

$$Am = \frac{RQR}{8} \times \frac{M}{12} \times Amp$$

Where **Am** is the mining production, **RQR** is the Rocketry QR, **M** is the number of months spent mining and **Amp** is Asteroid Mining Production multiple.

Table 2-11. Asteroid Mining Production Multiples

Asteroid Type	*Production Multiple*
C-type	2.0
S-type	0.75
M-Type	0.5

2.7.1.2 Lunar Mining

Once a Lunar region has been colonized it can be used for mining. Each region produces the following amount of material just as an Earth region produces Agro. Production figures can be calculated by the following formula:

$$Lm = \frac{RQR}{10} \times Lmp$$

Where **Lm** is the mining production, **RQR** is the Rocketry QR and **Lmp** is regional Lunar Mining Production multiple.

Table 2-12. Lunar Mining Production Multiples

Region Terrain	*Production Multiple*
Polar	2.0
Maria	0.5
Terrae	1.0

2.8 High Tech Trade

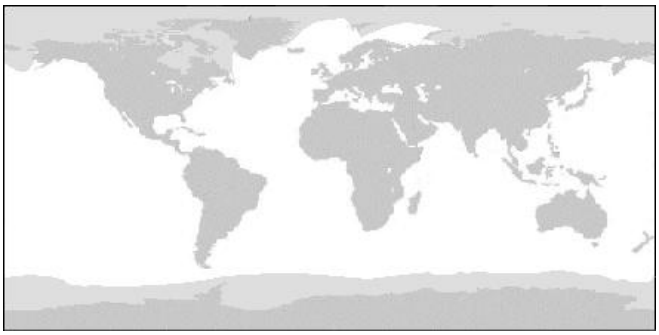
2.8.1 Ice Port Trade

Port cities that are subject to winter pack ice cannot normally host msp because the shipping may be iced in for half of the year.

With the development of Icebreakers (see see Sections 5.3.19 and 5.3.43) these ships can be converted into msp and based at a port city subject to winter ice.

These ships can be converted into msp according to their cargo rating but if converted to wartime duty return only as an ordinary transport. The trade route partner can only add msp to the route if they also build icebreakers and convert them into msp.

Table 2-13. Extent of Winter Sea Ice



Note that the winter months are December, January, and February in the Northern Hemisphere and June, July, and August in the Southern Hemisphere. Sea ice will reduce outside these periods leaving only the ice cap in the Northern Hemisphere and the constant Antarctic ice shelves in the Southern Hemisphere.

2.8.2 Mag-Lev Lines and Trade

Two nations whose *Capital* Cities are connected by a Mag-Lev line may conduct Mag-Lev line Trade (at a level of efficiency superior to a railroad). Mag-Lev Line Trade supercedes (or replaces) any existing trade route between the two nations.

2.8.3 Submarines and Trade

Nations having acquired the capacity to build cargo subs may use them on their trade routes (as any transport may be converted into MSP), as long as the distance between each **Anchor City** on the trade route is equal to, or less than, **twice** the Diesel-ship Operating Range of the nation.

Cargo sub merchant traffic may use the hexgrid ocean map overlay for tracing distances for trade routes and conduits. Cargo subs can be based either at normal port cities or underwater cities.

2.8.4 Rocketry and Trade

Later rockets and spaceplanes can be used for trade routes for small, valuable cargoes, passengers, mail and other items where speed of delivery surcharges make up the difference in volume profits.

Sub-orbital transports are converted to sMSP at the usual MSP conversion rate of 1 MSP per Cargo point. As these craft are tracing their route via a sub-orbital trajectory there is no terrestrial maximum range as antipodal transits are feasible. A minimum range applies, traced on the normal map of 20 – Rocketry QR where Sea Zones and Hexes count as 2 Range Points per zone or hex. Flights over the poles are permitted.

See Section 3.14.4 for details of the capability of these advanced transportation systems.

2.8.4.1 Conversion to Wartime Duty

At the beginning of any turn, each 1 MSP on a sub-orbital trade route may be turned into NFP at the cost of 4 GP.

3. THE ORDER FORM

3.1 EXPENSES: INVESTMENTS

The new Rocketry and Nuclear QRs are limited like the other Military Quality Ratings by the Tech Level of your Nation. The previous caps placed on QR advancement are also raised by the acquisition of new Tech Levels.

Table 3-1. Max. QRs per Culture and Tech Level

Civilized

Tech	Cavalry	Infantry	Warship	Siege	Artillery
3	5	5	4	5	--
4	7	6	5	7	--
5	8	7	6	8	--
6	9	8	7	10	--
7	10	10	10	12	4

If a Civilized Tech 7 Nation purchases one or more Artillery units from a Renaissance nation they can then begin building Artillery units and investing in their own QR, which starts at one (1).

Seafaring

Tech Level	Cavalry	Infantry	Warship	Siege
1	0	3	4	2
2	1	4	6	4
3	3	5	6	5
4	5	6	7	7
5	6	7	8	8
6	7	8	9	10
7	8	10	12	12

Barbarian

Tech Level	Cavalry	Infantry	Warship	Siege
2	3	4	4	4
3	5	5	4	5
4	7	6	5	7

Nomadic

Tech Level	Cavalry	Infantry	Warship	Siege
2	5	3	2	2
3	7	4	3	3
4	9	5	4	5

Pre-Columbian

Tech Level	Cavalry	Infantry	Warship	Siege
1	0 (1)	3	2	2
2	0 (2)	4	4	4
3	0 (3)	5	4	5

Note: Cavalry is available to Pre-Columbian cultures only after the expiration of the Cavalry Count in that geographic area.

Renaissance

Tech	Cavalry	Infantry	Warship	Siege	Artillery
8	11	12	12	15	6
9	11	14	15	17	9
10	12	15	17	20	11
11	13	16	20	23	13

Industrial One

Tech	Cav	Inf	Naval	Siege	Art	Mech	Air	Rock
12	14	18	27	26	20	--	--	--
13	14	20	30	29	22	5	5	--
14	14	22	34	32	24	10	10	1
15	15	24	37	35	26	15	15	3

Industrial Two

Tech	Cav	Inf	Naval	Siege	Art	Mech	Air
16	15	26	40	38	30	20	25
17	15	28	42	41	32	25	30
18	15	30	46	44	35	30	35
19	15	32	48	47	40	35	40

Tech	Rocket	Nuclear
16	6	2
17	9	4
18	12	6
19	15	8

Industrial Three

Tech	Cav	Inf	Naval	Siege	Art	Mech	Air
20	15	34	50	50	42	40	45
21	15	40	54	53	45	45	50
22	15	50	57	57	50	50	55

Tech	Rocket	Nuclear
20	20	10
21	25	15
22	30	21

3.2 CONSTRUCTION: BUILDING ARMIES

3.2.1 Fractional NFP

Industrial Era airships, aircraft and warships can now be manned with fractions of NFP to denote the relative sizes of crew needed by these vessels.

If a full unit of NFP is not used in the construction of such vehicles then the fractional amount can be saved to be used in the next turn.

3.2.2 New Unit Types

With the Industrial Era **Rocket**, **Nuclear, Kinetic Energy Weapon, Laser** and **Cybernetic** units become available. In Industrial Three infantry can be augmented with battlesuits and powered armor.

3.2.3 Rockets

Rockets are projectiles driven by the reaction of gases produced by a fast-acting fuel, either burning liquid or solid propellants, carrying an explosive warhead. Completion of the **R&D: Rocketry: Single-Stage Rocket** project gained the nation the **Rocketry QR**. All long-range rockets and spaceplanes are launched using the **Rocketry QR**.

Initially all rockets are 'single use' units, launched and then lost. Similarly space capsules are only capable of being used once. These units are very expensive and initially only provide a limited benefit – until satellites and ICBMs become available.

The early rocketplane and later shuttles and spaceplanes are reusable and are similar to any other unit.

3.2.3.1 Rocket Bombardment

A rocket unit is useless in battle or in a conventional siege. It is subject to a minimum and maximum range and can only be deployed against cities, fortresses or monolithic constructions within that range. Once in flight a rocket cannot be intercepted at Industrial One, and if successful will crash down onto its target inflicting damage in terms of GP/NFP/Time required to repair, if the location is not destroyed outright. If it carries a Nuclear weapon then the damage inflicted will be determined by the warhead and the **Nuclear QR**.

3.2.4 Nuclear Weapons

Nuclear weapons are a new and fearsome weapon, delivered to the target by another unit (ship, aircraft or rocket).

All nuclear weapons use the **Nuclear QR**, which governs whether they detonate, and the level of devastation caused. There are no inexperienced or elite Nuclear units.

Following the completion of the **R&D: Nuclear Theoretical Physics** project your Nation can build Nuclear Production Factories, which will in turn allow you to develop and build the various kinds of Nuclear weapon.

The Nuclear QR is also used to determine the efficiency of nuclear powered space drives.

3.2.5 Chemical Weapons

Following the completion of the **R&D: Chemical Weapons** project your nation can use weapons that employ toxic chemical substances to kill or incapacitate an enemy. These are deployed using the requisite QR for the delivery system – usually either Aircraft or Rocket.

3.2.6 Biological Weapons

Following the completion of the **R&D: Biological Weapons** project your nation can use weapons that employ disease-causing organisms to kill an enemy. These are deployed using the requisite QR for the delivery system – usually either Aircraft or Rocket.

3.2.7 Kinetic Energy Weapons

Kinetic Energy Weapons are hyper-velocity projectiles released from orbit, launched from a lunar mass-driver or fired from an orbital coilgun. They cause damage equivalent to a small nuclear weapon or large conventional bomb because of the energy release on impact. Asteroids can form very big kinetic kill weapons.

Kinetic Energy weapons employ the Rocketry QR.

3.2.8 Lasers

Lasers emit photons in a coherent beam. A high energy laser can be used as a directed energy weapon.

Laser weapons employ the Artillery QR.

3.2.9 Cybernetics

Artificial Intelligences capable of controlling a weapons platform, be it a tank or an aerospace craft.

3.3 CONSTRUCTION: COLONIES & CITIES

Agricultural improvements in the kinds of plows, seed, sewers, medicine, threshing machinery, etc. also improve the amount of Public Works that can be built in a province or city:

Table 3-2. Maximum Public Works

Tech Level	*C2*	*C*	*Other Terrains*	*City*
12-13	GPv × 30	GPv × 20	No Change	GPv × 15
14-15	GPv × 30	GPv × 25	No Change	GPv × 20
16-17	GPv × 35	GPv × 25	No Change	GPv × 25
18-19	GPv × 40	GPv × 30	No Change	GPv × 25

3.3.1 City Size and Regional Cultivation

When a city grows beyond a certain size it starts to cover agricultural land causing the opposite of regional cultivation.

Table 3-3. City Effect on Regional Cultivation

Tech Level	*City Size*	*C2*	*C*	*Other Terrains*
16-17	>15	-5% RC	-10% RC	No Change
18-19	>20	-10% RC	-20% RC	No Change

The effect of this can be removed or reduced by converting the city into an Arcology.

3.3.2 Arcology

An arcology can be built at TL20. It is a habitat or settlement maintaining an extremely high human population density but reducing the ecological footprint of a city.

An arcology has the benefit of not reducing regional cultivation because it builds up and down instead of sprawling across the land. It also automatically includes four Wallpoints because it is one enormous building or a linked complex of buildings. If the arcology includes a fortress then the fortress will often be either below the city or mounted on the very top at near cloud level.

When an arcology expands it usually expands up or down, so its Wallpoints do not have to be removed and rebuilt as an additional cost of the city expansion.

An existing city can be converted into an arcology only by being completely rebuilt – the NFP is retained but the GP must be paid for again. In this instance the arcology can be built with all the increased levels at once. The Wallpoints must be pulled down and the NFP reused otherwise the walls are lost.

Table 3-4. Arcology Construction & Expansion Costs

	c2/c/i region	*w/m/j region*	*s/d/t region*	*result*
Initial	30gp/20nfp	40gp/25nfp	50gp/30nfp	[1/0]
Increase	20gp/10nfp	25gp/15nfp	25gp/20nfp	[+1/0]

3.4 CONSTRUCTION: MEGA-BRIDGES

The development of new materials and technologies allows the construction of massive suspension bridges. Many will carry traffic across ancient Ferry Points with the benefit that crossing the bridge requires the expenditure of only one (1) AP obviating the extra cost of moving across the Ferry. These bridges (at these Tech Levels) are not suitable for carrying railroads.

Each mega-bridge also costs a number of City (generic) Yard Capacity points.

Note that each Mega-Bridge Project has a minimum Tech Level requirement.

Table 3-5. Mega-Bridge Construction Levels

Level	*Tech Level Requirement*	*City Yard Capacity Cost*	*Description*
4	16	20	Bali Bridge (connecting Bali with Pajajaran).
4	16	15	Hokkaido-Honshu Bridge (connecting Hokkaido and Akita in Japan).
4	16	20	Sicilian Bridge (connecting Sicily with Calabria in Italy).

3.5 CONSTRUCTION: TUNNELS

With the Industrial Age great tunnels can now be bored through the earth and under the sea. These tunnels carry railroads and have the effect of any other rail line for the purposes of control, trade and travel.

If you wish your undersea tunnel to carry more than one rail line then you have to build more tunnels…

Each tunnel also costs a number of City (generic) Yard Capacity points (this includes the normal generic yard cost for a railroad segment).

Note that each Tunnel Project has a minimum Tech Level requirement.

Table 3-6. Tunnel Construction Levels

Level	*Tech Level Requirement*	*City Yard Capacity Cost*	*Description*
4	16	15	Bosporus Bridge (connecting Thrace with Bithnia Europe/Asia Minor).
4	16	30	Channel Tunnel (connecting Sussex with Ponthieu).
5	16	40	Gibraltar Tunnel (connecting Morocco with Andalusia).
4	16	25	Hokkaido-Honshu Tunnel (connecting Hokkaido and Akita in Japan).

3.6 CONSTRUCTION: SPACEWATCH

A SpaceWatch program can be built when a nation has completed the **R&D Projects: Radar** and **Mainframe**. It is a Base Level Two project and represents a network of regional observatories and radar stations, and eventually satellites used to monitor the space launches of other nations – it can spot large space vehicles and exhausted rocket boosters as well as space platforms, stations and solar power satellites.

It can also be used to detect and monitor the orbits and approaches of Near Earth asteroids, either to detect potential impacts with Earth or as mining opportunities.

If a potential Earth impact asteroid is detected then there are a number of options:

- Send a mining ship to build a mass-driver to allow its trajectory to be altered, see section 3.18.3. This assumes that there is time to allow a mass-driver to work.
- Send ships to dock with the asteroid and *push* to deflect its trajectory. Low thrust engines will also require significant time to affect the trajectory. See Table 3-19 for the types of propulsion.
- Send a ship to place nuclear weapons on the oncoming asteroid to vaporize all or part of it, or send a mining ship to dig a shaft and deploy a nuclear weapon inside it. This poses the danger of breaking the asteroid into smaller but still dangerous fragments. If detonated inside the asteroid there is also the possibility of gravity drawing the fragments back together again, creating a rubble pile. A rubble pile is especially dangerous – see Section **Error! Reference source not found.**.
- Deploy nuclear weapons in front of or to the side of the asteroid to alter its trajectory. This method is very like a Nuclear Pulse Rocket, see section 5.3.29. This strategy also requires time to be effective.

When SpaceWatch identifies a potential threat, the GM will assign the characteristics of the asteroid (see section 3.18) and the time to go. The size of the asteroid is indicated by its Cargo Mass and its strength by its type. The Siege Strength of an asteroid is determined in section 3.18.2.

The ability to deflect a threatening asteroid could also be abused to divert non-threatening bodies towards Earth. See section 3.18.4.

3.7 CONSTRUCTION: INTERNET

With the completion of the **R&D Microchips** project a nation can build an internet system, connecting its government infrastructure, commercial businesses and ultimately every home that holds a personal computer.

In game terms this:

- Increases the base Tax Rate by 10%.
- Increases the International Trade Value of the nation by 10% when trading with another nation that has also completed an internet system if the two nations have a common land border or a Submarine Communication Cable links them. The increase represents the ease of communication and implementation of more efficient stock control, shipment monitoring and 'just in time' delivery systems.
- Increases the Imperial Size Divisor by one, representing the increased governmental efficiency as databases are built up and information is shared between government departments and agencies.

The base cost of the internet is 100gp, 10 nfp and 2 years. The base cost is multiplied by the Imperial Size of your nation to get the final, Total Cost.

The cost of an Internet project can be defrayed through the use of Engineers (see Section 5.4) as they install the necessary cables and servers. It cannot be defrayed by Technical Assistance (see Section 5.5).

Note that completing an internet system may make your nation more vulnerable to various types of espionage attack. See Section 8 for details.

3.8 CONSTRUCTION: SPACEPORTS & MASS-DRIVERS

3.8.1 Spaceport

Base Level Two

A Spaceport can only be built once the **R&D Project: Rocketry: Dual-Stage Rocket** has been completed. A Spaceport can be built at a city, fortress or in a region.

It represents the infrastructure required to launch larger rockets, consisting of command posts, fabrication buildings, fuel dumps, training facilities, launch pads, and gantries. If the Spaceport is not co-located with the necessary Rocket Factories then the rockets must be transported to the site either by rail or by ship.

A Spaceport includes runways for use by aircraft, and at TL20 includes the launch and landing facilities for Single Stage to Orbit rockets.

3.8.2 Nuclear Rocket Baffle

Base Level Three

If a nation has completed the **R&D project Rocketry: Nuclear Pulse Rocket** (see Section 5.3.29) then they can build gigantic steel shields to contain and direct blast and fallout from the nuclear detonation at launch. If a Nuclear Rocket is launched from within this shield then damage to the surrounding regions and cities is reduced by half. Once used, this monolithic construction remains radioactive and cannot be demolished to reuse the NFP used in its construction.

Note that the Nuclear Pulse Rocket must be constructed at the launch site as it is too massive to transport.

3.8.3 Electromagnetic Launch Rail

Base Level Two

At TL 18 an electromagnetic launch rail can be built. Mag-lev technology is used to propel a launch cradle along a specially-constructed track to impart impressive acceleration to a space vehicle or to a jet bomber or heavy bomber. The cradle can also be rocket-powered with the rail only providing near-frictionless magnetic repulsion.

The launch rail adds one (1) to the range of the craft - see Section 3.14.2. These can only be used to assist certain types of craft, see Section 3.14.4 and for some must be co-located with a Spaceport.

3.8.4 Lunar Mass-Driver

Base Level One

Although the technology is available at earlier Tech Levels, a Lunar Mass-Driver can only be constructed when a Moon Base is operational.

A mass-driver, an electromagnetic catapult, is used to deliver material to either one of the Lagrange Points or to Earth orbit. The lunar regolith contains oxygen, silicon, aluminum, iron, titanium and magnesium and this can be used for the construction of other facilities.

One Lunar Mass-Driver can send 20 cargo points of mined material into space each turn – see Section 3.18.

3.8.4.1 Lunar Mass-Drivers as Weapons

At this Tech Level a Lunar mass-driver can also be used as a weapon – directing buckets of material towards a target. For practical bombardment of a target on Earth or in space, the projectiles require thrusters for direction and a targeting system.

A lunar mass-driver can be used to launch a nuclear bomb or a kinetic energy weapon at a monolithic construction, city or fortress on Earth, or at space platforms, space stations or solar power satellites in orbit, or other installations on the Moon itself.

A nuclear bomb must have been built at a Nuclear Production Facilities and delivered to the location of the mass-driver.

3.8.4.2 Kinetic Energy Weapons

A kinetic kill weapon is a projectile of metal or rock that inflicts damage due to its velocity, see Section 5.3.50 for details. A lunar mass-driver can fire KEW projectiles without the **R&D Project Rocketry: Kinetic Energy Weapon** having been completed.

A kinetic energy weapon launched from a mass-driver is a relatively low tech projectile, and can be built using the industrial capacity of a Lunar Base from cNFP.

3.9 CONSTRUCTION: SHELTERS & BUNKERS

3.9.1 Air Raid Shelters

Base Level One

Air Raid shelters provide some protection for a population against conventional strategic bombing (including rocket bombardment and kinetic energy weapons), and limited protection against nuclear attack.

They can only be built in Cities and Fortresses.

3.9.2 Underground Command Center

Base Level Two

At Tech Level 18 Underground Command Centers can be built to shelter all or part of the governmental organization: Bureaucracy and Infrastructure, as well as the Royal Family and assorted flunkies and hangers-on.

This nuclear proof bunker is effectively a 'hidden' fortress and hold supplies for approximately six months. If the **R&D Hardened Electronics** project has been completed it includes secure communication lines to allow all or part of the government to continue to operate after a nuclear attack. It should be built in the region containing the capital to allow members of the government to reach it. Note that portions of the government can permanently shelter in this hole in the ground whilst performing their normal duties but then its existence is unlikely to be secret.

The Command Center can shelter five points of BL or Infra, in any combination, or ten ordinary units (excluding ships, aircraft or rockets of any sort). The bunker is impervious to nuclear attack or normal bombing, but can be penetrated by Kinetic Energy Weapons. It defends against these with the Siege QR x 2 of the nation.

It will take a Leader a minimum of 2AP to move the government to the bunker, so unless it is permanently occupied, a surprise first-strike attack is likely to render it superfluous.

3.10 CONSTRUCTION: POWER GENERATION

3.10.1 Power Plant

Base Level One

A Power plant can only be built at Tech Level 12 and above. A power plant represents an oil or gas refinery, storage depot, a coal, gas or oil power station, hydroelectric power station and at higher TL a fission or fusion plant.

Power Stations can be built in controlled Cities and Regions. The number that can be built in a Region is equal to the GPv of the region. The number that can be built in a city is half the GPv of the city. Each Power Plant built produces EN points, see Section 2.6.

3.10.2 Solar Power Aerostat

Base Level Two

If a nation has completed the R&D Project: Airships and Carrier Jet Fighter, at Tech Level 20 a gigantic aerostat can be built and lifted to the stratosphere. Once aloft it can act as a primitive solar power satellite capable of beaming energy down to a rectenna on Earth.

The aerostat employs propellers to stay on station, and can be reached using small jet aircraft (jet fighters and jet cargo planes). It can move from its normal location at 10 AP and can be used as an airborne carrier. However, it is extremely fragile and vulnerable and must end each turn above a controlled city or region.

In addition to the usual Monolithic Construction costs an Aerostat also costs 50 City (generic) Industrial Capacity points.

3.10.3 Solar Power Satellite

Base Level One

Completion of the **R&D Project: Solar Power Satellites** allows the nation to construct massive satellites and the terrestrial rectennas to receive the power beamed down from space. To determine how much energy an SPS generates, see Section 2.6.6.

A solar power satellite, or SPS, is a satellite built in GEO orbit that uses low-level microwave power transmission to beam solar power to a rectanna on Earth, where it can be used in place of conventional power sources. In space the solar collectors have an unobstructed view of the Sun, virtually unaffected by the day/night cycle, weather, or seasons. Alternatively, the SPS can be used to beam energy to a rectanna on the Moon.

Each SPS is massive and must be based in a GEO location above the rectenna on Earth or in L4, L5 to beam energy to the Moon.

An SPS is built by spending the Monolithic Construction GP costs and lifting theNFP to its designated location. This means it is likely to appear as a national project over several turns. Completion creates the SPS. It is not able to generate energy until the associated rectenna is complete on Earth. Material mined from an asteroid or the Moon can be used to provide all or some of the NFP – see Section 3.18.

3.10.3.1 Solar Power Satellites as Weapons

The microwave beam of a SPS is usually very wide and not harmful. However, the beam can be focused onto a city to cause damage. To redirect the beam requires a Leader to direct the SPS for 5AP causing 25 points of Siege damage. Air Raid shelters and bunkers will protect against the damage, which affects firstly PWB and then the GPv of the city.

3.10.4 Solar Power Rectenna

Base Level Two

The terrestrial receiver is kilometers in diameter and receives the microwave energy beamed to the Earth or the Moon or from an aerostat above the same region. If built on the Moon the Base Level is Three and materials must be moved to or fabricated on the Moon.

A rectenna is a rectifying antenna, a special type of antenna used to directly convert microwave energy into DC electricity. Its elements are usually arranged in a mesh pattern, giving it a distinct appearance from most antennae.

The microwave energy beamed down from space is relatively harmless and the land beneath the grid can be used for farming. The system has no capability of being used as a weapon – if the beam is moved off the rectenna it simply defocuses.

A single rectenna can receive energy from up to five SPS or two Solar Power Aerostats.

3.10.5 Soletta

Base Level Two/One

A soletta is a gigantic mirror built in orbit at TL20+ at a Lagrange Point or GEO if a nation has built a rocket or other launch system capable of delivering the NFP to its orbit. A space platform or station in its orbit is required to support construction.

It can focus light either onto a planetary body (such as the Earth or Moon) or onto a Solar Power Satellite in the same location. It can also be used as a 'sun shade' to reduce global warming (and agricultural production), especially if placed in the Earth-Sun E1 Lagrange point.

In the future solettas may be useful in terraforming Venus or Mars – shading the former from solar output and focusing additional light onto the later.

If a soletta is built from Earth based NFP then it is a Base Level Two construction. If it is built from lunar or asteroid material it is only a Level One project – because much of its materials utilize by-products of orbital manufacturing.

When built and placed in orbit the function of the soletta must be determined. The function can be changed by a Leader action taking 5 AP.

- It can be used to increase the length of the growing season in the Temperate zone, increasing the agricultural production of three neighboring regions by 20%.
- It can be used to enhance the energy production of a single Solar Power Aerostat by 15%.
- It can increase the energy production of a single Solar Power Satellite by 20%.
- It can be used to decrease agricultural production of three neighboring regions by 20% if it is located in Earth Orbit.
- It can be used to decrease global agricultural production by 20% if it is located at E1.

Multiple solettas can be linked together to increase the size of the zone affected or to increase the efficiency of an aerostat or SPS.

3.11 CONSTRUCTION: MAG-LEV RAILROAD PROJECTS

3.11.1 Building Mag-Lev Railroads

Industrial Nations (Tech Level 18 and above) can build a new type of National Project: the Mag-Lev Railroad (MR). A Mag-Lev train is able to move almost as fast as an aircraft, supported by magnetic levitation above the track.

Like a Royal Road, a Mag-Lev Railroad is built between the center of a province (though usually anchored to a city) and the center of an adjacent province. Each MR segment (or level of capacity) is a Level Two Project with a base cost of 100gp and 50nfp. Unlike other Projects, each MR segment also costs 20 City (generic) Industrial Capacity points.

A Mag-Lev Railroad segment can only be built in a province containing a Friendly city that is within the HBZ, or from a province already containing a Mag-Lev Railroad segment that is, in turn, connected to a Friendly city within the HBZ. A Mag-Lev Railroad segment can have more than one **level** of capacity.

A contiguous controlled series of Mag-Lev Railroad segments are called a "Mag-Lev line".

If a Mag-Lev Railroad segment must cross a River, a (new) Bridge must be built specifically to carry the railroad. For purposes of keeping the GM from going insane, only one Bridge is required per river crossing, regardless of the number of Mag-Lev Railroad levels between the two regions. See Base Rulebook section [5.8.10] for details. A Mag-Lev railroad cannot cross a Ferry Point but it can use a specifically built Mega-Tunnel.

3.11.2 Moving Units by Mag-Lev Line

Each level of Mag-Lev Railroad can carry 20 cargo points of units per turn in a **single** direction. This is the Rail Capacity of a Mag-Lev track. Multiple levels of rail between provinces either allow more Cargo moved in one direction, or half as much in each direction.

An army (a Leader and one or more units) moving by rail may move the full length of the rail-line in 0.5 AP if the Cargo-size of the army is less than or equal to the rail line capacity. Larger cargo-requirement armies must be 'shuttled', which each additional block of capacity costing 0.5 AP per set.

If a Mag-Lev line 'contracts' due to a segment being below the capacity of the others, extra AP will be spent to unload everyone, shuttle them forward on the lower capacity track, then load them up again. Very messy.

3.11.3 Mag-Lev Line Communications

Like a Royal Road or railroad, a Mag-Lev enables extremely swift and efficient communications between the capital of a nation and its attendant provinces and outlying regions. The Homeland Build Zone (and the King's Command and Control Radius) is extended from the capital by a railroad.

The AP cost for HBZ or CCR to enter a region is zero when following a Mag-Lev line. Terrain effects (due to mountains, bad terrain, etc.) are still accounted in the cost of tracing the HBZ or CCR.

Mag-Lev lines passing through Tse-Tse Fly regions negate the effects of said flies on CCR tracing.

3.11.4 Third-Party Mag-Lev Line Projects

Merchant Houses of the proper Tech Level (18 and above), may embark upon Mag-Lev line construction projects for another 'host' nation. In this case the project appears on the Merchant Houses' stat sheet during construction, then moves to the 'host' Nation's upon completion.

The Mag-Lev line may be constructed with national NFP (provided by the 'host' nation), Project Recruitment NFP (provided by the Merchant House), or a combination. National NFP provided in this way are **not** halved.

The GP to finance the project must be spent by the Merchant House directly (though of course they may be reimbursed by the 'host' Nation). The Merchant House must provide **all** of the Industrial Capacity used to build the Railway.

A Mag-Lev line construction Project must begin in a region containing a city capable of producing the Merchant Houses' "generic" Industrial Capacity used to fuel the project.

3.12 CONSTRUCTION: AT THE POLES

At Industrial Two exploration of the poles and the building of installations on Greenland or Antarctica become feasible. These environments are hostile and often only accessible for half the year.

The polar regions are also of strategic interest as bases there can assist in early warning systems against missile attack or be used to base rockets and missiles covering the top of each hemisphere.

3.12.1 Polar Outpost

A Polar Outpost consists of a number of heavily insulated huts and buildings, built to withstand the fierce winters and the long days and nights at the pole. A Polar Outpost must be built on a coastline (not fronted by an ice shelf) or be able to trace a Line of Communication to an outpost or base on the coast.

It is built by spending 15 GP and moving 10 NFP by ship or aircraft to its location. This means that a Polar Outpost is likely to appear as a national project over several turns. Completion creates the Outpost and 1 Wall Point.

Further Wall Points can added.

3.12.2 Polar Base

A Polar Base consists of a large facility, either dug in to the rock or an actual domed city protected from the elements. A Polar Base must be built on a coastline (not fronted by an ice shelf) or be able to trace a Line of Communication to base on the coast.

As a coastal base is likely to be iced in during the winter it cannot be used to base msp unless derived from cargo submarines or icebreakers.

Table 3-7. Polar Base Construction & Expansion Costs

	ap	*am*	*result*
Initial	40gp/25nfp	50gp/30nfp	[1/0]
Increase	25gp/15nfp	35gp/20nfp	[+1/0]

A polar base is built by spending the relevant GP and moving 10 NFP to its designated location. This means that a Polar Base is likely to appear as a national project over several turns.

The Intrinsic Industrial capacity of the base can be used it if is within the national HBZ. Submarine Yards and Rocket Factories can also be built at the City.

3.13 CONSTRUCTION: UNDERWATER FACILITIES

With the completion of the relevant project facilities and bases can be built underwater. These can be built on the sea bottom, under the sea floor itself, or on the interior of submerged sea mounts. These bases could be hundreds of miles out to sea and need not have any umbilical contact of any kind with the surface or with the shore.

These facilities must still be able to trace a Line of Communication via a controlled, un-blockaded Port City or Fortress.

3.13.1 Underwater Installation

An Underwater Installation can be constructed once the **R&D Underwater Installation** project has been completed. See Section 5.3.18.

An Underwater Installation consists of a number of pressurized habitats located in a large lake, sea zone or ocean

hex. It is effectively a Port Fortress where submarines can be docked, refueled and replenished.

It is built by spending 25 GP and moving 10 NFP by cargo sub to its designated location. This means that an Underwater Installation is likely to appear as a national project over several turns. Completion creates the Installation and 1 Wall Point.

Further Wall Points can be added representing pressure shielding and hard points and silos for the mounting of SBBMs. The number of Wall Points denotes the maximum number of SBLMs that can be mounted on it.

3.13.2 Underwater Cities

An Underwater City can be constructed once the **R&D Underwater City** project has been completed. See Section 5.3.32.

An Underwater City consists of a number of pressurized habitats and facilities located in a lake, sea zone or ocean hex. It is effectively a small port city where submarines can be docked, refueled and replenished, also used to exploit the undersea environment via fisheries, mining and drilling.

Table 3-8. Underwater City Construction & Expansion Costs

	Lake	*Sea Zone*	*Ocean Hex*	*result*
Initial	50gp/20nfp	60gp/25nfp	70gp/30nfp	[1/0]
Increase	25gp/10nfp	30gp/15nfp	35gp/20nfp	[+1/0]

It is built by spending the relevant GP and moving 10 NFP by cargo sub to its designated location. This means that an Underwater City is likely to appear as a national project over several turns.

Wallpoints can be built for the City but it cannot base SBLMs unless an Underwater Installation is built at the City.

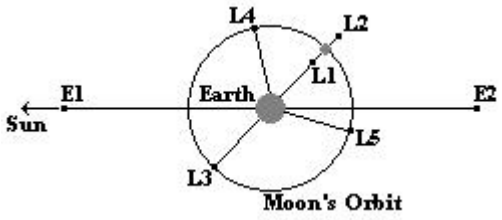
The Intrinsic Industrial capacity of the City can be used it if is within the national HBZ. Submarine Yards and Rocket Factories can also be built at the City.

The facility can also be used to base MSP derived from cargo subs to support a trade route. Note however, that this removes virtually any chance of the City being a secret installation, and it cannot be used as a terminal port for tracing trade routes to the nation – unless the City is part of an undersea nation. If cargo sub derived MSP is returned to wartime service, then it returns at the nearest controlled surface port as an ordinary transport, unless its released NFP is going to be used to build another unit using the industrial capacity of the Underwater City.

3.14 ROCKETS AND SPACE TRAVEL

With the introduction of Rocketry a new map is introduced to cover orbits above the Earth and transfer routes to the Moon and the five Lagrange Points of the Earth-Moon system. See section 4.3.

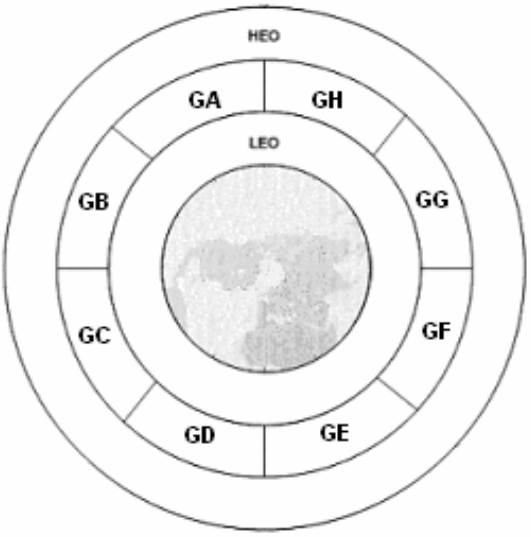
Table 3-9. Earth Lagrange Points



Early rockets are capable of only sub-orbital flights, but more advanced rockets (and rocketplanes) are able to achieve various orbits. The abstract map used provides a number of 'locations':

- The Earth.
- Low Earth Orbit.
- Geosynchronous/geostationary Orbit, divided into a number of segments.
- High Earth Orbit
- The Five Lagrange Points. These are treated as 'islands' for movement purposes and a unit may fly 'across' them without entering the 'island. L4 and L5 represent large 'islands' of orbital stability.
- High Lunar Orbit.
- Low Lunar Orbit
- The Moon.
- In addition two of the Sun-Earth Lagrange points (1.5 million kilometers from Earth), E1 and E2 are also 'nearby' destinations, with a Range of 6.

Table 3-10. Earth Orbits

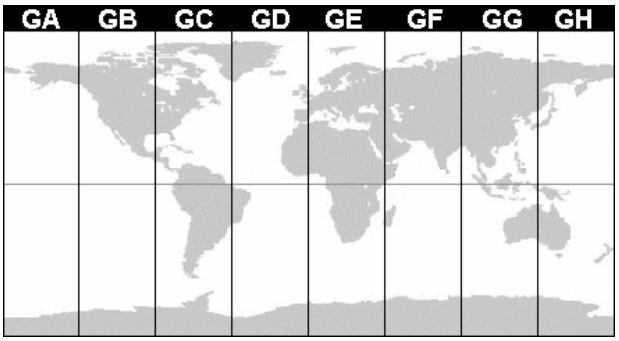


This ignores the complexities of orbits and transfer routes to a manageable number. Note that any units on a transfer route at the end of a turn are lost – all units must end either on the Earth, Moon, in orbit or at one of the Lagrange Points. To end the turn in orbit or at a Lagrange Point mobile units must be docked at a Space Platform or Space Station, and units on the Moon must end the turn at a Lunar Outpost or Moon Base. Higher Tech Levels will permit mobile units to end the turn in orbit or at a Lagrange Point or even on transit to one of the planets…

3.14.1 Geostationary Coverage

Non-maneuvering objects within LEO are orbiting the Earth faster than the Earth rotates. Those in HEO are orbiting the Earth at a slower rate. Those in a geosynchronous or geostationary orbit are orbiting at approximately the same rate as the Earth rotates below them. This becomes significant when spy satellites and warsats come into play as owning this 'high ground' becomes a strategic necessity.

Table 3-11. Geostationary Coverage



For game purposes, the geosynchronous or geostationary orbits are divided into eight segments. Each segment provides coverage of an eighth of the Earth's surface. The equator is shown only for reference.

3.14.1.1 Satellites in Orbit

A satellite in segment GF will provide a bonus in spying on any region within the segment, and a reduced bonus in spying on segments GE and GG. It will not be able to provide any information on the other segments. Similarly a warsat could attack ICBMs with a footprint targeting any region in GF, but nowhere else.

In comparison, a satellite in LEO or HEO will provide a general bonus as (simplistically) within a turn it will pass over a very large proportion of the Earth's surface several times. The coverage provided by any warsat in these orbits will also be reduced unless there is a sufficient number of warsats to be over the defended region at the time of attack.

See Section 5.3.16 for the benefits of spy satellites.

3.14.2 Launch Capability

Different types of rocket have different capabilities for carrying cargo to the various orbits.

Table 3-12. Base Rocket Lift Capability

Rocket Type	Cargo to LEO	Cargo to GEO	Cargo to HEO	Latitude Effect?
Single-Stage Rocket	No	No	No	No
Dual-Stage Rocket	1	0	No	Yes
Rocketplane	0	No	No	No
Aero-Spaceplane	1	No	No	No
Multi-Stage Rocket	2	1	0	Yes
ICBM	0	No	No	No
SLBM	0	No	No	No
TBM	No	No	No	No
MIRV	0	No	No	No
Heavy Lift Rocket	3	2	1	Yes
Single Stage to Orbit	4	No	No	Yes
Sub-Orbital Dropship	5	No	No	Yes
Nuclear Pulse Rocket	40	40	40	Yes
Mars Rocket	n/a	n/a	n/a	n/a
Shuttle	2	No	No	Yes
Heavy Shuttle	4	No	No	Yes
Spaceplane	3	3	2	Yes
Heavy Spaceplane	4	4	3	Yes
Trans-atmospheric Fighter	No	No	No	Yes
Trans-atmospheric Heavy Fighter	1	No	No	Yes
Cybernetic Autonomous Fighter	No	No	No	Yes
Laser Rocket	2	2	No	Yes

The Base Rocket Lift Capability is also affected by the latitude of the launch. How much mass a launch vehicle can place in orbit depends on the location of the launch site and the intended orbit. Since the rotational speed of the Earth's surface is largest near the equator, launching from sites near the equator allows the launcher to take advantage of that additional speed. A spacecraft located on the equator is carried by the Earth at about 400 meters/second, or about 5% of the orbital velocity.

A rocket launched in the equatorial band gains an additional range point, whilst one above 50º latitude is reduced by one. This makes launch sites on or near the equator very desirable.

Given that the map above is very small scale, it is the GM's decision as to whether a Space Port on the border of a band lies within one band or the other. So there.

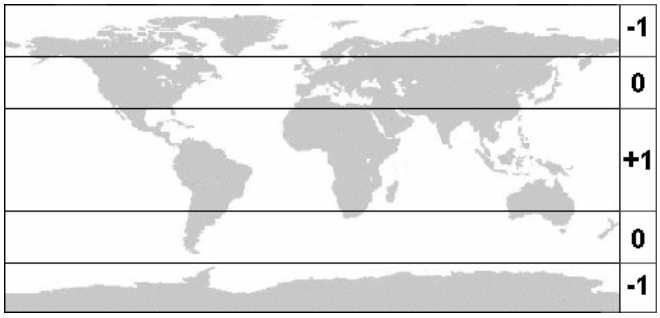
Example:

The Swedish Russians have a Space Port at Rostov which lies within the 0 latitude band. This means that their dual-stage *Tsaravitch* rocket launched from there can only lob the tiny (cargo 1) *Vostok* manned capsule into Low Earth Orbit.

However, the Aztec Empire has a Space Port at Nanchao in Central America, which gains a +1 Latitude Effect. This means that their dual-stage *Firetower* rocket can lift the larger (cargo 2) *Mitl* capsule or two spy satellites into LEO, or lift a smaller (cargo 1) capsule into a GEO orbit.

The Aztecs are happy, the Swedes are sad.

Table 3-13. Latitude Effect on Lift Capability



A rocketplane launched from near the Equator cannot reach GEO orbits.

Aero-spaceplanes and shuttles cannot fly higher than LEO but due to the Latitude Effect could carry an additional cargo point into orbit.

Use of an Electromagnetic Launch Rail adds one (1) to the lift capability meaning that the unit can either reach a higher orbit with its standard cargo, or carry an additional cargo point to its standard orbit – see Section 3.8.3, and Section 3.14.4 below.

3.14.3 Nuclear Engines and LEO

At Industrial Three Nuclear powered spacecraft provide a feasible means of manned exploration of the Inner Solar System. However, this technology is hazardous:

- Nuclear Pulse engines used within LEO will excite the Van Allen Belt – see Section 6.5.4.
- Nuclear Thermal and Nuclear Electric engines are comparatively safe. However, if the craft were damaged the disintegration of the nuclear reactor could introduce high-level radiation to the Earth's atmosphere.

3.14.4 Reusability, Trade and Launch Rails

Early spacecraft are rarely reusable. Once the payload has been delivered to its destination the booster is lost. It either falls back to Earth or is abandoned somewhere in low orbit to become a hazard to navigation or eventually make a fiery return into the atmosphere.

Table 3-14. Base Rocket Lift Capability

Rocket Type	Reusable?	Trade?	Launch Rail?
Single-Stage Rocket	No	No	No
Dual-Stage Rocket	No	No	No
Rocketplane	Yes	No	No
Aero-Spaceplane	Yes	No	Yes
Multi-Stage Rocket	No	No	No
ICBM	No	No	No
SLBM	No	No	No
TBM	No	No	No
MIRV	No	No	No
Heavy Lift Rocket	No	No	No
Single Stage to Orbit	Yes	Yes	Yes
Sub-Orbital Dropship	Yes	Yes	Yes
Nuclear Pulse Rocket	No	No	No
Mars Rocket	No	No	n/a
Shuttle	Yes	No	No
Heavy Shuttle	Yes	No	No
Spaceplane	Yes	Yes	Yes
Heavy Spaceplane	Yes	Yes	Yes
Trans-atmospheric Fighter	Yes	No	Yes
Trans-atmospheric Heavy Fighter	Yes	No	Yes
Cybernetic Autonomous Fighter	Yes	No	Yes
Laser Rocket	No	No	No

3.14.5 Space Range

Once a rocket has lifted its cargo into an orbit, if the cargo is a space vehicle then it has an Operational Range which indicates how far it can move on the Earth-Moon map.

Each transfer line has an associated Range, and it costs one Range Point to transfer from one orbit to another. It costs one Range Point to move from one GEO segment to another, so it is usually cheaper to either drop into a faster LEO orbit or a faster HEO orbit to move between GEO segments.

Once in space, movement is going to be very swift around the Earth Moon system. For instance, a mission to the Moon and back will be achieved well within even the shortest Years per Turn (see Table 2-8). Launch from a Space Port and recovery of the heroic crew on touchdown back on Earth will take a certain number of AP. For game mechanics, all movements between orbits, transfer routes, landings and dockings take a minimum of 1 AP.

Where a space vehicle has an Operational Range greater than the total orbital changes and transfer route require it is assumed that it is capable of greater maneuver and this will be a factor in space combat…

If a space vehicle has insufficient Range to complete a transfer route or to reach a safe location at the end of the turn (such as Earth, a Lunar Outpost, Moon Base, Space Platform or Space Station) it is assumed to be lost through a catastrophic malfunction. Only interplanetary vessels capable of performing journeys lasting months or years are an exception to this. See Section 3.14.6.1 for the example of a mission to Mars.

3.14.6 Exploring the Solar System

Beyond the Earth-Moon system the distances and travel times at Industrial One and Two become very long indeed. With the exception of the Mars Rocket and the Nuclear Pulse Rocket, all Industrial One and Two Earth-Moon space vessels employ chemical propulsion or low yield ion propulsion. They are not capable of supporting the Mission Duration of interplanetary exploration.

Table 3-15. Planetary Data

Planet	*Mean Distance (millions of km)*	*Mean Distance (AU)*	*Mean Orbital Velocity (km/sec)*	*Orbital Period (Earth years)*
Mercury	57.9	0.387	47.88	0.241
Venus	108.2	0.724	35.02	0.615
Earth	149.6	1	29.79	1.0
Mars	227.9	1.523	24.13	1.88
Jupiter	778	5.2	13.07	11.86
Saturn	1427	9.539	9.67	29.46
Uranus	2870	19.184	6.81	84.01
Neptune	4497	30.06	5.45	164.8
Pluto	5900	39.439	4.74	248.5

- AU = Astronomical Unit (the distance of the Earth from the Sun).
- 1 AU = 149,597,870 kilometers.

3.14.6.1 Example: Mars Mission

Approximately every 780 days opposition occurs, which is when Mars is nearest to Earth. This minimum distance varies between about 55 and 100 million km due to the elliptical orbit of the planets.

Missions to Mars fall into the following categories:

- Conjunction class characterized by low speed transits, usually Hohlman transfer orbits, and an extended, approximately 500 day stay on Mars before returning to Earth. The long stay is required because by the time the ship has arrived at Mars the Earth has proceeded too far around the sun to overtake on a return trip.
- Opposition class needing faster transits, higher delta-V breaking requirements at the destination, and far shorter stay times on Mars, roughly 30 to 90 days. Typical total trip time is about 430 days. Often, an opposition class mission means that the spacecraft crosses inside the orbit of Venus on return in order to catch up with the Earth.
- Point-and-shoot opposition class mission where the spacecraft transits to Mars in a few months, stays from 30 to 60 days, and returns to Earth in a few months. Total trip time is under nine months. This type of mission requires very powerful propulsion system.

Note that the longer the duration, the greater risk to the crew from radiation and other hazards.

Given the duration of these journeys the spacecraft must sustain life support and a habitat for the crew – including a rotating ring to provide such gravity whilst the vessel is not under thrust. The vessel includes science stations and limited engineering facilities for maintenance and repair.

Unless several craft are launched at the same time, following the same transfer orbit, there is no feasible means of rescue in the event of disaster.

3.14.6.2 Simplified Transit Times in the Solar System

To travel between one planet and another, the spacecraft must generate Delta-V equivalent to the difference in orbital velocity.

The following tables provide the minimum propulsion delta-v required to move from the orbit of one planet to another, and the journey time in months using a Hohmann Orbit. An Interplanetary Transfer Network trajectory requires a lower delta-v but the journey time is too long for a manned mission, save aboard a Cycler. Earlier interplanetary probes are assumed to follow a Hohmann orbit, with the probe using a gravitational sling-shot to achieve the required delta-v.

Table 3-16. Hohmann Orbit Delta-V (km/sec)

	Mercury	*Venus*	*Earth*	*Mars*	*Jupiter*
Mercury		12.548	17.145	21.354	25.643
Venus	12.548		5.202	10.531	17.993
Earth	17.145	5.202		5.593	14.439
Mars	21.354	10.531	5.593		10.154
Jupiter	25.643	17.993	14.439	10.154	

	Asteroid Belt
Mercury	24.574
Venus	15.455
Earth	11.175
Mars	6.091
Jupiter	4.733

- Note: delta-v assumes transit from the orbit of one planet to the orbit of the other. It does not include the delta-v for take-off and landing.
- Asteroid Belt includes only asteroids in the main belt such as Ceres.

Table 3-17. Hohmann Orbit Transfer Times (months)

	Mercury	*Venus*	*Earth*	*Mars*	*Jupiter*
Mercury		2.5	3.5	5.6	28.4
Venus	2.5		4.8	7.2	31.0
Earth	3.5	4.8		8.6	33.2
Mars	5.6	7.2	8.6		37.5
Jupiter	28.4	31.0	33.2	37.5	

	Asteroid Belt
Mercury	12.0
Venus	14.0
Earth	15.7
Mars	19.1
Jupiter	48.4

The actual distances between the planets varies according to their relative positions in their orbits. Unless the GM wishes to plot the positions of the planets (possibly using an online Orrery) and calculate the dates of launch windows for transfer orbits it is recommended that Launch Windows are ignored.

The synodic periods are provided in the table below for those who need to know.

Table 3-18. Hohmann Orbit Launch Windows (months)

	Mercury	*Venus*	*Earth*	*Mars*	*Jupiter*
Mercury		4.8	3.8	3.3	2.9
Venus	4.8		19.4	11.1	7.9
Earth	3.8	19.4		26.0	13.2
Mars	3.3	11.1	26.0		27.2
Jupiter	2.9	7.9	13.2	27.2	

	Asteroid Belt (Ceres)
Mercury	3.0
Venus	8.6
Earth	15.5
Mars	39.7
Jupiter	91.5

$$TT = \frac{H\Delta_V}{M\Delta_V} \times Ht$$

Where **TT** is the Transit Time of the journey in months rounded up, $\mathbf{M\Delta_V}$ is the Delta-V of the Mission spacecraft, $\mathbf{H\Delta_V}$ is the Hohmann Orbit Delta-V from Table 3-16 and **Ht** is the Hohmann Transfer Time from Table 3-17.

This is a seriously *major* simplification but it provides a framework for calculating orbit transfer times without considering the Rocket Equation and other mechanics.

The $\mathbf{M\Delta_V}$ is determined according to the propulsion system and the requisite QRs.

The duration and relative thrust of the propulsion burn is provided for color.

Designer's Note: Virtually all Industrial Two and Three propulsion systems are relatively low yield and will follow trajectories similar to Hohmann orbits. Once all spacecraft (except Electric propulsion) have performed the main engine burn their trajectory is set and cannot abort.

Fast orbital transfers will have to await Fusion technology.

Table 3-19. Propulsion Systems

Type	*Drive*	*Bonus ?*	*Spare Cargo Bonus?*	*Duration of Burn*	*Thrust*
Magnetic Nuclear Pulse	15	Nuc QR	Yes	Days	High
Nuclear Thermal	8	Nuc QR / 2	Yes	Minutes	Med
Nuclear Electric	7	Nuc QR / 4	Yes	Months	Low
Nuclear Pulse Rocket	10	Nuc QR	No	Days	High
Mars Rocket	5	None	No	Minutes	High
Solar Electric	See Next Table	None	Yes	Months	Low

The effectiveness of the Solar Electric drive is governed by its proximity to the sun. Beyond the orbit of Mars it provides no significant propulsion.

Table 3-20. Solar Electric Drive

	Mercury-Venus	*Venus-Earth*	*Earth-Mars*	*Mars+*
Solar Electric	10.5	8.5	4.5	Not usable

$M\Delta_V$ = Drive + Bonus + Unused Cargo

Examples:

The Aztec Empire has constructed a Solar Electric Mars Mission, the *Tonatiuh One*. They have elected to carry only limited exploration equipment, freeing up 2 points of cargo. This gives the *Tonatiuh One* a drive of 6.5. It will take (5.593/6.5) x 8.6 months to reach Mars = 7.39, rounded up: 8 months.

The Danes have constructed a Magnetic Nuclear Pulse Mars Mission, the *Knut*. They have elected to use all available cargo and have a Nuclear QR of 6. This gives the *Knut* an impressive drive of 21. It will take (5.593/21) x 8.6 months to reach Mars = 3 months.

3.14.6.3 Planetary Sling-shots

To increase the delta-v of a space vehicle a Gravitational Sling-shot can be performed, requiring a Rocketry QR roll. This permits deep space missions to be performed, but adds the duration of a journey to another planet. Sling-shots using the Moon can be performed, but a slingshot commencing from LEO via the Moon only adds a delta-V of 4.1 km/sec.

To perform one of these (very simplified) maneuvers the spacecraft must fly to another planet and be designated as performing a slingshot. The delta-v of the planet is then added to the drive of the spacecraft.

Example: The South Afriqan Space Agency intends sending a manned mission to Jupiter using a Nuclear Thermal vehicle. Normally it would take 59.9 months, rounded up: 60 months to arrive. This is too long. The GM confirms an alignment of the planets that makes a sling-shot maneuver via Venus practical. It will take the spacecraft 4 months to reach Venus. It then performs a slingshot aimed at Jupiter.

A Nuclear Thermal engine has a drive of 8; adding the delta-v of Venus gives an effective drive of 8 + 5.202, rounded down to 13. The delta-v from Venus to Jupiter is 17.993, so the transit time becomes (17.993/13)*31=42.9, rounded up to 43 months. Added to the transit time to Venus, this gives a duration of 47 months, saving a whole thirteen months of journey time.

Unfortunately, the QR roll indicates a thruster malfunction and the SASA spacecraft fails the slingshot, grazes the atmosphere of Venus and is lost.

Under relatively rare circumstances a series of slingshots can be performed in the Inner Solar System to reduce travel times to the outer planets.

3.14.6.4 The Moons of Jupiter

Even if a mission reaches the vicinity of Jupiter to orbit one of the major moons it would have to match its velocity around Jupiter. This could be achieved by using a gravitational slingshot around Jupiter (requiring a Rocketry QR roll) to insert the spacecraft into the desired location.

Table 3-21. Galilean Satellite Delta-V (km/sec)

Jovian Moon	*km/sec*
Io	17.3
Europa	13.7
Ganymede	10.9
Callisto	8.2

3.14.6.5 Mission Duration

Each interplanetary spacecraft has a Mission Duration limit. This indicates how long the spacecraft systems can operate before a return to an operational space platform or station is required. Duration can be increased by 3 months per unused cargo point. Note that this unused cargo cannot be added as a bonus to the Drive rating. If a spacecraft stays out longer than its Mission Duration then its systems fail, the crew die and the spacecraft is lost.

Whilst en route an interplanetary mission will appear on the stat sheet as a Project with zero gp and nfp to pay, but a Years to Complete to record the time to arrival.

At least one month must be spent in the orbit of the target planet unless a fly-by mission is being performed to release a planetary probe. To stop the GM going mad, gravitational sling-shots are ignored here.

Effective Mission Duration can be increased by the completion of the R&D Human Hibernation project.

3.14.6.6 Robot Cargo Ships

A robot version of the interplanetary vessels can be constructed. These have an additional 3 cargo points and are useful for delivering cargo to another planet to expand the capabilities of an interplanetary mission.

However, such ships lack the capacity for maintenance and repair once under way. On reaching the destination the Rocketry QR (*and* the Nuclear QR for spacecraft using nuclear propulsion) must be rolled or the cargo ship is lost forever.

Nuclear Pulse Rockets cannot act as Robot Cargo Ships.

Vessels controlled by a cybernetic AI (see Section 5.3.96) are not subject to the limitations of a simple robot vessel, as they can autonomously command the vessel, both for repair and to avoid hazards not included in its programmed course.

In addition, it can carry twice the cargo of a normal ship as there is no overhead for life support or crew accommodation.

3.14.6.7 Space Combat

Combat between two space vehicles or habitats is only possible if they are in the same location (an orbit, Lagrange Point or in proximity to an asteroid). In addition to the normal Combat and Siege ratings, the excess Range capability of a vehicle can be used to maneuver, break off or pursue an enemy. This means that in addition to specifying the movement of a vehicle, any excess Range must be specified for Combat purposes, and the use to which that excess is to be used:

- Evade. The vehicle(s) will attempt to avoid combat.
- Attack. The vehicle(s) will maneuver or pursue.

Examples:

The Baklovakian space pirates are attempting to attack a Frankish spacecraft. The Baklovakian has an excess range of 5 whilst the Frankish spacecraft as an excess range of 6.

The Baklovakians waste fuel in pursuit but fail to engage their target.

A flight of Aztec battlespace fighters intercept a Swedish-Russian mining ship. The fighters have an excess range of 6 for Attack. The mining ship has an excess range of 2 for Evade.

6 – 2 = 4.

The Aztec attack will have a maneuver bonus of 4. The Swedish miners are in big trouble.

3.14.6.8 Space Combat in the Far Beyond

It is extremely unlikely that I2 or I3 spacecraft could match trajectories sufficiently closely to interact in the empty void between the planets. Only planetary orbits and particular locations such as asteroids offer likely opportunities for vehicles to meet.

All I3 Interplanetary Mission craft are equipped with Local Space Defense to protect from meteors, and have sophisticated sensor suites.

3.14.6.9 Interplanetary Spacecraft in Earth-Moon Space

Interplanetary spacecraft can be used to transport supplies and other units in Earth-Moon space with an effective Range shown in the table below. The drive and cargo bonuses do not apply in this confined volume of space.

It will be noted that most interplanetary spacecraft can go anywhere they want, though none of these craft can land on the Earth or Moon. It still takes them 1AP to dock with a space platform or station, or with another craft.

Electric propulsion craft are relatively low velocity, requiring several weeks of gentle acceleration so they are of little application in the 'small scale' of the Earth-Moon system.

Table 3-22. Propulsion Systems: Range

Type	*Range*
Magnetic Nuclear Pulse	60
Nuclear Thermal	50
Nuclear Electric	20
Nuclear Pulse Rocket	40
Mars Rocket	30
Solar Electric	10

An interplanetary spacecraft entering orbit or a Lagrange point at the end of an interplanetary journey will only have a fraction of this range remaining. As Years per Turn will be at one month a turn, the fraction remaining from the calculated interplanetary trajectory duration will indicate what Range the ship has remaining.

3.14.7 Near Earth Asteroids

The asteroids of the Main Belt *could* be explored during Industrial Two and Three but they are too distant to be exploited. However, there are a large number of Near Earth Asteroids ranging from small rocks to large mountains that approach within 1.3 AU of the Sun or cross the Earth's orbit. Many of these require a relatively low delta-v to intercept from Earth-Moon space.

The Near Earth Asteroids are grouped into the following classes:

- Aten asteroids having a semi-major axis less than 1 AU, named after 2062 Aten.
- Apollo asteroids having a semi-major axis greater than 1 AU, crossing the Earth's orbit, named after 1862 Apollo.
- Amor asteroids approaching the orbit of the Earth from, but do not cross it named after the asteroid 1221 Amor. Most Amors cross the orbit of Mars.

See Section 3.18 for the types of asteroid and their value. The GM will determine how much of value can actually be mined and provide an assessment provided by the nation's TL. More detailed observation (an Investigate action using SpaceWatch facilities or a dedicated interplanetary probe) may provide a fully accurate evaluation of the type of asteroid and its resource potential.

Asteroids can be classified by observation (roughly) by spectral type - though there is margin for error. Near Earth Asteroids can be mapped by performing the Monitor SpaceWatch Network (see Section 6.4.2.9) action. This action may detect Near Earth Asteroids, indicating their probably type, their orbit, when they will come within Range and how long they will be in Range.

Whilst an asteroid impact on Earth could be catastrophic, at Industrial One and Two the technology exists that might defect such an Earth-killer (if it is detected in time).

3.15 CONSTRUCTION: SPACE PLATFORMS AND SPACE STATIONS

Space platforms and space stations represent permanent facilities in space. The ability to build these constructs requires the relevant R&D project to be completed.

The main expense is lifting the nfp up from Earth. Each point of NFP and each point of Wall Point equals one cargo point launched from Earth by rocket or spaceplane to its location. cNFP derived from space-based resources becomes very cost effective.

Rockets are expensive and single-use; aero-spaceplanes, shuttles and spaceplanes offer a reusable and cheaper means of sending NFP into space. Note that the Rocketry QR determines if a launch is successful.

Co-builds can be made for space stations. The co-builder must provide the GP and NFP and either the lift capability or arrange for the owner to lift the build to the location.

Spacecraft can dock at a space platform or space station. This is equivalent to the action of a terrestrial ship entering or leaving a port.

3.15.1 Space Platform

A space platform can be constructed in orbit once the **R&D Rocketry: Space Platform** project has been completed. See Section 5.3.25.

A space platform consists of a number of modules and is a first stepping stone into the Solar System. Space platforms are usually built in Low Earth Orbit and can only be placed in LEO or GEO orbits. A space platform includes science, power, habitation, fabrication modules in a micro-gravity environment.

A space platform is effectively a port fortress in space. It is built by spending 100 GP and lifting 10 NFP to its designated location. This means that a space platform is likely to appear as a national project over several turns. Completion creates the space platform and 1 Wall Point. A space platform cannot be increased in size.

Further Wall Points can be launched and added to the space platform, representing defensive systems against meteorite impacts and attack, and hard points and silos for the mounting of weapon units. The number of Wall Points denotes the maximum number of weapons units (nuclear warheads, space weapons) that can be mounted on it.

Note that space platforms are extremely vulnerable to kinetic impacts. A nuclear detonation will only destroy the station if it is in LEO or the explosion is very close (as the facility must be shielded from solar and cosmic radiation).

The platform should be provided with a designation such as *Spacelab, Salyut, Mir, Almaz, 921-2*.

Once completed the nation owning the space platform gains the following advantages:

- A bonus to their university investment.
- If the platform is in Earth orbit the ability to perform SRF actions without using spy satellites.
- Nuclear warhead units can be mounted on the space platform converting it into an orbital bombardment platform.
- Space weapon units can be mounted on it for self-defense up to a maximum of twenty.
- If the space platform is in a GEO orbit advanced space weapons can defend the hex beneath it. The exact large hex it defends must be noted when the space platform is constructed or the space platform must be moved using Tugs to the location.
- The capability to build spacecraft in orbit from components launched from Earth.
- The capability to dock spacecraft at the space platform as a port fortress.

Note that whilst a space platform cannot be demobilized to build other units it can be linked to a space station becoming a zero-gravity annex to the central core.

The costs of supplying and maintaining a space platform are included in the standard fortress support costs. To be operational the nation must have one Spaceport (or one Air Base if it is using spaceplanes).

If a space platform is not operational then it is assumed that the crew has abandoned it and the owning nation ceases to gain any benefit from it. It cannot be used to dock other space vehicles. It could be salvaged by another nation, or if in LEO the orbit could degrade resulting in a fiery return to Earth…

3.15.1.1 Moving a Space Platform

A space platform can be moved from LEO to a GEO and vice versa by the use of space tugs or heavy landers. One tug is required per Wall Point or one heavy lander per four Wall Points to change the orbit of the platform. It takes 2AP to move the facility.

3.15.1.2 Agro Consumption

Like a normal fortress, a space platform consumes no Agro.

3.15.2 Space Station

A space station can be constructed once the **R&D Rocketry: Space Station** project has been completed. See Section 5.3.40.

A space station is a wheel in space –a small port city – that rotates to generate centripetal (centrifugal) force. It consists of a rotating habitation ring connected to a low gravity or zero gravity central core. The core consists of the docking area and industrial units. The industrial capacity of the station can be used to process material mined from an asteroid or the Moon – see Section 3.18.

Table 3-23. Space Station & Expansion Costs

	LEO	*GEO*	*Elsewhere*	*result*
Initial	200gp/ 20nfp	220gp/ 25nfp	230gp/ 30nfp	[1/0]
Increase	100gp/ 10nfp	120gp/ 15nfp	125gp/ 20nfp	[+1/0]

A space station is built by spending the GP and lifting the NFP by rocket or spaceplane to its designated location. This means that a space station is likely to appear as a national project over several turns. Completion of the space station creates a 1GPv city. A newly built space station is Friendly to the nation that built it, thus providing its full value in GP. It does not provide any NFP to the owning nation.

Material mined from an asteroid or the Moon can be used to provide cNFP, using the industrial capacity of a completed space station (see Section 3.18). A Moon Base implicitly includes mining facilities and so building materials can be more cheaply obtained from the Moon. The building of a mass-driver (see Section 3.8.4) further reduces the costs of space construction.

The maximum size of a space station or space colony is the Rocketry QR of the nation, representing technical capability.

Wall Points can be launched and added to the space station. These represent shielding and defensive systems against meteorite impacts and attack, and hard points and silos for the mounting of weapon units. The number of Wall Points denotes the maximum number of weapons units that can be mounted on it. If a space station has no Wall Points it consists of an inflated ring linked to the central core.

Note that space stations are extremely vulnerable to kinetic impacts. A nuclear detonation will only destroy the station if it is in LEO or the explosion is very close (as the station must be shielded from solar and cosmic radiation).

The space station should be provided with a designation such as *Island One, Gateway Station, Space Station V*.

Once completed the nation owning the space station gains the following advantages:

- A bonus to their university investment.
- If the station is in Earth orbit the ability to perform SRF actions without using spy satellites.
- Nuclear warhead units can be mounted on the space station converting it into an orbital bombardment platform.
- Space weapon units can be mounted on it.
- If the space station is in a GEO orbit advanced space weapons can defend the hex beneath it. The exact large hex it defends must be noted when the space station is constructed.
- The capability to build spacecraft in orbit from components launched from Earth.
- The capability to dock spacecraft at the space station as a port city.
- The ability to use the intrinsic Industrial Capacity of the space station as Rocket Factories to build space units (this is an exception to the HBZ rule).
- The ability to host other factories according to city size. The NFP must still be lifted by rocket or spaceplane from Earth unless it is mined from an asteroid or the Moon and uses the industrial capacity of a completed space station – see Section 3.18.

A space station cannot be moved or demobilized to build other units. A space station cannot be used to base msp. An existing space platform can be attached to the space station or a new platform can be built as an annex to the central hub. This 'fortress' represents weapon and docking bays.

Table 3-24. Space Platform Annex Costs

LEO	*GEO*	*Elsewhere*	*result*
100gp/ 10nfp	100gp/ 10nfp	150gp/ 20nfp	[1/0]

The costs of supplying and maintaining a space station are included in the standard city support costs. To be operational the nation must have one Spaceport (or one Air Base if it is using spaceplanes) and craft that can reach it.

If a space station is not operational then it is assumed that the crew has abandoned it and the owning nation ceases to gain any benefit from it. It cannot be used to dock other space vehicles. It could be salvaged by another nation, or if in LEO the orbit could degrade resulting in a fiery return to Earth…

3.15.2.1 Agro Consumption and Production

A space station consumes agro as per a normal port city with a Terrain Consumption Multiple of Cultivated. Supplying the station with consumables would represent a significant drain on the launch budget, so some measure of self-sufficiency is a priority.

3.15.3 Space Colony

When a space station becomes a 5GPv city it becomes a space colony. At this point it generates limited agro (in hydroponics tanks).

When a space station becomes a space colony, every GPv provide it with industrial capacity equivalent to five Rocket Factories. This means that space vehicles can be built at the colony.

A space colony can be used to base msp used to trade with the colonies of other nations.

3.15.3.1 Types of Space Colony

Although in this game system space colonies evolve from space stations, this can be taken as the gradual construction of these larger orbital constructs. Radiation shielding is provided by processed lunar rock and slag from various industrial processes. There are a number of basic types of space colony:

- **Bernal Sphere:** A large sphere with attached cylinders. The sphere rotates but only has gravity along its equator. The form of a sphere has an optimum ability to contain air pressure efficiency at providing radiation shielding.
- **O'Neill Cylinders:** A giant rotating cylinder containing a terraformed interior. The cylinder has six equal-area stripes that run its length. Three of the stripes are windows with large hinged mirrors to reflect sunlight in to the land stripes.
- **Stanford Torus:** Shaped like a large circular space station the wheel rotates with an earthlike interior and elevators leading to the industrial micro-gravity hub. A mirror hangs below the wheel to reflect light into the interior.

See also Asteroid Habitats, section 3.19.2.

3.15.3.2 Agro Consumption and Production

A space colony is treated as a normal 5GPv port city for the purposes of agro consumption. Each GPv above five is treated as though it is a c2 (intensively cultivated) region. This emulates the hydroponics and fish tanks aboard the space colony. It also includes small park spaces providing other food sources such as orchards.

3.15.3.3 Recovery of Non-Operational Space Facilities

A non-operational space platform or space station can be made operational again by spending half the GP required to build it and moving half the NFP required in its construction to its location. This represents the repair and maintenance of its systems in addition to providing a crew. Abandoned installations of other nations can also be re-colonised in this way.

Note that the orbit of space platforms and stations in LEO may degrade over time without constant station-keeping. The GM may determine that the installation is beyond recovery and may have entered the Earth's atmosphere. If so, the point of re-entry will be determined by the GM with the wreckage falling to Earth, potentially breaking up into fragments, each of which will cause damage equivalent to a kinetic energy weapon.

3.16 SPACE CYCLERS

A Space Cycler is is special type of space platform or station. An asteroid habitat cannot be converted into a Cycler at these Tech Levels because of the thrust required to place the habitat into a Cycler orbit.

Instead of orbiting a planet it orbits the sun following a trajectory that encounters two or more bodies on a regular basis, for example Earth and Mars.

As a Cycler roughly follows a Hohmann Transfer Orbit it requires little or no propellant. Instead, it relies on gravity assist maneuvers to keep going. The Cycler does require an

initial boost to achieve the necessary trajectory but thereafter can rely on low thrust ion engines using either solar power or nuclear energy.

Note: in reality Cycler orbits are not identical to Hohmann Transfer Orbits, but this is assumed for simplicity…

3.16.1 Cycler Characteristics

A Cycler has disadvantages compared with ordinary spacecraft:

- Its transfer time between two planets at a minimum is the Hohmann Orbit Transfer Window. See Table 3-17.
- Its trajectory depends on how often its location coincides with one of the planets on its route.
- In addition, once a Cycler is boosted into its trajectory it cannot be expanded or its components be reused unless it is brought into a planetary orbit.
- It cannot cycle between more than two planets.

A Cycler has a number of advantages:

- Once it is in place, it will continue its flight until it either runs out of supplies or is decelerated using tugs to return it to a planetary orbit.
- If based on a platform it can carry twenty cargo points.
- If based on a station it can carry twenty cargo points per GPv.
- The Cycler does not have to carry spaceplanes or landers if these are based at locations at its destinations.

Agro costs and production are identical to those for a platform or station. Construction costs for the Cycler platform or station are identical to the standard costs except that it is necessary to pay for the booster engines. The industrial capacity of a Cycler station cannot be used once it has been boosted into its orbit.

3.16.2 Boost Phase

Once the Cycler has been constructed it is necessary to add engines sufficiently powerful to boost it into its desired trajectory. To do this the engine output must at least match the Hohmann Orbit Delta-V.

A Cycler consists of 10 Cargo Mass points per city level; a platform is 10 Cargo Mass points. The $\mathbf{M\Delta_V}$ of the boost engines must at least match the $\mathbf{H\Delta_V}$, the Hohmann Orbit Delta-V from Table 3-16. You require considerable thrust to boost a mass as large as a Cycler into a Hohmann transfer orbit.

$$\mathbf{M\Delta_V = Cargo\ Mass/(Drive + Bonus)}$$

Drive is the combined drive of all the boost engines built onto the Cycler. It is possible to mix and match engines to build, for instance, several Nuclear Pulse Engines and Nuclear Electric or Nuclear Thermal engines. Note that it is not possible to combine Solar Electric engines with Nuclear Pulse engines in the boost phase, but these can be carried and unfurled for in-flight use at the end of the boost phase.

Table 3-25. Cycler Boost Propulsion Systems

Type	*Drive*	*Bonus?*	*Cost*	*Yard Cap*
Nuclear Thermal	8	Nuc QR / 2	1000 gp/ 10 nfp	25n/30r
Nuclear Electric	7	Nuc QR / 4	1250 gp/ 8 nfp	30n/30r
Nuclear Pulse Rocket	10	Nuc QR	2000 gp/ 40nfp	35r/25r
Solar Electric	See Next Table	None	1250 gp/ 8 nfp	30r

The effectiveness of the Solar Electric drive is governed by its proximity to the sun.

Table 3-26. Solar Electric Drive

	Mercury-Venus	*Venus-Earth*	*Earth-Mars*	*Mars+*
Solar Electric	10.5	8.5	4.5	Not usable

3.16.3 Planetary Encounters

Once in-flight, the Cycler will maintain its orbit until it ceases to be maintained, is brought to a halt to orbit a planet (requiring equivalent thrust to that used to boost it) or is destroyed.

Although it now has the Delta-V to follow a resonant or near resonant trajectory between the orbits of two celestial bodies the different orbital periods means than often when the Cycler reaches the orbit of a planet, the planet is not there. To simply this, assume that the transfer time from one planet to the other is twice the standard Hohmann Transfer Orbit duration in months given in Table 3-17.

3.17 CONSTRUCTION: LUNAR OUTPOSTS AND MOON BASES

Lunar outposts and bases represent permanent facilities on the Moon. The ability to build these constructs requires the relevant R&D project to be completed. The location of the outpost must be specified (see Section 4.2).

The main expense is lifting the NFP up from Earth, and possibly via a space platform or station. Each point of NFP and each point of Wall Point equals one cargo point launched from Earth to its final location. Material mined from an asteroid or the Moon can be used to provide cNFP.

Co-builds can be made for moon bases. The co-builder must provide the GP and NFP and either the lift capability or arrange for the owner to lift the build to the location.

Space vehicles can dock at a lunar outpost or base. This is equivalent to the action of a terrestrial ship entering or leaving a port.

3.17.1 Lunar Outpost

A lunar outpost can be constructed once the **R&D Rocketry: Lunar Outpost** project has been completed. See Section 5.3.49. The location of the outpost should be specified on the Lunar Map, see Section 4.2.

A lunar outpost consists of a number of modules partially buried in the Lunar surface to provide protection from the radiation of solar flares. A lunar outpost includes science,

power, habitation, and fabrication modules and is used to explore the lunar environment.

A lunar outpost is effectively a port fortress in space. It is built by spending 150 GP and lifting 10 NFP to its designated location on the Moon. This means that an outpost is likely to appear as a national project over several turns. Completion creates the outpost and 1 Wall Point. It cannot be increased in size.

Further Wall Points can be added representing shielding and protection from meteorites.

The outpost should be built at a specified location on the Lunar Map and provided with a designation.

Once completed the nation owning the lunar outpost gains the following advantages:

- A bonus to their university investment.
- Space weapon units can be emplaced.
- The capability to base space vehicles at the outpost as a port fortress.

Note that whilst an outpost cannot be demobilized to build other units it can be linked to a lunar base.

The costs of supplying and maintaining an outpost are included in the standard fortress support costs. To be operational the nation must have one Spaceport (or one Air Base if it is using spaceplanes) and one space platform or station and at least one heavy lander capable of reaching it.

If an outpost not operational then it is assumed that the crew are dead or have abandoned it and the owning nation ceases to gain any benefit from it. It cannot be used to base other space vehicles. It could be salvaged by another nation.

3.17.1.1 Agro Consumption

Like a normal fortress, a lunar outpost consumes no Agro.

3.17.2 Moon Base

A moon base consists of domes and other installations – a small city on the Moon!

The ability to build these constructs requires the relevant R&D project to be completed, see Section 5.3.60. The location of the outpost must be specified (see Section 4.2).

Table 3-27. Moon Base & Expansion Costs

	Cost	*Result*
Initial	250gp/ 20nfp	[1/0]
Increase	125gp/ 10nfp	[+1/0]

The costs are offset a little compared with a space station because some of the building material is readily available. NFP must still be launched from Earth (with one NFP equaling once cargo point). This means that a moon base is likely to appear as a national project over several turns. Completion of the moon base creates a 1GPv city. A newly built moon base is Friendly to the nation that built it, thus providing its full value in GP and NFP.

The maximum size of a Moon Base is the Rocketry QR of the nation, representing technical capability.

Wall Points can be moved as NFP to the moon base. These represent shielding and defensive systems against meteorite impacts and attack.

The moon base should be provided with a designation such as *Moon Base One* or *Moon Base Alpha.*

Once completed the nation owning the Moon Base gains the following advantages:

- A bonus to their university investment.
- Space weapon units can be emplaced.
- The capability to base space vehicles at the outpost as a port fortress.
- Reduced space station expansion costs as the Moon Base implicitly includes mining facilities and so building materials can be more cheaply obtained from the Moon.
- The ability to build a mass-driver (see Section 3.8.4) on the Moon to reduce the costs of space construction, launching material mined on the Moon into orbit – see Section 3.18.
- The Base can be used to colonize regions of the Moon which allows these regions to be mined. It provides the industrial capacity to convert mined material into other things.

Note that a Moon Base cannot be moved or demobilized to build other units. A Moon Base cannot be used to base msp.

The costs of supplying and maintaining a Moon Base are included in the standard city support costs. To be operational the nation must have one Spaceport (or one Air Base if it is using spaceplanes) and one space platform or station with at least one heavy lander capable of reaching the base.

If a base not operational then it is assumed that the crew are dead or have abandoned it and the owning nation ceases to gain any benefit from it. It cannot be used to base other space vehicles. It could be salvaged by another nation.

3.17.2.1 Agro Consumption and Production

A Moon Base is treated as a normal port city for the purposes of agro consumption for the first 5GPv. Normal Terrain Consumption Multiples apply. Supplying the base with consumables represents a significant drain on the launch budget, so some measure of self-sufficiency is a priority.

Each GPv above five is treated as though it is a c2 (intensively cultivated) region. This emulates the hydroponics and fish tanks.

Note that Moon Bases supply Lunar regions with agro, not the other way around.

3.17.3 Lunar Colonies

All Lunar regions (see section 4.2.1) are treated as **(-/-),** just waiting for some very wealthy people to come along and settle there, hewing mining camps and building fabrication plants out of the wilderness.

The polar regions, with the potential benefits of water under the surface or lurking as ice in the eternal shadow of craters near the poles, and locations in perpetual sunlight, handy for continuous solar power are treated as Trade Centers once colonized gaining an increase the nation's International Trade Value.

The surface of the Moon (the non-polar regions) can also be mined for deposits of Helium3, a useful component for fusion based power. Lunar colonies are required to exploit this resource and to mine the lunar surface – see Section 3.18.

Until a Lunar region is colonized it can be claimed by a nation (indeed the first to land on the Moon *could* claim the entire place…) but it remains as uncontrolled. There may be no hostile natives but the environment itself is bleak and relentlessly hostile.

A lunar region cannot be colonized until it holds an operational Moon Base, or the region is connected to a Moon Base by a mag-lev railway segment.

The colonization of a Lunar region can be accomplished by the expenditure of 100 GP and 25 NFP for each one (1) GPv increase, starting at a base value of minus one (-1). In other words, the first 100 GP and 25 NFP installment will make the area a (0/?) region, the second installment will make it a (1/?) region. The colonization of a Lunar region represents numerous small settlements supporting surveying and mining.

The GP and NFP may be expended over a period of time with each GPv increase coming when the requisite GP and NFP have been expended and delivered to the Moon.

The maximum combined size of the total lunar colonies cannot exceed the total combined GPv size of the operational national Moon Bases. This represents the maximum life support capability of the Moon Bases in hydroponics tanks and other resources. The Moon is a harsh mistress.

3.17.4 Lunar Mag-Lev Railway

To expand the colonization of the Moon, mag-lev railways can be built extending from a Moon Base and using the inherent industrial capacity of the base. NFP must be shipped from Earth or gained as cNFP.

Table 3-28. Lunar Mag-Lev Railroad Costs

Maria	*Terrae*	*Polar*
100gp/ 10nfp	125gp/ 10nfp	150gp/ 10nfp

3.17.4.1 Moving Units by Rail

Each level of Mag-Lev Railroad can carry 20 cargo points of units per turn in a **single** direction. This is the Rail Capacity of a rail line. Multiple levels of rail between lunar regions either allow more Cargo moved in one direction, or half as much in each direction. See Section 3.11 for details of moving units on terrestrial Mag-Lev lines.

3.17.5 Division of Space Facilities in the Event of a Civil War

A Nation may break into one or more successor states due to Dynastic Failure or Civil War. In this case, space based assets will be retained by the factions controlling Space Ports. If only one faction controls a Space Port then they may retain all satellites, space platforms and stations, lunar outposts and Moon bases.

3.17.5.1 Space-based Factions

Like any other territory, space stations and Moon bases *might* secede from the warring Earth-bound factions or support a Leader in orbit or beyond. In this event, the majority of space assets beyond LEO are likely to declare for the space-based faction. The chance of this is low at Industrial One and Industrial Two because of the dependence of the extraterrestrial facilities on the home world.

If the space faction retains command of space weapons, especially nuclear warheads then they may be able to do more than defend themselves against terrestrial forces. The newly independent space faction is, however, going to be at a disadvantage in earning GP, NFP and agro, but will not have to import NFP from Earth (it cannot) and is reliant on cNFP.

3.17.5.2 Recovery of Non-Operational Lunar Facilities

An non-operational lunar outpost, base or colony can be made operational again by spending half the GP required to build it and moving half the NFP required in its construction to its location. This represents the repair and maintenance of its systems in addition to providing a crew. Abandoned installations of other nations can also be re-colonized in this way.

3.18 CONSTRUCTION: USING ASTEROID AND LUNAR MATERIAL

The costs of building space platforms, stations and colonies, and Moon Bases and other facilities can be reduced by using material mined from a Near Earth Asteroid or from the Lunar surface.

Each point of asteroid or lunar material can be converted into construction NFP using the industrial capacity of a space station or Moon Base.

This makes mining in space very useful as there is no need to lift NFP up from the Earth's gravity well. A Lunar Mass-Driver is also very useful in moving Lunar material to orbital factories.

Table 3-29. Asteroid Material Processing

Type	*%*	*CPv*	*Processing Cost (GP)*	*Notes*
C-type	75%	0.5	7	Carbonaceous – carbon and hydrated minerals.
S-type	17%	0.25	8	Silicaceous - of metallic nickel-iron mixed with iron- and magnesium-silicates.
M-Type	8%	1.0	4	Metallic - nickel-iron, pure or mixed with stone.

Note: This refers to Inner System Asteroids. This differs from the composition percentages of the Asteroid Belt.

Table 3-30. Lunar Material Processing

Region	*CPv*	*Processing Cost (GP)*
Polar	1.0	5
Maria	0.5	10
Terrae	0.2	8

Each point of material can be converted into raw material. Note that each point is one cargo point (one point of Cargo Mass), regardless of its value.

RAW = cargo points x CPv

The raw material can be converted into construction NFP by using the industrial capacity of a space station or Moon Base. The raw material must be moved to the location of the industry – Lunar material can be launched from a mass-driver. The cost per Cargo Mass point is:

GPcost = RAW x Processing Cost

Resulting in:

cNFP = RAW

Lunar cNFP can also be used to build simple kinetic energy weapons. See Section 3.8.4.1.

3.18.1 Asteroid Size

Asteroids vary in size from relatively small rocks to flying mountains. An indication of the 'size' of an Asteroid is provided by its Cargo Mass index. Asteroids vary in Cargo Mass from a value of one (not really worth the time and effort to mine) to hundreds of thousands. There are about a thousand Near Earth asteroids almost a kilometer in diameter (in game terms approximately 10,000 Cargo Mass points) with a very few of two kilometers in diameter. Asteroids in the Main Belt come in much larger sizes.

To practically use the larger Near Earth asteroids it will be necessary to fracture them having drilled a hole and detonated a small nuclear warhead.

3.18.2 Asteroid Strength

The Siege Strength of an asteroid is determined by its size as Cargo Mass and its type.

Table 3-31. Asteroid Natural Siege Strength

Type	*Base Strength*	*Structural Strength Range*	
		Minimum	*Maximum*
C-type	0.1	0.2	1.3
S-type	0.3	0.3	1.5
M-Type	0.5	0.1	2.0

Siege Strength =
Cargo Mass
x Base Strength
x Structural Strength

An asteroid with a Structural Strength less than 0.4 is a rubble pile; an asteroid with a Structural Strength less that 0.5 is fractured.

The structural strength of the asteroid is affected by its porosity (the amount of empty space within it), how fractured it is and whether it is a conglomeration of rubble. If it is composed of loose dust and rock it is easy to mine but useless for habitat construction. It is also virtually impervious to nuclear detonations as it will break up (threatening any nearby mining ship) and over time mostly recombine.

When attempting to destroy or fracture an asteroid with nuclear weapons, the Siege Strength of the nuclear warhead is opposed by the Siege Strength of the asteroid. A bonus can be added if the asteroid is not a rubble pile or severely fractured if a shaft is excavated to allow the bomb to explode from within (this requires a mining ship). With careful placement of weapons near, on or within the asteroid its trajectory may be deflected. If it shatters there is the chance it will break into smaller but still threatening pieces (useful for mining) or recombine.

Even if the asteroid is not severely damaged by the explosion there is a chance that its trajectory will be altered.

3.18.3 Asteroid Mass-Driver

Base Level Varies

Instead of mining a Near Earth Asteroid in situ at TL20 and above a mining ship can deliver a mass-driver to move the flying mountain to a more convenient location.

At Industrial Three this is the only way of moving an asteroid to Earth-Moon space or anywhere else other than attempting to deflect it with nuclear explosions. Once constructed the automated mass-driver uses rock and dust mined from the asteroid itself to change its orbit, eventually to bring it to a convenient location where its entire remaining mass can be mined for cNFP.

The cost of the project includes removing any spin from the asteroid and installing the mass-driver. The mining ships can then leave the rock, tagged as property as it takes months or years to move to the desired location. A rubble pile asteroid is too broken up to be moved with a mass-driver.

When the asteroid is first located the GM will determine its size and the Base Level of the Project, as well as the time duration required. The Base Level depends on the Cargo Mass of the asteroid and the degree to which its orbit must be adjusted. It is liable to take many orbits of the Sun before it can be brought into Earth-Moon space. The miner can attempt to fracture the asteroid to provide pieces of a more practical size.

When embarking on the construction mission the player must then declare the actual Base Level being deployed. If the actual project has half the Base Level then it will take twice as long to move the asteroid; if it has a quarter then four times; if it is twice the Base Level then half the time; if four times the Base Level then a quarter of the time. No other variations are permitted.

The project is performed by paying the GP cost, and by moving the NFP cost to the asteroid using a mining ship or ships. Once all of the GP and NFP costs have been paid the Project duration count can commence. It only takes a month to construct the mass-driver itself – unless all the NFP is not delivered at once.

When the Years to Completion have been satisfied the asteroid has arrived at the desired location and can be processed using the Industrial Capacity of a space station. It can also be converted into an asteroid fortress or habitat (see section 3.19.

Note that once built the mass-driver itself is 'lost'. Even on arrival its GP and NFP cannot be reused.

Each Base Level required also reduces the cargo mass of the asteroid by one point, representing material used to move it.

Example

The Albanian Asteroid Mining Company has identified Near Earth Asteroid AM-01540 and intends moving it to L5. This is identified as a Base Level 4 Project, meaning that it would take eight years to move it to L5. The Albanians decide to mount a Base Level 2 mass-driver onto the rock, meaning that it will take sixteen years to arrive. As it is a metallic asteroid consisting of 120 cargo mass points of material it is very valuable and well worth the wait. The Albanians send two mining ships and construct the mass-driver.

Once the mass-driver is complete a new project appears as:

	GP	NFP	Years	
Move AM-01540 to L5	0.0	0.0	0.0	= Paid
	0.0	0.0	16.0	= Cost

When the asteroid arrives it will consist of 116 cargo mass points.

3.18.3.1 Asteroid Mass-Drivers as Weapons

Unlike a Lunar mass-driver (see section 3.8.4) an asteroid mass-driver cannot be used as a weapon to launch kinetic energy weapons or nuclear warheads. It does eject a substantial amount of rubble and dust and so constitutes a hazard to busy locations. Normally when moving into Earth-Moon space the asteroid will already be moving very slowly to enter orbit or one of the Lagrange points.

If an asteroid mass-driver is used in Earth-Moon space then any vessel, installation or station in the same location may be damaged.

3.18.4 Asteroids as Weapons

With the ability to move or deflect asteroids (see section 3.6) there is a danger of asteroids being used as weapons to impact the Earth or other bodies.

At Industrial Two and Three the technologies for moving asteroids are slow and relatively primitive, so any threatening object is liable to be seen months or years before impact – unless it has already been moved into Earth-Moon space, supposedly for mining. An incoming asteroid is liable to result in opposing missions to deflect it.

In space any asteroid will often be moving so slowly that a collision can be easily avoided – even space platforms and stations would be able to make avoidance maneuvers. If a nuclear weapon has been inserted via a mining shaft and if detonated, then the fragments will be lethal to any nearby installations and vessels. The asteroid will have a greater velocity, relative to the Earth, if it has been placed on an intersecting trajectory rather than one intended to make it available for exploitation. This may have a higher or lower Base Level than standard mass-driver usage.

If an impact is attempted on the Earth or Moon then hitting the desired location requires a successful Rocketry QR test, subject to the velocity of the object: the higher the velocity, the greater chance that it will miss, either entirely or coming down somewhere else. Against the Earth there is also a chance that the Earth's atmosphere will modify its trajectory so divergence must be tested for.

The actual damage caused depends where it hits, its velocity and its size.

An asteroid hitting the Moon is liable to destroy or damage mining colonies and bases in the hex where it comes down and cause Moonquakes in the surrounding hexes.

An asteroid hitting the Earth will be particularly devastating if it hits an ocean, causing massive tsunami. Debris will also be thrown into the atmosphere reducing both local and global Agro production. If the asteroid is large this is a potential Doomsday event.

Table 3-32. Asteroid Impact Effects

Structural Strength	*Structure*	*Impact Multiple*	*Effect*
<0.4	Rubble pile	(2)	Airburst in atmosphere (else a cluster of impact craters)
<0.5	Fractured	2	Cluster of impact craters
	Solid	1	Large Impact Crater

Type	*Type Multiple*
C-type	1
S-type	2
M-Type	4

Size	*Size Multiple*	*Effect*
<4	0 (0.25)	No Effect in atmosphere. Burns up in the Earth's Atmosphere. (Effect in vacuum).
<10,000	Size/1000	Megatons of damage: Local Effects
10,000+	Size/500	Million Megatons+ of damage: world wide climatic damage; extinction level event.

Table 3-33. Terrain Impact Effects

Terrain Type	*Terrain Impact Multiple*
m	0.5
w, d, t	0.75
c, c2, s, l, j, o	1.0

3.18.4.1 Impact Effects

Impact Damage =
Impact Multiple x Type Multiple
x (Size Multiple x 50)
x Terrain Impact Multiple

For a land impact or airburst the damage should be applied to the region/city hit by the asteroid. The damage caused by an impact weapon is divided equally into the components: GPv population loss, pwb loss, Wallpoints, damage to factories and yards and units present at the location.

If the region is totally destroyed (all contents vaporized including GPv) then the remaining damage should be applied to the regions surrounding the impact point. Any damage remaining should be applied to the regions surrounding those, and so on, until all damage has been used up.

A fragmented impact can be far worse than the damage caused by a single blow involving an undivided body. In the worst case the fragmentation can cause an airburst, or pieces may come down over a wide area in two or more regions.

Note that air raid shelters and bunkers reduce the effects of an airburst. They do not reduce the effect of a land impact.

3.18.4.2 Water Impacts

For a water impact the effects are more widespread.

Table 3-34. Water Impact Effects

Sea Zones/ Open Ocean Hexes from impact	*Effect*
0-1	Apply full damage to coastal cities and coastal regions (including islands). All shipping in coastal waters is destroyed.
2	Apply half damage to coastal cities and coastal regions (and islands). Half shipping is destroyed in coastal sea zones. In open waters ships ride out the massive waves without damage.
3-4	Apply quarter damage to coastal cities and coastal regions (and islands).
5-8	Apply quarter damage to coastal cities and

Sea Zones/ Open Ocean Hexes from impact	Effect
	port areas.
9-16	Apply eighth damage to coastal cities and port areas.

3.18.4.3 Rubble Pile Airburst Effects

Airburst Damage =
Type Multiple x (Size Multiple x 100)

An airburst may cover both land and water – the effects are the same: anything on the surface (buildings, ships, whatever) within the radius of the multiple fire balls is incinerated. Thin layers of blue-green glass may be deposited on the surface because of the extreme heat. Outside the immediate radius searing heat and blast will cause major damage.

3.18.5 Asteroid Piracy

Just in the old days of claims jumping on Earth, an asteroid can be stolen. If an asteroid is being mined by a nation then it is likely to be treated as national territory – at least whilst it is being mined. After a mining ship leaves because the asteroid's orbit is reaching the point where the miner has to head for home it probably reverts to being unclaimed territory.

If the asteroid is being moved by mass-driver then it is still under claim. The automated mass-driver will not be a clever device, but it will be regularly transmitting its position for navigation purposes and reporting its status. As its journey is liable to take months or years there is no reason why it cannot be located and interfered with. A pirate could rendezvous with the asteroid and reprogram the mass-driver just as merchant shipping can be seized.

In this event the owner looses communication with its rock and someone else steers it onto another course, either to steal or for some other nefarious purpose. Stealing an asteroid is an act of war unless it is concealed.

3.19 CONSTRUCTION: ASTEROID HABITATS

An asteroid moved into orbit or to a Lagrange Point can be converted into a space platform or station. Only Silicaceous and Metallic asteroids can be used in this way, and there is a still a chance that the asteroid may be too fractured or an agglomeration of loose dust and rocks. A mining ship can survey the asteroid before moving it to determine whether it is useful.

If the installation is to be built into the asteroid then this means that it can be partially mined to provide cNFP and the remaining material provides free Wallpoints.

The mass of the asteroid remaining after construction provides free Wallpoints up to and beyond the Siege QR of the nation.

Table 3-35. Asteroid Wallpoints

Asteroid	Wallpoints
S-Type	C/3
M-Type	C/2

An asteroid has a Cargo Mass value indicating its size. The building of an Asteroid Fortress or Habitat hollows out some of this size: 20 cargo points for a fortress and 30 cargo mass points per city level for a Habitat. Additional material can be mined from the asteroid, but this reduces its Wallpoint value by reducing its shielding and compromising its structural integrity.

Example

Near Earth Asteroid AM-01540 has been moved into L5 by the Albanian Mining Company and 30 cargo mass points worth of material has been mined from it, leaving it with 86 points. The Qing Empire purchases the asteroid and decides to convert it into a space fortress. Another 20 points are now purposefully mined from the interior rather than the surface, and the fortress is installed and space-based lasers and kinetic energy weapons are added to it. The surface is now festooned with solar panels and antennae.

Once complete the *Zhanxing* is a formidable fortress with 33 Wallpoints.

At Industrial Two and Three asteroid fortresses and habitats can only be moved *very slowly* by building a mass-driver and using some of the cargo mass of the asteroid itself, unless the asteroid is very small.

The following type of engines can be installed on a small asteroid if the requisite R&D project has been completed. A mass-driver can be built at TL20.

One engine is required per 10 Cargo Mass points, where an Asteroid Fortress is equivalent to 10 Cargo Mass and a Habitat is 20 Cargo Mass points per city level. Each engine installed reduces the Wallpoints by one point.

Table 3-36. Asteroid Engine Systems

Type	Drive	Bonus ?	Range	Cost
Magnetic Nuclear Pulse	15	Nuc QR	60	500gp/ 5nfp
Nuclear Thermal	8	Nuc QR / 2	50	500gp/ 5nfp
Mass-Driver	1	-	6	50gp/ 25nfp

Example

The Qing decide to mount three Thermal Nuclear engines onto the *Zhanxing*. The Qing Nuclear QR is 10.

The Cargo Mass of the *Zhanxing* is 66 + 10 = 76.

With three engines mounted this gives a performance of 30/76 = .394, rounded up 0.4 of the Drive and Range. The *Zhanxing* now has a Drive rating of (8+5) x 0.4 = 5.2 and a Range of 50 x 0.4 = 20. It now has 30 Wallpoints. A slow but formidable battlestation.

With sufficient engines this means that an asteroid habitat *could* be converted into a slower than light interstellar vessel, but it would need to sacrifice a large amount of its volume for fuel tanks.

3.19.1 Asteroid Fortresses

An asteroid fortress is effectively a port fortress in space. It is built by spending 100 GP, mining 10 cNFP from its interior and then either lifting 10 NFP to its designated location or spending 20 cNFP to outfit it. This means that an asteroid fortress is likely to appear as a national project over several turns. Completion creates the asteroid fortress. A space platform cannot be increased in size or have additional Wallpoints added. A space station can also be built in the hollowed out interior but this reduces its Wallpoints.

Space vehicles can dock at an asteroid fortress. This is equivalent to the action of a terrestrial ship entering or leaving a port.

3.19.1.1 Agro Consumption

Like a normal fortress, an asteroid fortress consumes no Agro.

3.19.2 Asteroid Habitats

An asteroid can also be hollowed out to form a space habitat. The initial cost is high because the asteroid has to be shaped as well as hollowed to ensure that it is stable when rotating to provide centripetal (centrifugal) force.

Co-builds can be made for asteroid habitats. The co-builder must provide the GP and NFP and either the lift capability or arrange for the owner to lift the build to the location.

Space vehicles can dock at an asteroid habitat. This is equivalent to the action of a terrestrial ship entering or leaving a port.

Table 3-37. Asteroid Habitat & Expansion Costs

	Earth Orbit	*Elsewhere*	*Result*
Initial	Cost gp/ 30nfp	Cost gp/ 40nfp	[1/0]
Increase	50gp/ 10nfp	75gp/ 20nfp	[+1/0]

Where Cost = Cargo Mass x 20 gp

Example

Near Earth Asteroid AS-02001 has been moved into L4 by the Albanian Mining Company. The asteroid is 80 cargo mass points in size. It is purchased by the Knights of Tabor and they pay the Albanians to convert it into a Habitat.

This costs 80 x 20 = 1600gp and 40nfp. At the end of the work the asteroid now has a cargo mass of 50 and so has 16 Wallpoints as it is a Silicaceous-Type asteroid. It is now a cylindrical hollowed out asteroid. If the Habitat is increased in size then it will loose part of these Wallpoints.

30 Cargo Mass points were removed to build the habitat. These were converted by the wily Albanians at their own space station into 7.5 points of cNFP at a cost of 60gp – and then sold back to the Knights…

3.19.2.1 Agro Consumption and Production

An asteroid habitat is treated as a normal port city for the purposes of agro consumption. Each additional GPv is treated as though it is a c2 (intensively cultivated) region. This emulates the hydroponics and fish tanks and the considerable surface area of the interior cylinder which provides space for small park spaces, orchards and fields. Light is reflected from mirrors and distributed into the interior either by efficient fiber optic cables or light ducts.

3.20 Construction: In the Far Beyond

Space platforms and stations can be built in the orbit of other planets after a manned mission has been performed. Similarly outposts and bases can be built on Mars or on asteroids.

These distant constructions cost twice as much as a facility in orbit or an installation on the Moon. This is because these remote installations have to be far more independent than those in the cozy Earth-Moon system, and must be virtually self-sufficient.

Note that if a facility is abandoned (no NFP added towards its completion for a game year) then the construction fails. No supply ships have arrived and the construction crews suffer a slow lonely death, and your nation receives a lot of bad press, unless someone else has stepped in and taken over.

Once complete the facility is self-supporting, though if ships from home don't arrive very often they may revolt or accept the diplomatic overtures of other powers.

At Industrial Three true colonies cannot be emplaced on Mars. Serious terraforming of Mars is also not practical at these Tech Levels.

3.21 Construction: Space Elevators

3.21.1 Earth Space Elevator

Base Level Twenty

A Space Elevator can be built when a nation achieves TL 22 and has at least one operational space station in GEO. It must be built at or very near the equator and in addition to the standard Monolithic Construction costs also costs 100 City (generic) Industrial Capacity points derived only from space stations or space colonies in Earth orbit or the Lagrange Points. This represents the manufacture in micro gravity of carbon nanotube components for the elevator. Material mined from an asteroid or the Moon can be used to provide all or some of the NFP – see Section 3.18.

The space elevator consists of the base tether on Earth, the cable and a counterweight in geosynchronous orbit. Climbers ascend and descend the cable carrying passengers and cargo, and have to be shielded as the cable passes through the Van Allen Belts.

Satellites and space platforms and stations in LEO will zoom past the cable and agreement will have to be reached to prevent collisions.

3.21.1.1 Location of the Base Tether

At the equator a space elevator will go straight up to GEO. If built off the equator it will go up at a slant resulting in a longer cable and additional side forces on the anchor. The cable would curve gently, and the counterweight will be somewhere between directly over the equator and directly over the base tether. Every degree off the equator adds one Base Level to the cost of the project; at Industrial Three a Space Elevator cannot be placed further than 30º off the equator. [In game terms any region on the equator counts as 0º, and the GM will determine the additional Base Level according to the site of the base tether.]

The base tether can be built on any terrain (except Mountainous) including islands with the normal Terrain costs. However, if tethered on a type one or two mountain range the Base Cost is reduced by one Base Level, but the region holding the tether must be clearly identified.

The tether can be situated at a port or inland fortress allowing the fortress wall points to add additional protection. It could also be built at a city or a city can subsequently be founded there to take advantage of the trade running up and down the elevator.

For an additional Twenty Base Levels the tether can be built on an artificial island in a Sea Zone. The base tether can then be used as a port fortress, initially with one Wall Point.

3.21.1.2 Moving Units by Space Elevator

A space elevator can carry 50 cargo points of units per turn in a **single** direction.

Every degree off the equator reduces the cargo point capacity by one because of the additional transit time.

An army (a Leader and one or more units) moving by a climber up or down the space elevator may move the full length in 0.5 AP if the Cargo-size of the army is less than or equal to the capacity. Larger cargo-requirement armies must be 'shuttled', which each additional block of capacity costing 0.5 AP per set.

3.21.1.3 Economic Effects of a Space Elevator

Owning a space elevator provides enormous advantages as the cost of traveling to and from orbit are cut and everyone flocks to use this new system. The owner of an operational space elevator gains a bonus to their ITV of ten.

The elevator is fully powered by the solar panels of the station anchor in orbit. Energy from Solar Power Satellites in line of sight of the anchor station can also be routed via cables in the space elevator increasing their EN value as no energy is lost via microwave beams. The SPS no longer need to use a rectenna to transmit their power to the planet below.

The anchor station in GEO will become a major transit hub for Earth-Moon space.

3.21.1.4 Combat Strength of a Space Elevator

A space elevator is probably the largest monolithic construction that can be built on Earth. It is also vulnerable to attack, stretching some 35,786 km from the tether on the surface of the Earth to the anchor space station in geosynchronous orbit. It has a siege strength of 50 and should be heavily defended at both ends.

3.21.1.5 Effects of Damage

If the elevator cable is broken near the surface of the Earth, the outward force exerted by the counterweight in orbit causes the entire length to rise upward into a stable orbit.

If it is severed higher up, to about 25,000 km the lower segment would fall to Earth, whilst the higher portion would rise up into orbit. The falling length would potentially drape itself across the Earth, but much of it would burn up on re-entry. The surviving strands could cause damage depending on where they settle. The design of the elevator should include self-destruct mechanisms to break the strand into smaller lengths. The elevator climbers should include emergency escape pods to permit passengers to bail-out.

3.21.2 Lunar Space Elevator

Base Level Ten

A Space Elevator can be built when a nation achieves TL 22 and has at least one operational space station at L1 or L2 and a Moon Base. In addition to the standard Monolithic Construction costs also costs 60 City (generic) Industrial Capacity points derived only from space stations or space colonies in Earth-Moon space. Material mined from an asteroid or the Moon can be used to provide all or some of the NFP – see Section 3.18.

A Lunar Space Elevator must be tethered at L1 or L2 (see Section 4.3) and this is a much greater distance than that between the Earth and Geosynchronous orbit. L1 on the Nearside of the Moon is 56,000 km up from the surface, and L2 on Farside is 67,000 km up.

The monolithic construction is cheaper than the Earthly equivalent because the cable does not need to be so strong, and the only environmental stresses on the structure will be from meteoritesand cosmic rays.

The Lunar space elevator does not need to be tethered at the equator and could even be based at one of the Moon's poles to take advantage of any ice mining...

3.21.2.1 Economic Effects of a Lunar Space Elevator

Owning a lunar space elevator provides advantages as it requires very little energy to travel from the anchor station to Lunar orbit. The owner of an operational space elevator gains a bonus of 4 to their ITV.

3.21.2.2 Combat Strength of a Space Elevator

The lunar space elevator has a siege strength of 30 and should be heavily defended at both ends.

3.21.2.3 Effects of Damage

Very similar to the effects of damage to the Earth space elevator except that any climber escape pods descending to the surface cannot glide down but need rockets to soft-land or to ascend to a safe orbit.

4. MAPS

Maps are central to the game play of *Lords of the Earth*. They show the locations of the regions and cities, the terrain, borders, builds and in some games what nation controls the region. The Space Age introduces three new maps: Antarctica, a map of the Moon initially used to plot the destination of lunar landers and later the location of Lunar Outposts and Bases, and the Earth-Moon Map.

4.1 ANTARCTICA

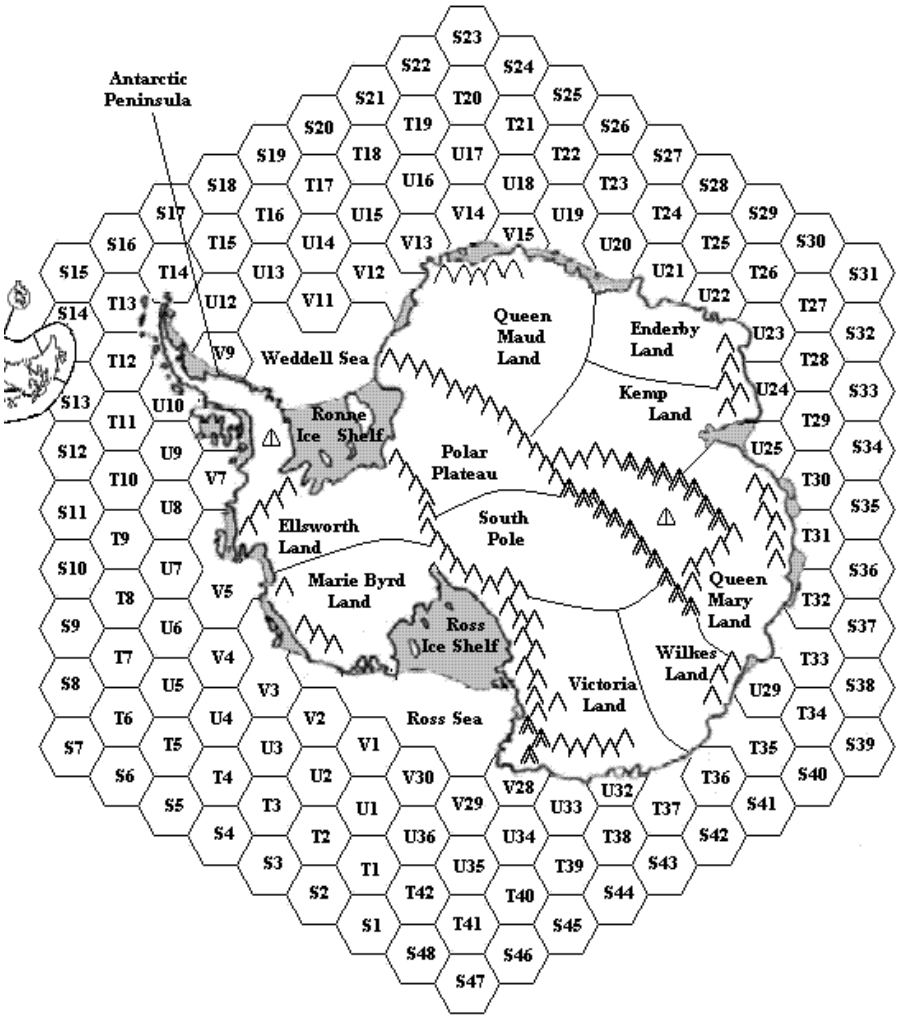
The Antarctic environment is so hostile it almost acts as preparation for extraterrestrial exploration. It also becomes of importance in the quest for resources and as a site for military bases.

The map of Antarctica allows the forbidding south polar regions to be explored and exploited. This large-scale map sits on the bottom of the stand Lords of the Earth map, with the most southerly row of large hexes on that map forming the border of this map.

4.1.1 Antarctic Terrain

A number of new terrains are introduced:

Table 4-1. Antarctic Map



- Ice Shelf. The Ice Shelves can be traversed by infantry units. Outposts and Polar Bases cannot be built on the Ice Shelves – which are denoted by dark grey areas either along the coastline or in two large bays. If an Outpost or Base is built on the coast fronting the Ice Shelf it cannot be used as a port.
- Polar Mountainous regions. These are dangerous areas of broken mountainous terrain and may be dangerous to fly over, with fierce crosswinds. The continent is divided by the Transantarctic Mountains and by the Mountains of Madness.
- Polar regions – the rest. Even more forbidding and desolate than tundra. Approximately seventy lakes lie deep under the surface of the continental ice sheet. Eastern Antarctica is colder than its western counterpart because of its higher elevation.

Table 4-2. Antarctic Border Terrain Symbols

Symbol	Terrain Feature
	Small Mountains (type-1)
	Large Mountains (type-2)
	Ice Shelf

4.1.2 The Southern Ocean

The Southern Ocean is the body of water encircling the continent of Antarctica. All sea zones and open ocean hexes should be treated as Hostile with cyclonic storms traveling eastwards around the continent. Waves can be enormous, and the currents treacherous making the ocean dangerous even for Industrial Two and Three shipping.

Icebergs range from gigantic to smaller fragments, making the waters within the Antarctic Circle particularly dangerous to navigate. The pack ice around Antarctic is highly seasonal, expanding to an area roughly equal to that of the continent in winter (approximately two ocean hexes surounding the continent, see also Table 2-13). Wooden vessels will be trapped and crushed by the ice. Metal hulled Industrial age ships will probably survive being trapped.

Icebreakers can be developed to push through the pack ice – see Sections 5.3.19 and 5.3.43.

4.1.3 Troop Types

Only infantry, mechanized and air units can be employed in Antarctica and must end the turn at an outpost or base. Mechanized units cannot cross an Ice Shelf without the possibility of falling through a crack in the surface.

See Table 6-6. Regional Terrain Action Modifiers for the costs of moving in the polar region.

Aircraft can only operate from an airbase at a Polar Outpost or Base.

Airships and helicopters can be used more easily, but must make a QR check to operate in the severe Antarctic weather without disaster. Ordinary surface ships docked at coastal locations will be iced in for several months of the year, generally from May through to October.

4.2 THE LUNAR MAP

The Lunar map retains the use of the Fortress and City symbols to denote the location of outposts and bases.

4.2.1 The Lunar Surface

The Lunar surface itself is broken into three terrain types:

- The dark, relatively lightly cratered maria or 'seas' cover about sixteen percent of the Moon's surface. Note that three of these are composed of two hexes but are treated as one region for the purposes of movement. When locating an outpost or base in these regions the relevant hex number should be provided.
- The relatively bright, heavily cratered highlands are called terrae. Note that a number of craters are named for orientation but denote no special effect on movement.
- The north and south polar regions are likely locations for expeditions to find water in the surface of the Moon. This resource will be important in the expansion of space stations and future exploration of the Solar System.

See Table 6-6 for the movement costs of lunar terrain.

Table 4-3. Lunar Landing QR Modifiers

Landing Location	*QR Adjustment*
Maria	-
Terrae	-1
Polar Region	-1
Farside with no satellite or space station in Lunar orbit	-2

The Moon map is also divided into the nearside, facing Earth and the Farside. The following cumulative factors are made to the Rocketry QR when landing on the Moon, unless the landing is at an existing outpost or base.

Example:
The Swedish Russians are attempting a landing on the Moon to investigate the Tycho Magnetic Anomaly. The Swedish Rocketry QR is 8. Landing at Tycho modifies this to 7. If they fail their QR they will either overshoot into another hex or crash. Let's hope the cosmonauts are having a lucky day.
Accidents in space are usually fatal.

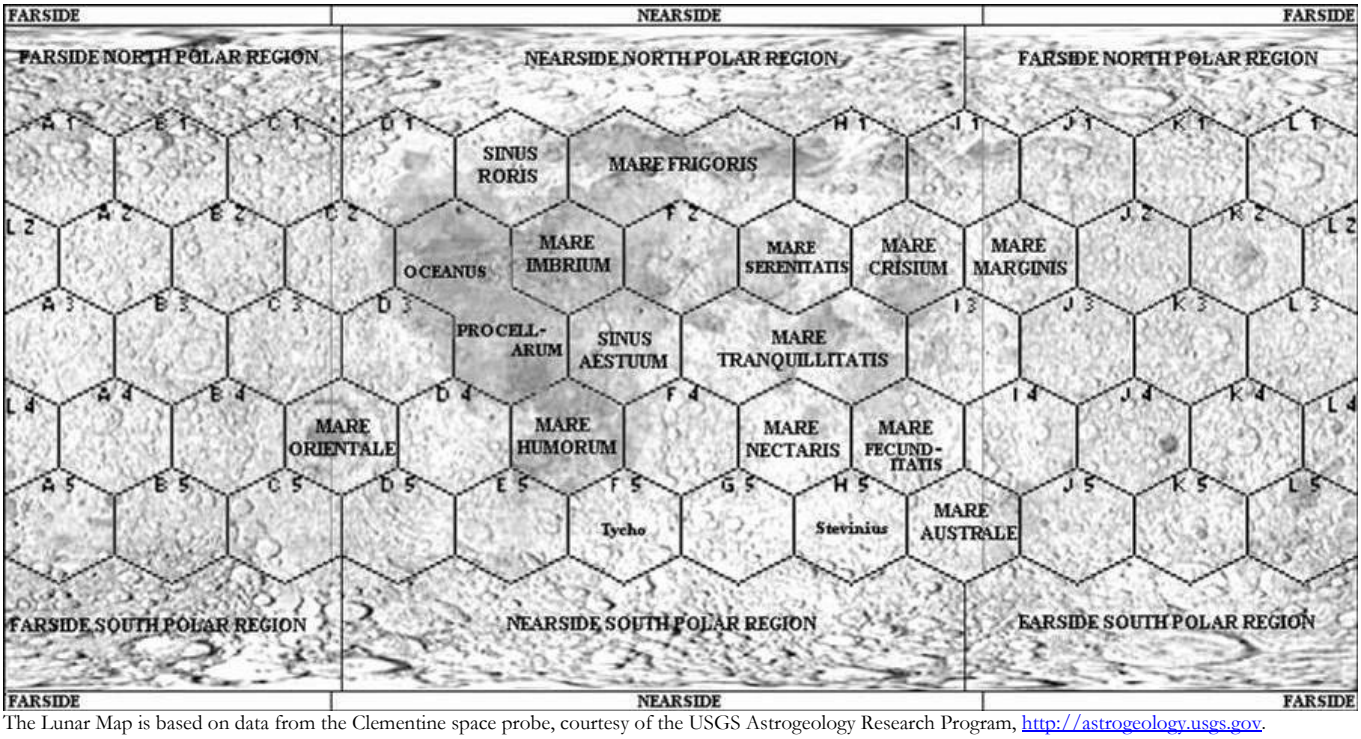
With advancing Tech Levels and improving Rocketry QRs the Moon becomes an important destination, not only for exploration but as a source of resources. It is much cheaper to mine on the Moon, and refine the material either on the Moon or at a space station than to ship equivalent mass up the gravity well from Earth. See Section 2.7.1.2 for details of Lunar mining.

4.2.2 Communication on the Moon

Communication is impossible between the Nearside and Farside, or across the Nearside without satellites or space stations either in Lunar orbit or situated at L2. A network of transmitters must be built. On the Nearside communication can be supported by installations on or in orbit above the Earth.

Similarly travel on the surface is relatively slow due to the rugged terrain. It is quicker for a lander to hop from one location to another, and for long distances to ascend to orbit. Lunar crawlers and Meg-Lev railways offer a means of surface transportation. A Mag-Lev railways offers a means of shipping material to a Moon Base for processing or to a Mass-Driver to be sent into space.

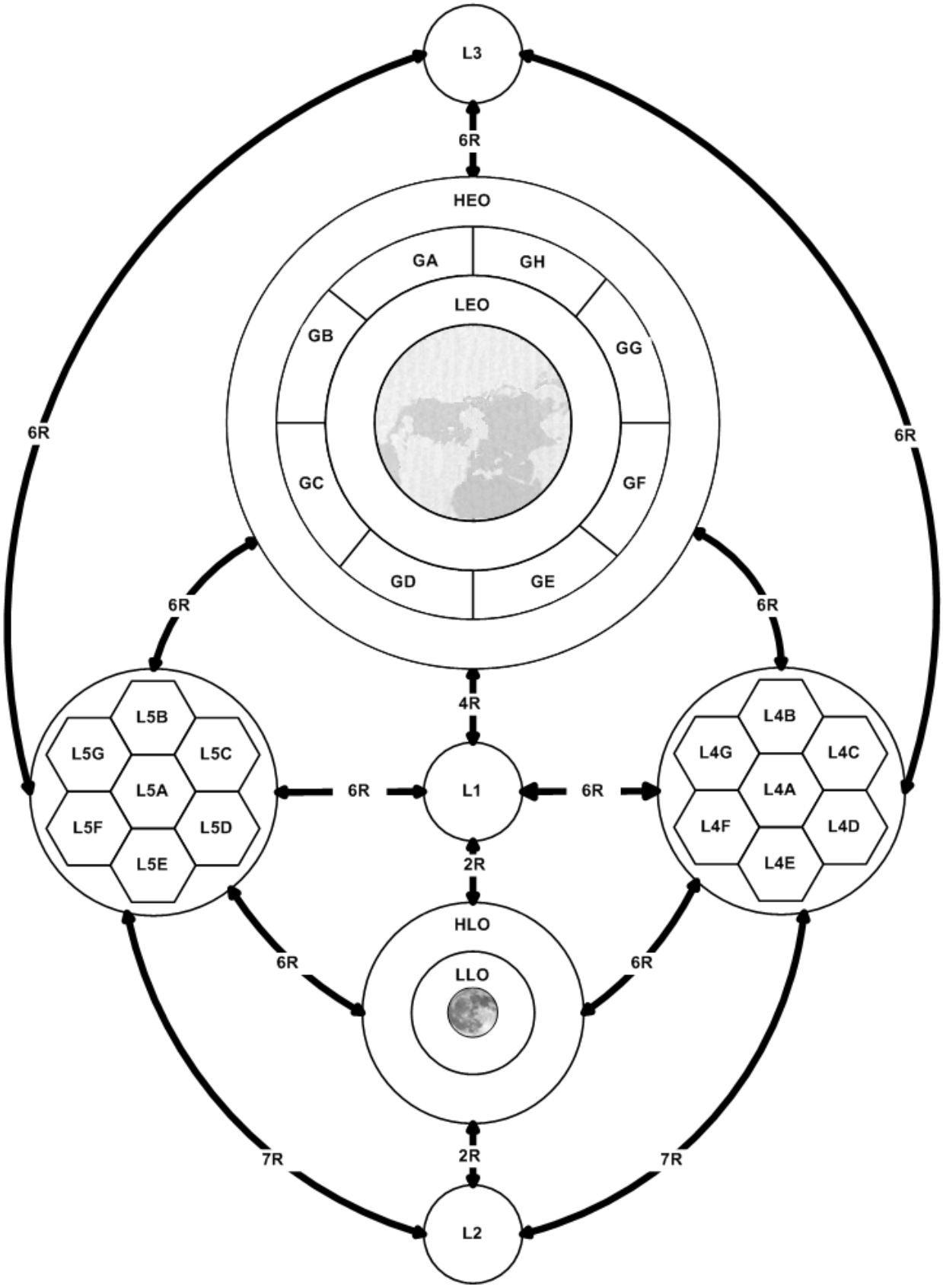
Table 4-4. Lunar Map



The Lunar Map is based on data from the Clementine space probe, courtesy of the USGS Astrogeology Research Program, http://astrogeology.usgs.gov.

4.3 The Earth-Moon Map

Table 4-5. Earth-Moon Map



5. RESEARCH AND DEVELOPMENT

The acquisition of a variety of technologies and unit types is controlled by Research and Development (R&D) projects. These are like National Projects, save their completion is not just a matter of men, gold and time.

Each R&D project is assigned a certain number of **Advances** which must be attained before the project is complete. Like increasing an AQR; gold, money and time are invested and each turn a die roll is made by the GM to assess progress.

Depending on the amounts invested, the difficulty of the project, the die roll and a host of modifying factors (your Nations' government type, economy, religious strength, imperial size and university level) you may gain one or two advances, make no progress, or even back up a step as the project encounters some dead-end or obstacle.

When a project is complete, you gain the ability to use the devised technology or unit type.

When starting an R&D Project you must also provide a project location (either a region or city under your control within the HBZ of your nation).

5.1.1 Pre-requisites

Note that some R&D Projects have pre-requisites which include not only a previously completed R&D project, a minimum Tech Level but also a certain number of completed Air/Ship/Submarine Yards or Factories.

As Projects start at the beginning of the turn, during Builds, all of the pre-reqs must have been completed the *previous* turn (or earlier).

5.2 R&D PROJECT COST *and* EXECUTION

When starting an R&D project, you **must** invest *at least* 1 GP and 1 NFP. Thereafter, as each project gains an Advance, your GP investment is zeroed (as for a QR), but your NFP and Time investment remain. On a rough basis, your chances of gaining an Advance on a given turn are equal to:

$$\% = (GP + (NFP \times 5) + (\text{Number of Years Invested} \times 5)) / (\text{Total Advances} + 1)$$

Over the entire life of the project, you **must** invest at least as many NFP as the number of **Advances** required by the project. If your NFP investment is not sufficient to match the next Advance level, then you will not progress until you have provided sufficient manpower.

When a project is completed, all invested NFP are zeroed. Once invested in a project, invested GP and NFP may **not** be withdrawn.

Example

The Pacific Mercenary and Trust Company is attempting to develop an improved *Ithaqua-Sanrio* kerosene engine (via the Internal Combustion Engine project). This project is a level 6 project. PM&T invests 300gp and 4 NFP into the project. The current turn length is 2 years per turn.

The first turn (assuming all supplementary modifiers cancel out), their chances of gaining an advance are (300 + (4 × 5) + (0 × 5)) = 320 / 7 = 45%. If they are successful in gaining an Advance, the next turn they will start with 0 GP, 4 NFP and 2 years invested.

While only 4 NFP remain invested in the project, they cannot gain more than 4 Advances, so at some point they will have to commit another 2 NFP to the endeavor.

Note the project, with an Advance requirement of 6 will take (at optimum speed) at least three 2-year turns to complete and more likely six 2-year turns (or more, if the team runs into some obstacle delaying their progress.)

5.3 RESEARCH PROJECTS

5.3.1 Armored Fighting Vehicle: Battle Tank

Tech Level Requirement	16
R&D Requirement	AFV: Heavy Tank
Advances Required	3

Completing the AFV: Battle Tank project allows the Nation to begin building *Battle Tank* (**afb**) units the following turn. Then there will be some smacky action! Each Battle Tank unit represents five really big tanks, crews and support personnel.

5.3.2 Jet Aircraft

Following the development of Monowing (prop) Aircraft, the inevitable next step in airplane design are jet turbine-based designs. These are represented by a new slate of R&D projects and the attendant aircraft unit types.

Project Name	**Jet Light**
Tech Level Requirement	16
R&D Requirement	Monoplane Light, 20 Aircraft Factories
Advances Required	5
Resulting Unit Type	jf, jb

Project Name	**Jet Heavy**
Tech Level Requirement	16
R&D Requirement	Jet Light, 20 Aircraft Factories
Advances Required	1
Resulting Unit Type	jct, jhb

5.3.3 Helicopters

Tech Level Requirement	16
R&D Requirement	Monowing Fighter, 10 Aircraft Factories
Advances Required	5

Completing the Flying Machines: Helicopters project allows the nation to begin building *Airmobile Infantry* units (**ami**). Note that Airmobile Infantry require **both** Intrinsic Yard and Aircraft Factory capacity points to build. This project subsumes both cargo and attack helicopters into one new unit type.

Airmobile Infantry fight with the Mechanized QR.

5.3.4 Rocketry: Dual-Stage Rocket

Tech Level Requirement	16
R&D Requirement	Single-Stage Rocket, 5 Rocket Factories, Radio
Advances Required	5

Completing the Rocketry: Dual-Stage Rocket project allows the Nation to build *Dual-Stage Rocket* (**dsr**) units and build a Spaceport to launch them from. The rocket consists either of two stages or a central core with a number of strap-on boosters. These early rockets require a Spaceport to launch from – anyone wanting intercontinental missiles launched from silos or submarines will have to wait on future projects.

These rockets carry a conventional warhead unless a nuclear device is made available. One unit represents one rocket. See Table 3-12. Base Rocket Lift Capability for the cargo capacity of this rocket. This rocket can deliver a warhead into LEO for a detonation in orbit. See Section 6.5.4 for the effects.

5.3.5 Rocketry: Manned Capsule

Tech Level Requirement	16
R&D Requirement	Dual Stage Rocket, 10 Rocket Factories, Spaceport
Advances Required	2

Completing the Rocketry: Manned Capsule project allows the Nation to build a low orbit *manned space craft* (**smr**) unit. This consists of a one-man capsule to sit up on top of a slim metal tube full of explosive propellant. Spaceflight!

Whilst this project causes all others to quail at your technological prowess (if the astronaut survives) it provides no other benefits. In time it may lead to other exciting things… Each unit represents a single-use rocket which must be launched from a Spaceport.

5.3.6 Rocketry: Rocketplane

Tech Level Requirement	16
R&D Requirement	Single-Stage Rocket, Jet Heavy, 5 Rocket Factories, 16 Aircraft Factories, Radio
Advances Required	6

Completing the Rocketry: Rocketplane project allows the Nation to build *Rocketplane* (**rpr**) units. Each unit represents one rocketplane and transporter. Note that as a single vehicle (for the purpose of rebasing) it is treated as a Heavy Bomber.

This primitive spaceplane consists of a rocket-powered vehicle launched from under the wing of a Jet Heavy Bomber just capable of touching the edge of space. It therefore does not require a Spaceport and can be launched from and land at the same Air Base. The rocketplane cannot carry any cargo or a warhead. A rocketplane unit consists of a modified jet heavy bomber, the rocketplane itself plus the pilot and groundcrew. Unlike other rockets of this Tech Level the rocketplane can be reused.

The rocketplane is capable of flying great distances at high altitude and uses Table 6-9. Large Hex Map for Rockets. As the rocketplane carries cameras it confers a scouting bonus relating to the areas it overflies as per a spy satellite – see Sections 6.4.2.7 and 8.

Completion of the project allows the initiation of more advanced spaceplane projects at higher Tech Levels.

5.3.7 Nuclear: Theoretical Nuclear Physics

Tech Level Requirement	16
R&D Requirement	None
Advances Required	8

Completion of the Theoretical Nuclear Physics project Project gains the nation a **Nuclear** Quality Rating which starts at one (1). All units derived from the **Theoretical Nuclear Physics** project and its descendants fight with the Nuclear QR.

Completion of this project allows the building of Nuclear Production Factories.

5.3.8 Nuclear: Atomic Bomb

Tech Level Requirement	16
R&D Requirement	Theoretical Nuclear Physics, 5 Nuclear Production Factories
Advances Required	6

Completing the Nuclear: Atomic Bomb project allows the nation to begin building Atom Bomb units.

This unit represents one large and heavy fission bomb. Future projects will bring lighter, less expensive nuclear weapons with a great yield.

An Atomic Bomb can only be moved by heavy bomber, rail or ship. It can be deployed by heavy bomber, ship or by dual-stage rocket as a warhead.

5.3.9 Cargo Submarines

Tech Level Requirement	16
R&D Requirement	Submarines, 4 Sub Yards
Advances Required	2

Completing the Cargo Submarines project allows the nation to build (**sut**) units.

Cargo Submarines can be used to carry cargo, including through blockaded coastlines though there is the possibility of being detected and depth-charged. They can also be converted into national msp. The building of this project leads to other underwater developments.

5.3.10 Jet Aircraft: In-flight Refueling

Tech Level Requirement	17
R&D Requirement	Jet Heavy, 20 Aircraft Factories
Advances Required	4

Completing the Jet Aircraft: In-flight Refueling project significantly increases the Operational Range of military aircraft (civilian aircraft performing aerial trade are not affected). The enhanced operational range is given below.

Table 5-1. Operational Ranges for In-flight Refueling

Aircraft Type	Jet
Carrier Fighter	4
Fighter / Carrier Bomber	7
Bomber	11
Heavy Bomber	16

5.3.11 Rocketry: Manned Orbital Capsule

Tech Level Requirement	17
R&D Requirement	Manned Capsule, 10 Rocket Factories
Advances Required	2

Completing the Rocketry: Manned Orbital Capsule project allows the nation to build a larger *manned orbital space vehicle* (**sor**) unit. This carries more crew and equipment that the primitive Manned Capsule. It is capable of moving out of LEO into higher orbits, and leads the way to manned Space Platforms, Space Stations and eventually the Moon.

5.3.12 Nuclear: Fusion Bomb

Tech Level Requirement	17
R&D Requirement	Atomic Bomb, 10 Nuclear Production Factories
Advances Required	6

Completing the Nuclear Fusion Bomb project allows the nation to start building Fusion Bomb units.

This unit represents one fusion bomb, smaller and more compact than an Atomic Bomb and with a far deadlier yield where a fission bomb is detonated next to fusion fuel. These are also known as hydrogen bombs, H-bombs or thermonuclear bombs.

A Fusion Bomb can only be moved by bomber, rail or ship. It can be deployed by bomber, ship or by dual-stage rocket as a warhead.

5.3.13 Chemical Weapons

Tech Level Requirement	17
R&D Requirement	None
Advances Required	5

Completion of the Chemical Warfare project permits the nation to build single-use (**chm**) units - Chemical Warfare bombs and warheads. These can be delivered to their target by bombers or by rockets or cruise missile. See Section 6.8.

These weapons are assumed to be deadly nerve agents which kill on being inhaled or making contact with the skin. The bomb or warhead is specially developed to propagate the chemical attack either as an aerosol or by an explosion, which is then carried on the wind.

5.3.14 Rocketry: ICBM

Tech Level Requirement	17
R&D Requirement	Dual-Stage Rocket, 10 Rocket Factories, Fusion Bomb
Advances Required	3

Completing the ICBM project allows the nation to start building (**icm**) units. An ICBM represents one long-range missile and its silo and command bunker. It includes a Fusion Bomb as its warhead. It can only be moved to its deployment site by ship or by rail. An ICBM can be located within a city, fortress or region, but once in place cannot be moved again. Once it is launched the unit is destroyed.

An ICBM has two Combat ratings: the first for in-flight and used only in 'combat' with defending ABMs, and the other for whilst it is sitting in its hardened silo. Note that the latter is either the value stipulated, or the Siege QR of the nation, whichever is lowest.

Once launched an ICBM is vulnerable to ABM units defending its designated target. On its trajectory it also briefly passes through LEO and is also vulnerable to the warsats available at higher Tech Levels.

An ICBM can deliver a warhead into LEO for a detonation in orbit. See Section 6.5.4 for the effects.

5.3.15 Rocketry: Multistage Rocket

Tech Level Requirement	17
R&D Requirement	Dual-Stage Rocket, 12 Rocket Factories, Spaceport
Advances Required	4

Completing the Rocketry: Multistage Rocket project allows the Nation to build *Multistage Rocket* (**msr**) unit. The massive rocket consists either of three stages or a central core with a number of strap-on boosters. It represents a very significant launch capability.

These rockets are intended to carry significant payloads into space, but could be used instead to deliver multiple warheads. One unit represents one rocket. See Table 3-12. Base Rocket Lift Capability for the cargo capacity of this enormous rocket. This rocket can deliver warhead(s) into LEO for a detonation in orbit. See Section 6.5.4 for the effects.

5.3.16 Rocketry: Spy Satellites

Tech Level Requirement	17
R&D Requirement	Dual-Stage Rocket, 5 Rocket Factories, Spaceport
Advances Required	3

This project represents the capability to build early spy satellite (**sat**) units capable of providing limited surveillance using cameras and ejecting canisters of film back to Earth. A satellite has to be lifted into orbit by a rocket.

Early Spy Satellites are only effective in a LEO orbit because of the limitations of the imaging system. An early Spy Satellite can only be used to support (unlimited) SRF or

ES:RF actions (see Section 6.4.2.7) in a single turn before it runs out of film canisters which are dropped down to land on Earth. It can be placed in orbit and left dormant for use later. (having many satellites in orbit is a good thing). See Section 8 for the uses of spy satellites.

More advanced satellites will provide more significant coverage.

5.3.17 Space Command

Tech Level Requirement	17
R&D Requirement	Manned Capsule or Spy Satellites
Advances Required	3

Completing the Space Command project provides the Nation with one Space Operations point and the capability to invest in this to gain additional levels. It represents the capability to co-ordinate and command space assets.

5.3.18 Underwater Installation

Tech Level Requirement	17
R&D Requirement	Cargo Submarines, 10 Sub Yards
Advances Required	3

Completing the Underwater Installation project permits the nation to commence building Installations underwater. See Section 3.13.1 for details.

5.3.19 Icebreaker

Tech Level Requirement	17
R&D Requirement	Improved Engines, 5 shipyards
Advances Required	3

Completing the Icebreaker project allows the nation to build (**ice**) units.

This is a special purpose vessel designed to move and navigate through ice-covered waters. It has an ice strengthened hull, an ice clearing shape, and the power to push through. If the nation has completed the R&D project Air Mobile Infantry then the Icebreaker can carry one helicopter in addition to its normal cargo to scout for 'lines' in the ice – natural breaks that can be exploited.

An ICE unit can push through one iced open ocean hex in 10AP and one iced seazone in 5AP. Note that it cannot break through an ice shelf or the polar cap.

5.3.20 Computers: Mainframe

Tech Level Requirement	18
R&D Requirement	Radio, (Analytical Engine)
Advances Required	6 (5)

Completion of the Computers: Mainframe project grants the Nation a bonus on other, subsequent R&D projects and acts as the basis for many new technologies. Completing this project also causes an entire priesthood of nerds devoted to the programming and maintenance of the damnable things.

Completion of the earlier Analytical Engine reduces the Advances Required by one because the earlier machines have provided knowledge of analogue computing – and a long tradition of pasty-faced technicians.

5.3.21 Submarines: Strategic Submarine

Tech Level Requirement	18
R&D Requirement	Submarines, ICBM, 6 Submarine yards
Advances Required	4

The Strategic Submarine project can be attempted concurrently with the development of SLBM. Until both the relevant missile project and the Strategic Submarine project are completed, however, neither is finished.

Completion of the Strategic Submarine project provides the Nation with the ability to build submarine (**ssb**) units.

A Strategic Submarine unit represents one submarine.

5.3.22 Rocketry: SLBM

Tech Level Requirement	18
R&D Requirement	ICBM, 10 Rocket Factories
Advances Required	4

The SLBM project can be attempted concurrently with the development of Strategic Submarines.

Completing the SLBM project allows the Nation to begin building (**slm**) units the following turn. These can be carried by specially designed submarines or based in silos at Underwater Installations.

An SLBM has a lower range than an ICBM but being launched from a mobile submarine it can be fired much closer to its target.

Once launched an SLBM is vulnerable to ABM units defending its designated target. On its trajectory it also briefly passes through LEO and is also vulnerable to the warsats available at higher Tech Levels.

An SLBM can deliver a warhead into LEO for a detonation in orbit. See Section 6.5.4 for the effects.

5.3.23 Rocketry: Heavy Lift Rocket

Tech Level Requirement	18
R&D Requirement	Dual-Stage Rocket, 15 Rocket Factories, Spaceport
Advances Required	4

Completing the Rocketry: Heavy Lift Rocket project allows the Nation to build (**hlr**) units. This gigantic rocket consists either of four stages or a central core with several strap-on boosters. It represents sufficient capability to carry very large payloads into space. One unit represents one rocket. See Table 3-12. Base Rocket Lift Capability for the cargo capacity of this enormous rocket.

5.3.24 Rocketry: Aero-Spaceplane

Tech Level Requirement	18
R&D Requirement	Rocketplane, 8 Rocket Factories, 30 Aircraft Factories
Advances Required	6

Completing the Rocketry: Aero-spaceplane project allows the Nation to build (**apr**) units. Each unit represents one orbiter and transporter. Note that as a single vehicle (for the purpose of rebasing) it is treated as a Heavy Bomber.

The aero-spaceplane represents an orbiter carried on the back of a specialized transporter to a high altitude where it fires its rocket engine to climb into space. Both vehicles are manned and use rocket engines to ascend, with the transporter using turbojets to fly back to its Air Base. The orbiter is capable of limited maneuver in orbit and makes an un-powered glide return and landing. Both parts of the unit must return to the same base or the unit is treated as lost on landing.

It can carry a nuclear warhead for use in orbit or as an orbital bomber. The aero-spaceplane is cripplingly expensive to develop and deploy but it does have one major advantage over conventional rockets: it is fully resusable.

The aero-spaceplane is capable of flying great distances at high altitude and uses Table 6-9. Large Hex Map for Rockets. As the rocketplane carries cameras it also confers a scouting bonus relating to the areas it overflies as per a spy satellite – see Section 6.4.2.7 and Section 8.

Completion of the project allows the initiation of more advanced spaceplane projects at higher Tech Levels.

5.3.25 Rocketry: Space Platform

Tech Level Requirement	18
R&D Requirement	(Manned Orbital Capsule or Aero-Spaceplane), 15 Rocket Factories
Advances Required	3

Completing the Space Platform project permits the nation to commence building Space Platforms in LEO or GEO orbits. See Section 3.15.1 for details.

5.3.26 Rocketry: Lunar Mission

Tech Level Requirement	18
R&D Requirement	(Manned Orbital Capsule or Aero-Spaceplane), (Multistage Rocket or Space Platform), 15 Rocket Factories
Advances Required	6

Completing the Lunar Mission project allows the nation to build two types of space vehicle: the Space Tug (**stg**) units and Lunar Lander (**sll**) units. Used in conjunction either with a manned orbital space vehicle (**sor**) unit or an aero-spaceplane (**apr**) unit this allows a journey to the Moon including a brief descent to the lunar surface.

- The manned orbital vehicle or space capable stage of the aero-spaceplane acts as the command module.
- The space tug acts as the service module and moves the combined craft to and from the Moon. It has a cargo capacity of (2) to allow it to move the lunar lander and command module.
- The lunar lander is used to descend and ascend from the Moon. This early lander cannot carry any cargo save for its crew.

There are a number of ways in which the mission can be achieved:

- Launched by a Heavy Lift or Nuclear Pulse rocket as a single payload.
- Launched by several simultaneous rocket launches in a single turn, requiring the mission components to dock in orbit (each docking action takes 1AP).
- Launched into space over several turns with the components being docked at a space platform or space station until the entire mission can be assembled.

This allows the various methods of attempting a Moon landing to be emulated and several different technological paths to the same goal.

Successful completion of a Moon landing (and return) will lead to other space projects. The location of the landing should be specified on the Lunar Map, see Section 4.2. The objective of this mission should usually be a landing on the Nearside of the Moon.

Note that if the lunar lander and space tug are not left docked at a space platform or station at the end of the flight then the units are lost.

5.3.27 Rocketry: Asteroid Mining

Tech Level Requirement	18
R&D Requirement	(Manned Orbital Capsule or Aero-Spaceplane), (Multistage Rocket or Space Platform), 15 Rocket Factories
Advances Required	6

Completing the Lunar Mission project allows the nation to build Asteroid Lander (**all**) units. Used in conjunction either with a manned orbital space vehicle (**sor**) unit or an aero-spaceplane (**apr**) unit this allows a journey to a Near Earth Asteroid. See section 2.7.1.1 for details and the benefits of asteroid mining. Note that an Asteroid Lander is a pure space vehicle – it cannot land on either the Earth or the Moon.

This project allows manned prospecting and limited mining of an asteroid, supporting a mission duration equal to the nation's Rocketry QR in months. At the end of this time the mission must return to Earth orbit. The orbit of the asteroid may also limit the duration of the mission as it recedes from the Earth-Moon system. If the astronauts leave it too long to return home then they die in the cold depths of space.

Note that if the asteroid lander and space tug are not left docked at a space platform or station at the end of the

flight then the units are lost. The cargo of asteroid material must also be left at a space platform or station.

5.3.28 Air Traffic Control

Tech Level Requirement	18
R&D Requirement	Radar, Mainframe
Advances Required	4

Completing the Air Traffic Control project provides a national bonus to Defense and React (including defense by ABM units) as it represents a network of military and commercial radar systems.

5.3.29 Rocketry: Nuclear Pulse Rocket

Tech Level Requirement	18
R&D Requirement	Mainframe, Atomic Bomb, Manned Orbital Capsule, 10 Rocket Factories, 10 Nuclear Production Facilities
Advances Required	4

Completing the Rocketry: Nuclear Pulse Rocket permits the nation to build the frankly dangerous (**npr**) unit. This represents one truly monstrous rocket.

A Nuclear Pulse Rocket works by dropping nuclear bombs out of the rear of a vehicle and detonating them 200 feet out and catching the blast with a thick steel or aluminum pusher plate. The impulse from the plasma wave hitting the pusher plate is reduced by large multi-story high shock absorbers, spreading the millisecond shock wave over several seconds to give an acceptable ride. Reaction mass is either built into the bombs or dropped between 'pulses' to provide thrust. A Nuclear Pulse Rocket launched from Earth looks something like a monstrous bullet mounted on shock-absorbers.

This rocket provides a gigantic lift capability for launching cargo into Earth orbit, to the Moon or beyond.

There is, however, a price to pay.

Launching a nuclear pulse rocket is equivalent to detonating several large nuclear bombs. On liftoff a Nuclear Pulse Rocket will result in damage to a region (and any city within it) equivalent to the detonation of one nuclear bomb. It will result in half as much damage to the surrounding regions. On reaching Low Earth Orbit the rocket will create an equivalent effect to a nuclear detonation in LEO, energizing the lower Van Allen Belt. The fallout from launch can be reduced by the building of massive steel baffles to contain and direct the blast of the first detonation – see Section 3.8.2.

Alternatively a Nuclear Pulse Rocket can be lifted partially into orbit atop a Heavy Lift Rocket as its 'first stage', but this reduces its cargo carrying capability from 40 to 10. It still pumps up the Van Allen Belt.

On every initial detonation (including launch) the Nuclear QR is used to determine if the rocket malfunctions. If it does there is a chance of an uncontrolled nuclear detonation destroying the vehicle and inflicting double damage. In addition, the Rocket QR is used to determine if the shock-absorbers malfunction resulting in severe damage to the rocket and any passengers.

Note that whilst this rocket could reach the Moon it cannot land there and must carry landers to ferry cargo to the Lunar surface. The Nuclear Pulse Rocket cannot land back on Earth.

A Nuclear Pulse Rocket can be constructed in orbit at a space platform or station and can be used as an early interplanetary spacecraft, and moved out of orbit using chemical rocket engines, taking 2AP.

5.3.30 Rocketry: I2 Interplanetary Mission#A

Tech Level Requirement	18
R&D Requirement	(Manned Orbital Capsule or Aero-Spaceplane), Nuclear Pulse Rocket, Space Platform, 15 Nuclear Production Factories, 15 Rocket Factories
Advances Required	6

Completing the Rocketry: I2 Interplanetary Mission#A allows the nation to an interplanetary space vehicle capable of reaching the Moon, Mars (or Venus) using the frankly lethal Nuclear Pulse Rocket. The spacecraft is capable of making a return journey carrying a small crew and a landing module – for Mars.

This massive spacecraft can be launched from Earth (see Section 5.3.29) or be fabricated in Earth orbit (possibly over several turns) and so a space platform or station is required to support its construction. The NFP must be transferred to the location. The same QR checks still apply and if 'launched' from LEO orbit is affects the Van Allen Belt. Note that if the vessel is lofted into orbit atop a Heavy Lift Rocket then its cargo capacity is reduced to 5.

The cost excludes the lander(s), which must be carried to Mars as cargo and will be abandoned at Mars to reduce the payload for the return flight.

Table 5-2. I2#A Interplanetary Mission Costs & Capacity

Unit Name	*Code*	*Cost*	*Yard Capacity*	*Cargo*	*Mission Duration*
Nuclear Pulse Rocket	npr	400 gp/ 10 nfp	15r/10n	20	36

The following Mars Landers and rovers can be built to be carried by the interplanetary spacecraft:

Table 5-3. I2 Landers & Other Equipment

Unit Name	*Code*	*Cost*	*Yard c*	*Cargo*	*(Cargo)*
Lunar Lander	SLL	100 gp/ 2 nfp	10r	2	-
Mars Lander	NLR	550 gp/ 5 nfp	15r	3	-
Mars Cargo Lander	NCL	500 gp/ 4nfp	15r	2	(1)
Planetary Probe	NPP	50.0 gp/ 1 nfp	2r	0.5	-

- The Lunar and Mars Landers can only make one descent and carries a return stage for a single ascent to

the mothership. Can only be built if the nation has completed the Single Stage to orbit project.

- The Mars Cargo Lander consists only of a descent stage to deliver equipment to the surface. Can only be built if the nation has completed the Single Stage to orbit project.
- A Planetary Probe is a short-range probe that can be dropped from orbit to provide data on planetary conditions. Useful for missions to hostile worlds such as Venus where a manned landing is impossible.

5.3.31 Rocketry: I2 Interplanetary Mission#B

Tech Level Requirement	18
R&D Requirement	(Manned Orbital Capsule or Aero-Spaceplane), Lunar Mission, 30 Rocket Factories
Advances Required	6

Completing the Rocketry: I2 Interplanetary Mission#2B allows the nation to build an interplanetary space vehicle capable of reaching Mars using chemical rockets only. The spacecraft is capable of making a return journey carrying a small crew and a landing module – for Mars.

Performing this mission is a major undertaking because the Mars expedition requires an enormous amount of mass launched from Earth with the vessel being constructed at a space platform or station in Earth orbit.

It is likely that the construction of the Mars Rocket will appear as a national project over several turns. In addition to the cost of the Mars Rocket itself, it will cost an enormous amount to haul the nfp up into orbit using other rockets.

Table 5-4. I2#B Interplanetary Mission Costs & Capacity

Unit Name	*Code*	*Cost*	*Yard Capacity*	*Cargo*	*Mission Duration*
Mars Rocket	mrr	200gp / 100 nfp	50 r	4	30

The Mars Landers and rovers in Table 5-3. I2 Landers & Other Equipment can be built to be carried by the interplanetary spacecraft.

5.3.32 Biological Warfare

Tech Level Requirement	19
R&D Requirement	None
Advances Required	5

Completion of the Biological Warfare project permits the nation to build single-use (**bio**) units - Strategic Biological Warfare bombs and warheads. These bioweapons can be delivered to their target by railroad, ships, bombers or by rockets or cruise missile. See Section 6.9.

The bomb or warhead is specially developed to propagate the bioweapon either as an aerosol or by an airburst.

5.3.33 Underwater City

Tech Level Requirement	19
R&D Requirement	Underwater Installation, 15 Sub Yards
Advances Required	4

Completing the Underwater City project permits the nation to commence building Installations underwater. See Section 3.13.2 for details.

5.3.34 ABM: Anti-Ballistic Missiles

Tech Level Requirement	19
R&D Requirement	Mainframe, Radar, Single-Stage Rocket, 10 Rocket Factories, Spaceport
Advances Required	6

Completing the Rocketry: Anti-Ballistic Missile project allows the Nation to build (**abm**) units. This unit represents a radar-guided missile system capable of defending a fortress or a city and surrounding region from attack by all types of rocket (including ICBMs, SLBMs and MIRVs), tactical nuclear weapons, and high altitude bombers such as the jet bombers and heavy jet bombers. It is also capable of shooting down rocketplanes that fly within its coverage. It can also defend against Kinetic Energy Weapons (although these are harder to kill) by deflecting them from their target.

It cannot engage in any other form of combat. Multiple ABM units can defend the same location. An ABM unit can be part of the defenses of an Air, Fleet, Army or Rocket base.

At this tech level an ABM unit consists of silos and radar systems and can only be moved by ship or by rail. Unlike nuclear weapons and other rockets an ABM system is not lost on use (unless the bombers or warheads destroy the fortress or city where it is based…).

5.3.35 Computers: Transistors

Tech Level Requirement	19
R&D Requirement	Mainframe
Advances Required	6

The transistor is a solid state semiconductor device with many advantages over vacuum tubes, not least being their small size. However, they are more susceptible to the Electro-Magnetic Pulse generated by nuclear weapons.

This technology will lead to many other projects.

5.3.36 Nuclear: Tactical Ballistic Missile

Tech Level Requirement	19
R&D Requirement	Fusion Bomb, 10 Nuclear Production Factories,
Advances Required	3

Completion of the Nuclear: Tactical Ballistic Missile project allows the nation to build nuclear tipped (**tbm**) units. These represent a launcher and supporting integrated armor (tank, armored car, tankers) elements. The launcher

may be a rocket launcher or artillery equipped with nuclear artillery shells.

The yields of such weapons range is relatively low so the Tactical Nuclear Weapon unit can be employed against a fortress or city in the same Region or in a neighboring Region. Once fired the unit is 'lost'.

5.3.37 Nuclear: Nuclear Power

Tech Level Requirement	19
R&D Requirement	Mainframe, Theoretical Nuclear Physics, Steamships
Advances Required	4

Completion of this project gives the nation the capability to build relatively small nuclear reactors known as naval reactors. The turn after this project is completed the Nuclear Submarine and Nuclear Carrier projects can be initiated. The project is also required for certain space propulsion systems.

5.3.38 Rocketry: Satellites

Tech Level Requirement	19
R&D Requirement	Transistors, Spy Satellites, 5 Rocket Factories, Spaceport
Advances Required	3

This project represents the capability to build reconnaissance satellite (**sat**) units capable of providing surveillance using cameras and transmitting the results back to Earth. A satellite has to be lifted into orbit by a rocket.

These advanced satellites can be placed in LEO, GEO or HEO orbits and can be used to support (unlimited) SRF or ES:RF actions (see Section 6.4.2.7) each turn and other espionage activities (See Section 8).

5.3.39 Rocketry: Interplanetary Probe

Tech Level Requirement	19
R&D Requirement	Satellites, 10 Rocket Factories, Spaceport
Advances Required	4

Completing the Interplanetary Probe project provides your nation with the capability to build (**rip**) units. These are small unmanned spacecraft launched away from Earth to reach either Mars or Venus. Whilst the successful rendezvous with another world provides only a bonus to the national University Investment it also provides much international prestige. The arrival of the probe at its destination is governed by the Rocketry QR and the support costs cover the groundside monitoring of the probe.

Note that this project can also be used to send a probe to the outer planets, but that also requires completion of the Nuclear Power project.

The probe will take several months to reach even Mars or Venus, see Section 3.14.6 for details. Unless it overshoots and is lost in the vastness of space, or undershoots and makes a new, small, crater…

5.3.40 Rocketry: Space Station

Tech Level Requirement	19
R&D Requirement	Space Platform
Advances Required	4

Completing the Space Station project permits the nation to commence building Space Stations in LEO or beyond. See Section 3.15.2 for details.

5.3.41 Nuclear Submarine

Tech Level Requirement	19
R&D Requirement	Nuclear Power, Transistors, Strategic Submarines, 10 Submarine yards
Advances Required	5

Completing the Nuclear Submarine project provides your nation with the capability to build (**nsb**) units. These represent one behemoth of the depths, capable of carrying many SLBM missiles. It can operate anywhere in the world's oceans, including under the polar ice, undetected and at maximum capability for extended periods.

By eliminating the need for oxygen for propulsion, nuclear power provides a means to drive a submerged submarine at high speeds.

5.3.42 Nuclear Carrier

Tech Level Requirement	19
R&D Requirement	Nuclear Power, Transistors, Aircraft Carrier, 10 shipyards
Advances Required	4

Completing the Nuclear Carrier project provides your nation with the capability to build (**ncv**) units. These represent one massive aircraft carrier.

A Nuclear powered supercarrier is able to operate independent of tankers or supply escorts. Their compact energy source negates the requirement for large propulsion fuel tanks and provides more space for weapons, aircraft fuel, and other consumables.

5.3.43 Nuclear Icebreaker

Tech Level Requirement	19
R&D Requirement	Icebreaker, Nuclear Power, 8 shipyards
Advances Required	3

Completing the Nuclear Icebreaker project provides your nation with the capability to build (**nce**) units. These represent one massive and powerful icebreaker.

The nuclear powered icebreaker is a purpose-built ship for use in waters continuously covered with ice. If the nation has completed the R&D project Air Mobile Infantry then the Nuclear Icebreaker can carry two helicopters in addition to its normal cargo to scout for 'lines' in the ice – natural breaks that can be exploited by the ship.

An NCE unit can push through one iced open ocean hex in 4AP and one iced seazone in 2AP. Note that it cannot break through an ice shelf or the polar cap.

5.3.44 Submarines: Hunter-Killers

Tech Level Requirement	19
R&D Requirement	Strategic Submarines, 5 Submarine yards, Sonar, Mainframe
Advances Required	4

Completing the Hunter-Killers submarine project provides your nation with the capability to build (**hks**) units. These are fast attack anti-submarine submarines that prowl the deep oceans in the hunt for the elusive strategic submarines that may be lurking just off the coastline or in the deep ocean trenches.

5.3.45 Hardened Electronics

Tech Level Requirement	19
R&D Requirement	Transistors
Advances Required	5

Completion of the Hardened Electronics project provides your nation with radiation hardened electronics, and makes your nation and units less susceptible to the Electro-Magnetic Pulse generated by nuclear weapons.

5.3.46 Cruise Missile

Tech Level Requirement	19
R&D Requirement	Jet Fighter, Transistors, Fusion Bomb, 20 Aircraft Factories, 5 Rocket Factories, 5 Nuclear Production Facilities
Advances Required	6

Completion of the Cruise Missile project permits your nation to build (**crm**) units. A cruise missile is an unmanned guided missile using a jet propulsion system to allow sustained subsonic flight. It is designed to carry a conventional or nuclear warhead. The cost of the unit includes the nuclear warhead.

The unit has a Combat strength only for defense against aircraft and point defense systems - it cannot fight other units. The missile flies too low to be engaged by ABM systems. It can be used against monolithic constructions, cities and fortresses, and at sea against large valuable enemy assets (any ship unit with a size rating of H or HH). The cruise missile inflicts damage using its Siege rating. On firing the missile the player must indicate if the warhead is nuclear or conventional; a nuclear warhead inflicts damage as per the normal nuclear effects with a base effect of 25 and a conventional warhead inflicts 5 points. The default warhead is nuclear.

The effectiveness of a cruise missile in flight is determined by the Aircraft QR. The Range of a cruise missile depends on the Rocketry QR, with a minimum Range of one and a maximum Range of eight.

A cruise missile can be fired from a bomber or heavy bomber (thus increasing the effective Range of the aircraft for a stand-off attack), a Strategic or Nuclear submarine (if the SLBM project has been completed), a warship (where it is carried as 'cargo') or from any type of base. Once fired, the unit is lost.

5.3.47 Naval: Point Defense

Tech Level Requirement	19
R&D Requirement	Radar, Transistors, Single-Stage Rockets
Advances Required	5

Completion of the Naval: Point Defense project enhances the Anti-Aircraft Strength of all warships that have an Anti-Aircraft Strength of more than zero. This project represents the development of automated anti-aircraft and anti-missile systems using radar.

Note that it cannot be used against rocketplanes, strategic rockets such as ICBMs but could be used against single-stage rockets and Tactical Ballistic Missiles as well as all kinds of aircraft.

5.3.48 Rocketry: Local Space Defense

Tech Level Requirement	19
R&D Requirement	Space Platform, Hardened Electronics, 15 Rocket Factories
Advances Required	3

Completion of the Local Space Defense project allows the nation to build (**lsd**) units which can be mounted on a space platform or station. These units represent relatively primitive space weapons: non-nuclear missiles, guns, small kinetic kill weapons. Local Space Defense systems can be used for defense and to attack a satellite, platform, station or vehicle in the same location.

This technology will lead to future space-based weaponry.

5.3.49 Rocketry: Lunar Outpost

Tech Level Requirement	19
R&D Requirement	Lunar Mission, Nuclear Power, Space Platform, 20 Rocket Factories
Advances Required	4

Completing the Lunar Outpost project permits the nation to commence building outposts on the Moon. See Section 3.17.1 for details.

It also allows the nation to build Heavy Lander (**shl**) units. These are big space vehicles that can only operate in a vacuum, and can carry 4 cargo points.

Note that to allow this project to be initiated, a Lunar Mission must have been performed successfully – the astronauts landing on the Moon and returning to Earth alive…

5.3.50 Rocketry: Kinetic Energy Weapon

Tech Level Requirement	19
R&D Requirement	Satellites, 10 rocket factories, Spaceport
Advances Required	3

Completion of the Kinetic Energy Weapon project allows the nation to build (**kew**) units. These must be launched into LEO to be used as a weapon and are a type of warsat, consisting of a projectile which can be released from orbit to strike a target on the ground with a force comparable to a small nuclear warhead but without radioactive fallout. Like nuclear weapons, these *thunder rods* are single use.

A kinetic energy weapon can be directed against monolithic constructions, cities and fortresses. They have no effect on underwater targets.

KEW can also be launched by Lunar mass-drivers - which does not require this project to be completed – and build using Lunar cNFP. See Section 3.8.4.1.

KEW can also be used as anti-ballistic missile weapons. See Section 6.6.2.

5.3.51 Microchips

Tech Level Requirement	20
R&D Requirement	Transistors
Advances Required	6

A monolithic integrated circuit is a miniaturized electronic circuit manufactured in the surface of a thin substrate of semiconductor material. These microchips provide significant processing power. However, they are more susceptible to the Electro-Magnetic Pulse generated by nuclear weapons.

This technology will lead to many other projects and also allows a national internet to be constructed – see Section 3.7 for details.

5.3.52 Land: Point Defense

Tech Level Requirement	20
R&D Requirement	Naval: Point Defense, Microchips
Advances Required	5

Completion of the Land: Point Defense project enhances the Anti-Aircraft Strength of all mechanized units that have an Anti-Aircraft Strength of more than zero. This project represents the development of automated anti-aircraft and anti-missile systems using radar.

Note that it cannot be used against rocketplanes, strategic rockets such as ICBMs but could be used against single-stage rockets and Tactical Ballistic Missiles as well as all kinds of aircraft. These systems are smaller and lighter weight than those developed for Naval: Point Defense.

5.3.53 Advanced Torpedoes

Tech Level Requirement	20
R&D Requirement	Torpedo, Single-Stage Rocket, Microchips
Advances Required	5

With the completion of this project the nation gains a bonus when using torpedoes. These high speed torpedoes use super-cavitation where a gaseous layer is created ahead of the projectile so that viscous drag is reduced and high underwater speeds can be achieved. Unfortunately steering this underwater missile is difficult, but against relatively slow submarines and surface ships it is still an effective weapon.

5.3.54 Advanced Sonar

Tech Level Requirement	20
R&D Requirement	Sonar, Microchips
Advances Required	5

Completion of the Advanced Sonar project provides a combat bonus for submarines or surface units fighting submarines. It represents advanced towed arrays or sonar nacelles.

5.3.55 Rocketry: Decoy

Tech Level Requirement	20
R&D Requirement	ICBM, 10 Rocket Factories
Advances Required	3

The completion of the Rocketry: Decoy project does not provide any new units but does provide a bonus to the Combat Strength of a rocket or missile (ICBM, SLBM or MIRV) against any type of ABM system (space or ground-based) at any stage following the missile's boost-phase. The decoys can seduce defending assets away from the real warheads.

5.3.56 Rocketry: MIRV

Tech Level Requirement	20
R&D Requirement	ICBM, Microchips, 10 Rocket Factories, 10 Nuclear Production Factories
Advances Required	3

Completing the MIRV project allows the nation to start building (**mrv**) units. These are a multiple independently targetable re-entry vehicle is a collection of nuclear warheads carried on a single ICBM. Using a MIRV warhead, a single launched missile can strike several targets, or fewer targets redundantly.

A MIRV represents one long-range missile and its silo and command bunker. It includes a Fusion Bomb as its warhead. It can only be moved to its deployment site by ship or by rail. A MIRV can be located within a city, fortress or region, but once in place cannot be moved again. Once it is launched the unit is destroyed.

The price of the unit includes four warheads. On launching the MIRV up to four targets within four contiguous regions or sea zones (or two ocean hexes) can be designated. A MIRV has two Combat ratings: the first for in-flight and used only in 'combat' with defending ABMs, and the other for whilst it is sitting in its hardened silo. Note that the latter is either the value stipulated, or the Siege QR of the nation, whichever is lowest.

Once launched a MIRV is not as vulnerable to ABM units defending its designated target as ICBMs due to its multiple target capability and the deployment of decoys as it releases the warheads. On its trajectory it also briefly passes through LEO and is vulnerable to the warsats.

A MIRV can deliver warheads into LEO for a detonation in orbit. See Section 6.5.4 for the effects.

5.3.57 ABM: Neutron Warhead

Tech Level Requirement	20
R&D Requirement	Fusion Bomb, Anti-Ballistic Missiles, 15 Nuclear Production Factories, 10 Rocket Factories
Advances Required	5

Completion of the ABM: Neutron Warhead project allows the nation to build (**anm**) units – these are improved ABMs mounting a nuclear warhead that attempts to destroy incoming missiles by damaging their electronic components with the intense neutron flux.

The unit represents a radar-guided missile system capable of defending a fortress or a city and surrounding region from attack by all types of rocket (including ICBMs, SLBMs and MIRVs) but not tactical nuclear weapons, or high altitude bombers such as the jet bombers and heavy jet bombers. It is, however, capable of shooting down rocketplanes that fly within its coverage. It can also defend against Kinetic Energy Weapons (although these are harder to kill) by deflecting them from their target.

It cannot engage in any other form of combat. Multiple ABM units can defend the same location. An ABM unit can be part of the defenses of an Air, Fleet, Army or Rocket base. At this tech level an ABM unit consists of silos and radar systems and can only be moved by ship or by rail. Unlike nuclear weapons and other rockets an ABM system is not lost on use (unless the bombers or warheads destroy the fortress or city where it is based…).

Designer's Note: Tactical Neutron Bombs are ignored in this supplement as their strategic effect duplicates the existing fusion bomb.

5.3.58 Rocketry: Interplanetary Rover

Tech Level Requirement	20
R&D Requirement	Microchip, Interplanetary Probe, 10 rocket Factories, Spaceport
Advances Required	4

Completing the Interplanetary Rover project provides your nation with the capability to build (**rov**) units. These are small unmanned spacecraft launched away from Earth to reach land on Mars and wander the deserts of the Red Planet, returning data to Earth. Whilst the successful rendezvous with another world provides only a bonus to the national University Investment it also provides enormous prestige. The arrival of the probe at its destination is governed by the Rocketry QR and the support costs cover the groundside monitoring of the probe.

The probe will take several months to reach Mars – see Section 3.14.6.2. On launch your GM will inform you when it will arrive. This project leads the way for a future manned expedition.

5.3.59 ABM: Advanced ABM

Tech Level Requirement	20
R&D Requirement	Anti-Ballistic Missiles, Microchips, 15 Rocket Factories
Advances Required	6

Completion of the ABM: Advanced ABM project allows the nation to build (**axm**) units – these are improved ABMs capable of not only defending the region where they are based but providing umbrella coverage to the surrounding regions and sea zones (or ocean hex).

Note: this unit will prioritize self-defense so if its own region as well as a neighboring region are under attack in a combat round it will defend the region it is situated in.

5.3.60 Rocketry: Lunar Base

Tech Level Requirement	20
R&D Requirement	Lunar Outpost, 25 Rocket Factories
Advances Required	5

Completing the Lunar Base project permits the nation to commence building large bases on the Moon. See Section 3.17.2 for details.

5.3.61 AFV: Lunar Crawler

Tech Level Requirement	20
R&D Requirement	Lunar Base, Heavy Tank
Advances Required	3

Completing the AFC: Lunar Crawler project permits the nation to build (**lcr**) units. These are tough vehicles that can only be used on the surface of the Moon. Whilst they provide life support and some protection against radiation, they must end the turn at a lunar outpost or base.

5.3.62 Flying Machines: Stealth

Tech Level Requirement	20
R&D Requirement	Jet Fighter, Microchips, Radar, 20 Aircraft Factories
Advances Required	6

Completion of this project lends a Combat bonus to your air assets.

5.3.63 Rocketry: Space Shuttle

Tech Level Requirement	20
R&D Requirement	(Aero-spaceplane) or (Jet Fighter & Multistage Rocket), 15 Rocket Factories, Spaceport, 15 Aircraft Factories
Advances Required	3/5

Completion of the Space Shuttle projects allows the nation to build (**spt**) and (**sht**) units. These are reusable space craft launched vertically like a rocket with the orbiter returning to earth as a hypersonic glider. The orbiter is capable of limited maneuver in orbit and makes an un-powered glide return and landing. The unit cost includes the expense of replacing those portions used in the vertical takeoff that are not reusable.

5.3.64 Command & Control

Tech Level Requirement	20
R&D Requirement	Microchips
Advances Required	3

Completion of this project represents the ability to build complex command and control systems for your military forces. It provides a Combat bonus to all of your naval, land, air and space assets. Note that it does not increase the combat proficiency of strategic missiles such as ICBMs, SLBMs or MIRVs.

5.3.65 Laser

Tech Level Requirement	20
R&D Requirement	Hardened Electronics
Advances Required	4

Completion of the Laser project will support subsequent R&D projects.

5.3.66 Precision Weaponry

Tech Level Requirement	20
R&D Requirement	Laser, Command & Control, Radar
Advances Required	4

Completion of the Precision Weaponry project provides a bonus to air and artillery strikes (including cruise missiles but not ballistic missiles) against specific targets: monolithic construction and yards and factories or large naval assets.

It provides munitions (smart munitions or smart bombs) which are self-guiding weapons intended to maximize damage to the target while minimizing "collateral damage".

When a laser designator is used it illuminates the target which is detected by the seeker head of the weapon which then guides the munition to the designated target.

Radar guidance allows the munition to autonomously track the target and to alter its course after being fired, typically to correct for aiming error, wind or a moving target.

5.3.67 Rocketry: Single Stage to Orbit

Tech Level Requirement	20
R&D Requirement	Heavy Lift Rocket, 20 Rocket Factories, Spaceport
Advances Required	6

Completion of the Rocketry: Space Based Laser project allows the nation to build (**sbl**) units.

A single-stage-to-orbit rocket is launched like a normal rocket – and lands vertically as well. This rocket is fully reusable but must take-off and land at a Spaceport. The SSO is a reliable workhorse vehicle used to routinely launch payloads into LEO.

It utilizes a plug nozzle rocket engine design, which doubles as a heat shield during atmospheric reentry, with the nozzles cooled by circulating liquid hydrogen.

5.3.68 Rocketry: Advanced Asteroid Mining

Tech Level Requirement	20
R&D Requirement	Microchips, Asteroid Mining, 25 Rocket Factories
Advances Required	5

Completing the Advanced Asteroid Mining project allows the nation to start building (**amv**) units. These are larger and longer range mining ships, capable of carrying equipment to extract more material and return it to Earth orbit. These still use chemical rockets and must end the turn docked at a space platform or station – it cannot land on either the Earth or the Moon.

5.3.69 Subsurface Guns

Tech Level Requirement	21
R&D Requirement	Advanced Torpedoes, Advanced Sonar, Naval Point Defense
Advances Required	3

With the completion of this project the nation gains a bonus against torpedo attack and a general Combat Strength bonus. A subsurface gun consists of an underwater gun turret or pod used to fire high-speed projectiles at mines, torpedoes and other vessels.

This bonus applies to all warships and submarines with a size rating of M or greater.

5.3.70 Spaceplanes

Project Name	**Spaceplane**
Tech Level Requirement	21
R&D Requirement	(Space Shuttle or Aero-spaceplane)), 15 Rocket Factories, Spaceport, 20 Aircraft Factories
Advances Required	5/4

A spaceplane utilizes an advanced dual or triple-use engine - an air-breathing rocket engine. The engines are designed to operate like a jet engine at up to around Mach 5 with the liquid hydrogen fuel used to cool the air entering the engine which is then burnt much like in a conventional jet. It then operates as a scramjet where air is compressed by the high speed of the vehicle, fuel is combusted, and the exhaust jet leaves at higher speed than the inlet air allowing it to achieve a speed between Mach 12 and Mach 24 (orbital velocity). At high altitude the air inlet is closed and the engine operates as a highly efficient rocket to orbital speed.

This technology is represented by a new slate of R&D projects and the attendant trans-atmospheric unit types.

On completing the spaceplane project the nation can build (**spl**) and (**hpl**) units. These represent advanced trans-atmospheric reusable craft, capable of carrying cargoes into Earth orbit, taking off and landing like a conventional aircraft and not requiring a Spaceport.

A spaceplane can be used as a sub-orbital transport, landing at any airport on Earth after a flight of barely two hours.

Project Name	Trans-atmospheric Fighter
Tech Level Requirement	21
R&D Requirement	Spaceplane, Jet Fighter, Precision Weaponry, 15 Rocket Factories, 15 Aircraft Factories
Advances Required	5

Project Name	Trans-atmospheric Heavy Fighter
Tech Level Requirement	21
R&D Requirement	Trans-atmospheric Fighter, 20 Rocket Factories, 20 Aircraft Factories
Advances Required	4

A Trans-atmospheric Heavy Fighter can carry and deliver one nuclear warhead in addition to its normal Combat and Siege ratings.

5.3.71 Sub-Orbital Dropship

Tech Level Requirement	21
R&D Requirement	Single Stage to Orbit, Local Space Defense, 25 Rocket Factories
Advances Required	5

On completing the Sub-orbital Dropship project the nation can build (**sdr**) units. A dropship is a rugged reusable single-stage vehicle capable of carrying equipment or a battalion of troops to LEO or to anywhere on Earth. It takes off and lands vertically, but can be launched horizontally on a launch rail. Loading and unloading is as per a ship, with any city being treated as a port city (assumed to have an airport or spaceport) and taking longer if the vehicle lands in a region. The cargo cannot fight until unloaded.

A dropship offers a means of launching a payload to any point of the Earth in just over an hour, allowing the projection of military power or disaster relief with minimal delay. It can land and takeoff from any flat location; operating the vehicle in mountainous terrain is hazardous with a negative bonus to the Rocketry QR.

During its boost and landing phases a drop ship is vulnerable to attack by orbital KEW and SBL like any other rocket. On landing it can also be attacked by ABM and point defense systems, but incorporates its own point defense to counter missiles and shells.

5.3.72 Solar Power Satellites

Tech Level Requirement	21
R&D Requirement	Space Platform, 15 Rocket Factories
Advances Required	4

Completion of the Solar Power Satelleites project permits the nation to commence building Solar Power Satellites. See Sections 2.6.6 and 3.10.

5.3.73 Rocketry: Space Based Laser

Tech Level Requirement	21
R&D Requirement	Laser, Local Space Defense, Command and Control, 15 Rocket Factories
Advances Required	5

Completion of the Rocketry: Single Stage to Orbit project allows the nation to build (**sbl**) units. An SBL is a satellite equipped with a high-energy chemical laser that can detect, track, target, and destroy hostile ballistic missiles at the speed of light with its megawatt-class high power beam.

This warsat can also be used to attack other satellites, space platforms and stations, and other space vehicles within one orbital ring or segment of its own position. At this Tech Level SBL cannot be used to attack ground targets.

5.3.74 Battlesuit

Tech Level Requirement	21
R&D Requirement	Command & Control
Advances Required	4

Completing the Battlesuit project allows the nation to build (**bsi**) units. There are no elite or inexperienced bsi units.

The battlesuit consists of armor with mechanical and electronic mechanisms designed to augment the wearer's abilities. It includes life support for hostile environments, protection from environmental hazards such as radiation and vacuum, sensors and targeting systems, and built-in weapons. The ceramic armor is strong enough to resist any conventional weapon less than high explosives or anti-tank rounds.

Infantry equipped with these battlesuits can operate on the Earth or in space, though at this Tech Level the suits do not include zero gravity manoeuvre units.

5.3.75 Rocketry: Battlespace Fighter

Tech Level Requirement	21
R&D Requirement	Local Space Defense, Precision Weaponry, Space Platform, 10 Rocket Factories
Advances Required	4

Completion of the Rocketry: Battlespace Fighter allows the nation to build (**sbf**) units. These are manned exoatmospheric vehicles purely to be used in space combat. A battlespace fighter must be based on a space platform or station or at a lunar outpost or base. They cannot enter the Earth's atmosphere.

5.3.76 Rocketry: Orbital Coil Gun

Tech Level Requirement	21
R&D Requirement	Kinetic Energy Weapon, Precision Weaponry, 15 Rocket Factories
Advances Required	4

Completion of the Rocketry: Orbital Coil Gun allows the nation to build (ocg) units to be based in orbit.

A coilgun uses a series of electromagnets to accelerate a magnetic darts to hyper-velocities. The dart acts as a kinetic energy weapon and can be directed towards enemy missiles and rockets, primarily in their boost-phase and against targets on the ground. It is most effective in vacuum. Because firing a stream of darks propels the coilgun in the opposite direction the warsat either employs a station-keeping function or moves into a lower orbit prior to unleashing its darts. Unlike the earlier KEW a coilgun is reusable.

5.3.77 Nuclear Thermal Propulsion

Tech Level Requirement	21
R&D Requirement	Nuclear Power, 15 Nuclear Production Facilities, Microchips
Advances Required	5

Completion of this project allows the nation to to design (but not build) space vehicles using this means of propulsion.

In a nuclear thermal rocket a working fluid, usually hydrogen, is heated in a high temperature nuclear reactor, and then expands through a rocket nozzle to create thrust. The nuclear reactor's energy replaces the chemical energy of the reactive chemicals in a traditional rocket engine.

See Table 5-5 and Table 5-6 for details of the cost of spacecraft using this drive.

5.3.78 Nuclear Electric Propulsion

Tech Level Requirement	21
R&D Requirement	Nuclear Power, 20 Nuclear Production Facilities, Microchips
Advances Required	4

Completion of this project allows the nation to design (but not build) space vehicles using this means of propulsion.

In a nuclear electric rocket, nuclear thermal energy is changed by direct thermoelectric or thermionic conversion into electrical energy that is used to power an electrical propulsion system. The powerplant is nuclear, not the propulsion system, providing a heat source for electric ion drives expelling plasma out of a nozzle to propel the spacecraft. Superconducting magnetic cells ionise hydrogen or xenon, heat it to extremely high temperatures, accelerate it and expel it at very high velocity to provide thrust. However, actual thrust is low if constant; a spacecraft employing this propulsion system will also use chemical rockets to transit the Van Allen Belts.

See Table 5-5 and Table 5-6 for details of the cost of spacecraft using this drive.

5.3.79 Solar Electric Propulsion

Tech Level Requirement	21
R&D Requirement	Solar Power Satellites, 30 Rocket Factories, Microchips
Advances Required	3

Completion of this project allows the nation to design (but not build) space vehicles using this means of propulsion.

This similar to but lower powered than Nuclear Electric Propulsion except that the energy source is derived from massive solar panels and any spacecraft employing this method is relatively fragile. Because of the need for sunlight, the propulsion is impractical beyond the orbit of Mars. The actual thrust is also low; a spacecraft employing this propulsion system will also use chemical rockets to transit the Earth's hazardous Van Allen Belts.

See Table 5-5 and Table 5-6 for details of the cost of spacecraft using this drive.

5.3.80 Rocketry: Long Range Asteroid Mining

Tech Level Requirement	21
R&D Requirement	Asteroid Mining, Space Based Laser, Space Platform, (Nuclear Thermal Propulsion or Nuclear Electric Propulsion or Magnetic Nuclear Pulse Propulsion or Solar Electric), Hardened Electronics
Advances Required	3

Completing the I3 Asteroid Mining project allows the nation to build really useful asteroid mining ships with a long mission duration that does not require the spacecraft to return to a space platform or station at the end of every turn.

It includes a rotating habitat for the crew as well as ore processing and cargo holds for cNFP. These ships could reach Mars but are specialized to their task, so they could

mine the moons of Mars but not support a landing mission to the Red Planet.

Note that ships using Solar Electric propulsion cannot be used beyond the orbit of Mars and are more suitable for work closer to the Sun.

Table 5-5. Long Range Miners - Costs & Capacity

Unit Name	Code	Cost	Yard Capacity	Cargo	Mission Duration
Nuclear Thermal Miner	dnt	1000 gp/ 10 nfp	25n/30r	15	24
Nuclear Electric Miner	dne	1250 gp/ 8 nfp	30n/30r	14	24
Magnetic Nuclear Pulse Miner	dnp	2000 gp/ 40nfp	35r/25r	15	18
Solar Electric Miner	dse	1250 gp/ 8 nfp	30r	18	24

5.3.81 Rocketry: I3 Interplanetary Mission

Tech Level Requirement	21
R&D Requirement	Interplanetary Probe, Space Platform, (Nuclear Thermal Propulsion or Nuclear Electric Propulsion or Magnetic Nuclear Pulse Propulsion or Solar Electric), (Spaceplane or Single Stage to Orbit), Command and Control, Hardened Electronics
Advances Required	3

Completing the Interplanetary Mission project allows the nation to build an interplanetary space vehicle capable of reaching Mars (or Venus). The spacecraft is capable of making a return journey carrying a small crew and a landing module – for Mars (which is either an adapted spaceplane or a modified single stage to orbit rocket).

These large spacecraft must be fabricated in Earth orbit (possibly over several turns) and so a space platform or station is required to support its construction. The NFP must be transferred to the location.

The cost of the vehicle and the duration of the mission depend on the type of propulsion and the trajectory of the flight to and from Mars or Venus. The mission is liable to take many turns, and this long range vessel is fully self-sufficient.

Successful completion of a planetary landing (and return) will lead to other space projects. See Section 3.14.6.1 for details of the Mars Mission.

The cost excludes the lander(s), which must be carried to Mars as cargo and will be abandoned at Mars to reduce the payload for the return flight.

Table 5-6. I3 Interplanetary Mission Costs & Capacity

Unit Name	Code	Cost	Yard Capacity	Cargo	Mission Duration
Nuclear Thermal Spacecraft	snt	1000 gp/ 12 nfp	25n/25r	5	24
Robot Nuclear Thermal Spacecraft	rnt	1500 gp/ 12 nfp	25n/25r	5	24
Nuclear Electric Spacecraft	sne	1250 gp/ 10 nfp	30n/25r	4	24
Robot Nuclear Electric Spacecraft	rne	1500 gp/ 10 nfp	30n/25r	4	30
Magnetic Nuclear Pulse Spacecraft	snp	2000 gp/ 50nfp	30r/25r	5	18
Robot Magnetic Nuclear Pulse Spacecraft	rnp	2500 gp/ 50nfp	30r/25r	5	18
Solar Electric Spacecraft	sse	1250 gp/ 10 nfp	25r	8	24
Robot Solar Electric Spacecraft	rse	1500 gp/ 10 nfp	25r	8	36

The following Mars Landers and rovers can be built to be carried by the interplanetary spacecraft:

Table 5-7. I3 Mars Landers & Other Equipment

Unit Name	Code	Cost	Yard c	Cargo	(Cargo)
Mars Lander	MLR	550 gp/ 5 nfp	15r	3	-
Mars Cargo Lander	MCL	400 gp/ 4nfp	10r	2	(1)
Mars Spaceplane	MSP	600.0 gp/ 4 nfp	25a	5	(1)
Crawler	MCR	50.0 gp/ 1 nfp	5Fc	1	-
Planetary Probe	MPP	50.0 gp/ 1 nfp	2r	0.5	-

- The Mars Lander can only make one descent and carries a return stage for a single ascent to the mothership. Can only be built if the nation has completed the Single Stage to orbit project.
- The Mars Cargo Lander consists only of a descent stage to deliver equipment to the surface. Can only be built if the nation has completed the Single Stage to Orbit project.
- The Mars Spaceplane is a spaceplane adapted to the Martian environment. It can fly in the Martian atmosphere, making several landings and returning to the mothership in orbit to refuel. Can only be built if the nation has completed the Spaceplanes project.
- The Mars Crawler can be used to explore the Martian surface.
- A Planetary Probe is a short-range probe that can be dropped from orbit to provide data on planetary

conditions. Useful for missions to hostile worlds such as Venus where a manned landing is impossible.

All of this materiel is abandoned either on the Martian surface or in space when the mothership makes its return to Earth.

5.3.82 Magnetic Nuclear Pulse Propulsion

Tech Level Requirement	22
R&D Requirement	(Nuclear Pulse Rocket or Nuclear Power), 30 Nuclear Production Facilities, Microchips
Advances Required	4/5

Completion of this project allows the nation to design (but not build) space vehicles using this means of propulsion. This is a much more efficient version of the primitive Nuclear Pulse Rocket using magnetic implosion.

Small pellets containing initially subcritical fissile material are compressed to beyond their supercritical point using a magnetic field. The explosion is several orders of magnitude smaller than a traditional nuclear bomb and creates plasma directed by a magnetic nozzle to generate vehicle thrust.

It cannot be used in LEO without a risk of pumping up the Van Allen Belt (see Section 6.5.4) and its fuel is highly radioactive. See Table 5-5 and Table 5-6 for details of the cost of spacecraft using this drive.

5.3.83 Rocketry: I3 Space Cruiser

Tech Level Requirement	22
R&D Requirement	Space Based Laser, Coilgun, Space Platform, (Nuclear Thermal Propulsion or Magnetic Nuclear Pulse Propulsion), Hardened Electronics, Battlespace Fighter
Advances Required	5

Completion of this project allows the nation to build powerful space warfare vessels, capable of cruising the Inner Solar System.

A cruiser is equipped with lasers, coilguns and missiles for space combat and can carry either two battlespace fighters or a spaceplane or Heavy Lunar Lander. The normal design of these vessels will be cylindrical, with the drive at one end and the shielded crew compartment at the other, with the carried vehicles either held in a hangar or held in external cradles. Heat radiators and solar panels are held can be extended or folded away for protection. An array of sensors is scattered around the vehicle, with turrets holding coil gun mounts or the mirrors for powerful lasers.

Note that Nuclear Electric and Solar Electric drives have too low a thrust to be of practical use for military spacecraft.

Table 5-8. I3 Space Cruisers - Costs & Capacity

Unit Name	*Code*	*Cost*	*Yard Capacity*	*Mission Duration*
Nuclear Thermal Space Cruiser	wnt	2000 gp/ 10 nfp	25n/30r	30
Magnetic Nuclear Pulse Space Cruiser	wnp	4000 gp/ 40nfp	35r/30r	24

5.3.84 Genetic Engineering

Tech Level Requirement	22
R&D Requirement	Microchips
Advances Required	4

Completion of this project allows the nation to increase the Agro yield of all cultivated and intensively cultivated regions. It will also lead to future technologies.

5.3.85 Advanced Biological Warfare

Tech Level Requirement	22
R&D Requirement	Genetic Engineering, Biological Weapons
Advances Required	5

Completion of the Advanced Biological Warfare project permits the nation to build single-use (**gen**) units - advanced bioweapon bombs and warheads that can be tailored to a particular population (a specific Geo Zone). These bioweapons can be delivered to their target by railroad, ships, bombers or by rockets or cruise missile. See Section 6.9.

5.3.86 Human Hibernation

Tech Level Requirement	22
R&D Requirement	None
Advances Required	5

Completion of this project allows the nation to double the Mission Duration of all subsequent Interplanetary Missions that depart Earth Orbit by using suspended animation techniques. This makes manned deep space missions practical as well as meaning that an interplanetary vessel can carry NFP double its cargo rating for the building of space platforms, stations, outposts and bases beyond the Earth-Moon system.

5.3.87 Powered Armor

Tech Level Requirement	22
R&D Requirement	Battlesuit
Advances Required	4

Completion of this project allows the nation to build (**psi**) units. There are no elite or inexperienced bsi units.

Powered Armor consists of an armored artificial powered exoskeleton with mechanical and electronic mechanisms designed to augment the wearer's abilities. It includes life support for hostile environments, protection from environmental hazards such as radiation and vacuum,

sensors and targeting systems, and built-in weapons. The ceramic armor is strong enough to resist any conventional weapon less than high explosives or anti-tank rounds.

Infantry equipped with Powered Armor can operate on the Earth or in space; the suits include zero gravity maneuver units.

5.3.88 Particle Accelerator

Tech Level Requirement	22
R&D Requirement	Laser, Nuclear Power
Advances Required	5

Completion of this project allows the nation to create focused beams of neutral subatomic particles virtually at light speed. This does not provide a practical weapon system but future projects will.

5.3.89 ABM Laser

Tech Level Requirement	22
R&D Requirement	Anti-Ballistic Missiles, Space Based Lasers, Nuclear Power
Advances Required	5

Completion of this project allows the nation to build (**gbl**) units.

These are high-power long range lasers that can be used effectively on Earth both to knock out incoming rockets, cruise missiles, aircraft and other units – advanced and highly destructive line-of-sight artillery. These units are massive and must be transported to their base either by rail or by ship.

They are also used to launch Laser Rockets. See Section 5.3.91.

5.3.90 Advanced Space Based Laser

Tech Level Requirement	22
R&D Requirement	ABM Lasers, Space Based Lasers
Advances Required	3

Completion of this project allows the nation to build and deploy (**abl**) units.

These are an improvement on SBL warsats but must be lifted into orbit to be useful. One of these units can be used against space-based targets, and on any rockets, cruise missiles and aircraft beneath it.

They can also be used to heat the atmosphere, either for ecological warfare or to move atmospheric phenomena such as hurricanes.

5.3.91 Rocketry: Laser Rocket

Tech Level Requirement	22
R&D Requirement	ABM Laser, Single Stage to Orbit, 25 Rocket Factories
Advances Required	5

Completion of this project allows the nation to build (**lrr**) units.

A laser rocket requires the use of an ABM Laser based at a Spaceport. Its beam is focused on a mirror that directs it to heat up propellant carried by the spacecraft. This provides a very cheap means of lifting cargoes into orbit because the engine (the laser) stays back on Earth.

5.3.92 Computers: AI

Tech Level Requirement	22
R&D Requirement	Microchips, Hardened Electronics
Advances Required	6

Completion of this project allows the nation to build complex computer systems that are effectively artificial intelligences, capable of being programmed and learning by experience. Whilst not as intelligent as humans they have the capability to analyze data vastly faster than humans.

This technology leads to many applications.

5.3.93 Cybernetic AFV

Tech Level Requirement	22
R&D Requirement	AI, Battle Tank
Advances Required	4

Completion of this project allows the nation to build (**cfv**) units. Cyber tanks!

As these vehicles do not have a human crew they simply require fuel and ammunition. This allows a more compact design, presenting a smaller target with equivalent or greater firepower. If isolated a cybernetic AFV is capable of autonomous action, subject to its last received orders.

5.3.94 Cybernetic Autonomous Fighter

Tech Level Requirement	22
R&D Requirement	AI, Trans-atmospheric Fighter, 20 Rocket Factories, 20 Aircraft Factories
Advances Required	5

Completion of this project allows the nation to build (**cpf**) units.

Like a cyber tank the cybernetic fighter aerospace craft is able to dispense with a human pilot, reducing the weight whilst permitting more energetic maneuvers than a piloted aircraft. The cyber fighter is subject only to the structural limits of its airframe, meaning that it can pull gees that a human pilot could not survive. It can be based at an airbase or a carrier.

5.3.95 Cybernetic Battlespace Fighter

Tech Level Requirement	22
R&D Requirement	AI, Battlespace Fighter, 20 Rocket Factories
Advances Required	5

Completion of this project allows the nation to build (**cbf**) units. This is effectively an autonomous reusable missile/weapons platform. Without a human pilot in the vacuum of space it can perform even greater accelerations and maneuvers than its cyber aerospace fighter cousin, limited only by its reaction mass. It can be based at a space platform or space station, or treated as a warsat waiting in orbit to be activated.

5.3.96 Cybernetic Space Vehicle

Tech Level Requirement	22
R&D Requirement	AI, I3 Interplanetary Mission
Advances Required	4

Completion of this project allows the nation to build fully automated interplanetary spacecraft. Unlike simple robot craft, the commanding AI can direct the repair and maintenance of its craft, meaning that there is less danger of the spacecraft being lost. As it does not require accommodation or life support for a human crew the cyber spacecraft can carry twice as much cargo.

5.3.97 Cybernetic Asteroid Mining

Tech Level Requirement	22
R&D Requirement	AI, Advanced Asteroid Mining, I3 Interplanetary Mission
Advances Required	5

Completion of this project allows the nation to build fully automated asteroid mining vessels. The commanding AI can direct the repair and maintenance of its craft as well as overseeing fully automated mining of an asteroid, returning the material to Earth orbit. Note that the Asteroid Miner is a pure space vehicle – it cannot land on either the Earth or the Moon.

The propulsion system used depends on the type drive. See the Long Range Mining Vessels, and double Mission Duration.

5.4 PROJECT RECRUITMENT

"Specialized" NFP may be acquired by the various kinds of Nations for National Projects (roads, railroads, research and development, mercantile colonies, etc.) through recruitment if they are Industrialized (TL12 and above). The NFP acquired by this process may **not** be used for the construction of cities, troops, fortresses (including field forts) or fleets.

Recruitment is handled by spending blocks of 25 GP and designating a specific project for the recruited NFP. Each 25 GP gains the project 0-5 (1d6-1) NFP.

Only Merchant Houses can use Project Recruitment for regional colonization (via the Merchant Colony project).

Project Recruitment cannot be attempted in the same turn as over-spending NFP. If an Open Nation controls (at Friendly or Homeland status) the 'home' site of an Merchant House, Religious Order or Religious Primacy - and the Open Nation over-spends NFP, then any Project Recruitment attempts undertaken by the House, Order or Primacy in that same turn will fail.

5.5 TECHNICAL ASSISTANCE

A Nation which already possesses the ability to build a unit type (having already completed their own R&D project) may provide help to another nation attempting to gain the capability by providing *Technical Assistance*.

One (1) NFP may be contributed by the assisting Nation to the recipient Nation's project. In addition to satisfying part (or perhaps all) of the NFP requirements for the project, the assistance so rendered reduces the number of Advances required for the project by one (1).

The NFP representing the technicians must be moved by one of the lending Nation's Leaders to the project site and then invested in the project.

Conversely, *capturing* one or more Factory points already capable of building a specific kind of unit produces Technical Assistance NFP equal to (# Factories or Yards divided by two, rounded down), which may then be used to jump-start one's own R&D Projects. This action destroys the Factory points as they are disassembled and studied.

5.6 OVERREACHING

A Nation that is only one Tech Level short of a Project's requirements (a TL 11 nation, for example, who wishes to embark on a TL 12 project), may do so if they acquire one or more examples of the item to be duplicated (or Technical Assistance NFP).

The number of Advances required for an Overreach R&D Project is increased by two (2) (which may then be reduced by one (1) by the investment of Technical Assistance NFP).

6. LEADERS AND ARMY ACTIONS

6.1 REVISED ACTION CAPACITIES

Just like nations during the Middle Ages period, the various kinds of Nations in the Post Medieval period have base Action capacities, based on their culture type. An exception to this are Warship and Transport units, which now calculate their Base Actions per Year from the Navigation Rating of their Nation.

Note that the previous (24-impulse) Action Chart has been replaced by new 48-impulse and 60AP Action Charts. See Table 9-14, which can be found on page 90 and Table 9-15 on page 91.

Table 6-1. Months Per Year Available For Actions

Culture	# of Months
Civilized	6
Seafaring	7
Barbarian	8
Nomadic	8
Pre-Columbian	5
Renaissance Land Units	8
Renaissance Ships	7 + Nav
Industrial One non-Steam Ships	8 + Nav
Industrial One Steamships	See build chart
Industrial One Land Units	9
Industrial Two Land Units	10
Industrial Three Land Units	11

Table 6-2. Unit Type Modifiers

Unit Type	*Modifier*
Leader	+2
Cavalry	+1
Infantry	+0
Siege	+0
Artillery	-1
Tribe Points	-1

Table 6-3. Equipment Type Modifiers

Equipment	*Modifier*
Heavy	-1
Medium	+0
Light	+1

Table 6-4. Unit Training Modifiers

Training	*Modifier*
Elite	+1
Regular	+0
Inexperienced	-1

Table 6-5. Leader Combat Rating Modifiers

Combat Leadership	*Modifier*
1 – 4	-1
5 – 8	+0
9 – 11	+1

The Unit Training Modifier does not apply to Leaders moving by themselves. If, however, they are moving with a unit type that has a greater Action capacity than they do they acquire the Action capacity of the unit *only while* they act in tandem with it.

The modifiers for Equipment and Training apply to ship units, as well as land units.

The Leader's Combat rating does not affect *his own* Action capability, but that of land units he is commanding instead. If he is commanding ships then his Combat Rating may boost the Action Capacity of the ships and thence his own capabilities. Kind of makes the head spin, don't it?

Example

Lord Captain Jehanli Drake, commanding the Marôcain pirate fleet in the Caribbean, is a L97A Leader and he commands a fleet of twelve 1st Rank Ships of the Line. The Marôcain Navigation rating is currently two (2). Drake's fleet gets 18 AP base (for those first-raters), plus two for the Navigation rating, plus one for Drake being a swell guy, = 21 actions per year. Quite enough to raise the very devil on the coast of Azteca and fill the Marôcain coffers with heavy red gold and their decks with coffles of slaves...

Table 6-6. Regional Terrain Action Modifiers

Culture Type	Regional Terrain Type					
	c/c2/i	*w*	*m*	*d/s*	*t*	*j*
Civilized	+0	+1	+2	+1	+2	+2
Seafaring	+0	+1	+2	+2	+2	+2
Barbarian	+0	+0	+1	+1	+1	+1
Nomadic	+0	+1	+2	+0	+2	+2
pre-Columbian	+0	+0	+1	+1	+1	+0
Renaissance	+0	+0	+1	+1	+2	+1
Industrial 1/2	+0	+0	+1	+1	+2	+1
Industrial 3	+0	+0	+0	+0	+1	+0

Culture Type	Regional Terrain Type					
	ai	am	ap	lp	lm	lt
Industrial 1/2	+6	+8	+7	+0	+1	+0
Industrial 3	+4	+7	+6	+0	+2	+0

Polar movement is difficult because of the hostile terrain and the large scale of the map.

6.2 SUB OPERATIONS

In the Space Age period an additional Sub Op becomes available. If the Submarines:Strategic Submarine and Rocketry: SLBM projects have been completed then a deadly new capability is added to the arsenal of the submarine leader.

A wolfpack containing one or more Strategic Submarine (ssb) units can conduct a nuclear missile attack on any target within the range of its SLBMs.

A wolfpack containing one or more hunter-killer (hks) units can actively hunt for enemy submarines. If the nation owns an operational underwater outpost or base these can be used to host Sub operations.

6.2.1.1 Sub Launched Bombardment (SBM)

Regular Leader AP cost is 1 AP.

Rockets with a **Siege** rating of one (1) or more may be directed to attack a single target per order against a city, fortress or project location (Railroad lines, Bridges, Pyramids, etc.) in a Region within their Operational Range. Damage is

done in terms of GP/NFP/Time required to repair the damage, if the facility is not destroyed outright.

Each Mission can direct multiple rockets to a single target. An additional Mission is needed to launch one or more rockets against another target (preparing for launch, calibrating the guidance instruments, and aligning the submarine).

When performing this Mission the rocket trajectory must be specified. See Table 6-9. Large Hex Map for Rockets and Table 6-8 Operational Ranges for Launch Systems.

6.2.1.2 Hunter-Killer (SKH)

Regular Leader AP cost is 10 AP.

This mission permits a wolfpack containing at least one hunter-killer submarine to seek out and engage enemy submarines in a sea zone or ocean hex.

6.3 AIR OPERATIONS

If the nation builds an aerostat, this massive 'cloud base' can be used as a mobile Air Base and used to host Air Operations.

6.4 SPACE OPERATIONS

The completion of the **Space Command** Project provides the Nation with one Space Operations point. Like Intel and Religious Operations the Nation can invest in this AQR as in any other to gain additional Space Ops up to the value of their Tech Level.

Table 6-7. Operation Leader Types

Type	*Description*
N	Admiralty - Naval Ops Leader
W	Wing Commander - Air Ops Leader
G	General Staff - Army Ops Leader
C	Space Commander – Space Ops Leader

Each Operations point generates a special type of Combat Leader. These Leaders possess only Combat and Charisma stats in the range 1-8 and cannot be used for any tasks other than the relevant Operations.

A SpaceCombat Leader can command rocket units and perform rocket operations.

A Combat Leader can optionally be promoted to full Leader status on the turn that a new national Lieutenant is generated by a BL increase, in place of that new Lieutenant. However, during that turn they cannot fight or engage in any missions whilst they travel to the Homeland, and the new Lieutenant they replace cannot be used in any way.

6.4.1 Space Operations

A Space Operations Combat Leader allows a group of rocket and space based units at a given **Space Base** to perform a Space Mission during the turn, without the intervention or assistance of a standard Leader.

A Space Base may be a Space Port, or a Space Platform or Station. With the building of installations on the Moon these too can be used to host Space operations.

A regular Leader, however, may take direct control of the units (attaching them to his army) and conduct Leader missions as well.

A Nation's space based units at a specific Base are called a 'Flight'. A Flight may undertake multiple missions during a turn, as resources (Combat Leader or Leaders) allow.

A Flight (composed of rockets, spaceplanes, engineers, and space units) employs the lowest Operations Range of any asset within the Flight.

Flight units tasked to an Action via an Army Operations Combat Leader can only conduct **one (1) mission per turn**. Space based units being commanded by a Leader, however, can conduct as many missions in a turn as the Leader has AP to pay for.

6.4.1.1 Rocket Ranges

Table 6-8. Operational Ranges for Launch Systems

Rocket Type	Min Range	Max Range	Nuclear Capable	Space port
Single-Stage Rocket	1	3	No	No
Dual-Stage Rocket	2	3 Large Hexes	Yes	Yes
Multistage Rocket	2 Large Hexes	4 Large Hexes	Yes	Yes
Nuclear Pulse Rocket	n/a	n/a	Yes	Yes
Heavy Lift Rocket	3 Large Hexes	Any	Yes	Yes
Single Stage to Orbit Rocket	3 Large Hexes	Any (must land at a Space port)	No	Yes
Sub-Orbital Dropship	3 Large Hexes	Any	No	No
ICBM	5	3 Large Hexes	Yes	No
SLBM	5	2 Large Hexes	Yes	No
MIRV	5	4 Large Hexes	Yes	No
TBM	1	2	Yes	No
ABM	Own Region		No	No
ANM	Own Region		Yes	No
AXM	1	2	No	No
Rocketry: Manned Capsule	--	--	No	Yes
Manned Orbital Capsule	--	--	No	Yes
Rocket plane	1	9 Large Hexes	No	No
Aero-Spaceplane	1	9 Large Hexes	To Orbit	No
Space Shuttle	1 Large Hex	9 Large Hexes	To Orbit	Yes
Heavy Shuttle	1 Large Hex	9 Large Hexes	To Orbit	Yes
Spaceplane	1	Any	To Orbit	No
Heavy Spaceplane	1	Any	To Orbit	No
Trans-atmospheric Fighter	1	Any	No	No

Rocket Type	Min Range	Max Range	Nuclear Capable	Space port
Trans-atmospheric Heavy Fighter	1	Any	Yes	No
Cybernetic Autonomous Fighter	1	Any	No	No
Laser Rocket	--	--	No	Yes

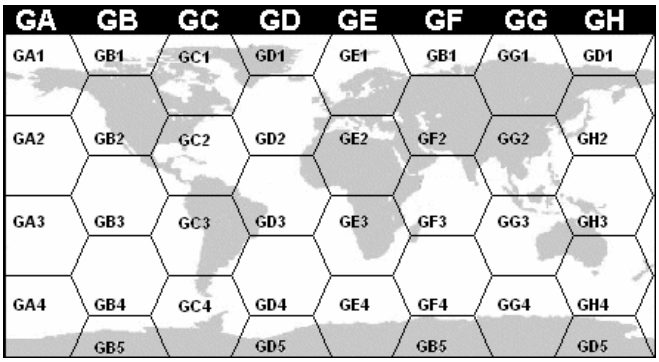
Sea Zones and Hexes count as 2 Range Points per zone or hex. An exception to this is Sea Hex/Zone combinations which in area make up approximately one Hex. Examples of this are: Hex 23C and *Freya Bank*, Hex 41H and *Inland Sea* and so on. In this case the Zone is 1 Range and the Hex is 1 Range.

The Large Hex Map provides an easy way to determine and define the trajectory of any inter-continental rocket. To calculate the range of the rocket, identify the launch site in one hex and the target in another. The launch hex and the target hex both count against the range of the rocket.

In addition to flying on the map, long range rockets can also fly over the Polar Regions. This means that any rocket trajectory can leave the top or bottom edge of the Map and reappear anywhere along that edge of the Map.

This map is also used in determining the course flown by rocketplanes and aero-spaceplanes.

Table 6-9. Large Hex Map for Rockets



6.4.1.2 Flight Bases

Flights have to operate from a *base* and can only engage in Actions (missions) within their Operations *Range* of the base.

A Flight can be based at an unbesieged, unblockaded City or Fortress controlled at Tributary or better, which is able to trace a Line of Communication back to the national Capital or be based on a Space Station so long as the nation has at least one operational Space Port on Earth.

Flights at an isolated City or Fortress cannot undertake any Army Operations (with or without a Leader) and if based on an unsupported Space Station must return to Earth or die.

6.4.2 Space Missions

The following missions can be attempted by Flight units being commanded by a General Staff Leader.

6.4.2.1 Flight Rebasing (SRB)

A rebasing Flight can relocate to another Base (which must meet the Base criteria listed above) by moving up to twice their Operations Range in AP, subject to normal movement costs.

6.4.2.2 Flight Defend Base (SDB)

The Defend action will keep an Army alert and prepared for an attack (even if it doesn't occur). An army that is using the Defend action will receive a favorable modifier in combat if it is attacked. This is the default condition of any Army Op.

6.4.2.3 Staff Officer – React (SSR)

A single Flight Op is tasked to support a regular Leader on React, increasing the Army's React Range by one AP. No more than one Army Op can be effective in supporting a Leader on React.

6.4.2.4 Staff Officer – Assistance (SSA)

A single Flight Op is tasked to support a regular Leader for the duration of the turn, moving with them, increasing that Leader's Combat Rating by one (1). In the event of the Leader's death the Staff Officer will take over their command, in the absence of another Leader to complete any outstanding Actions – but only those utilizing the Combat Rating; any Diplomacy- or Charisma-based actions will not be performed. The Army will end the turn at a suitable Army Base.

6.4.2.5 Bombardment (RBM)

Regular Leader AP cost is 3 AP for using a rocket salvo, 1 AP for an ICBM or SLBM salvo launch.

Rockets with a **Siege** rating of one (1) or more may be directed to attack a single target per order against a city, fortress or project location (Railroad lines, Bridges, Pyramids, etc.) in a Region within their Operational Range. Damage is done in terms of GP/NFP/Time required to repair the damage, if the facility is not destroyed outright.

Each Mission can direct multiple rockets at the Rocket base to a single target. An additional Mission is needed to launch one or more rockets against another target (preparing for launch, calibrating the guidance instruments, and aligning the launch pad). This mission is also used in unleashing ICBMs from their silos and SLBMs from submarines.

When performing this Mission the rocket trajectory across regions, sea zones, ocean hexes, Ice Sheet, taiga and Polar Regions must be specified.

There is no defense (at Industrial Levels One) against Rocket Bombardment.

6.4.2.6 Launch Manned Spacecraft (LMS)

Regular Leader AP cost is 5AP.

A manned spacecraft blast off from the Rocket Base and (hopefully) achieves orbit, and is safely returned to Earth. The AP duration of the Mission covers the sequence from launch, orbit and return.

As with any other Rocket Mission, the Rocketry QR governs the likely outcome.

A failure results in a big explosion on the pad, the breakup of the rocket in flight, failure to return the capsule to Earth, the capsule burning up on re-entry or failing to deploy parachutes or landing rockets… There is much that can go wrong with such a highly complex technological endeavor. Unless you wish to celebrate glorious (but deceased) heroes and heroines of your nation, you may wish to send irritating

primitive beeping satellites and unfortunate dogs and chimps into space instead of a human.

Later Projects will allow for docking at orbital space labs and space stations or flying to the Moon…

6.4.2.7 Analyze Satellite Data (SRF)

This is the equivalent of a standard Leader performing an ES:RF applied to spy satellite data (see Section 5.3.16). It permits the analysis of pictures to ascertain the location of Army, Fleet, Sub, Air and Rocket Bases and the approximate numbers of units there, as well as the presence of ICBM silos.

See also Section 8.

6.4.2.8 Command Space-Based ABM Systems (SBA)

Regular Leader AP cost is 5+AP.

A single Flight Op is used to maintain all the nation's space-based ABM systems in a state of high alert, ready to counter any ICBM, SLBM or MIRV attacks on the nation (and potentially allies as well) and any mass-driver attacks from the Moon. This places all KEW and SBL units not commanded by a Leader under the control of this Flight Op. In addition, in the event of an attack, orbital ABM under the command of another Leader, and ground-based ABM units are advised of the attack providing them with a combat bonus.

For this order to be enacted the nation must have an operational space platform or station in Earth orbit or at least four satellites in Earth orbit.

6.4.2.9 Monitor SpaceWatch Network (SSW)

Regular Leader AP cost is 5+AP.

If the nation has completed a Construction: SpaceWatch program then this order can be used to either monitor rocket launches and orbital facilities of other nations or to search for any Near Earth Asteroids, either to provide forewarning of a potential impact with Earth or to identify a mining opportunity.

If the nation has not built a SpaceWatch program then they can still perform this operation, but the minimum cost is 10AP and the chances of success are much reduced.

6.4.2.10 Command Mission (SCM)

Regular Leader AP cost is 4AP+

This order is used to command a manned mission to an asteroid or another planet. If used as a Space Op then the Op is collocated with the space vessel until it returns to a normal flight base.

6.4.2.11 Command Deep Space Vessel (SCD)

Regular Leader AP cost is 4AP

This order is used to direct a robotic or cybernetic vessel to perform a mission – usually traveling to a designated location. An AI can be commanded to deploy probes (or weapons).

6.5 NUCLEAR WEAPONS

6.5.1 Nuclear Operations

Nuclear Operations can be performed by an Aircraft Operations Combat Leader, a Naval Operations Combat Leader or Army Operations Combat Leader or a Space Operations Combat Leader without the intervention or assistance of a standard Leader.

A Leader, however, may take direct control of the Nuclear units (attaching them to his army if they are mobile, or using them at their base site if they are not) and conduct Nuclear missions as well.

6.5.2 Nuclear Missions

Nuclear Missions (actions) implemented through the use of an Army, Navy or Air Operations point are performed using the Combat rating of the Commander.

When a nuclear weapon is deployed by another unit, the nuclear weapon damage is applied, not the damage of the unit carrying it to its target.

6.5.2.1 Deploy Nuclear Bomb (DNB)

Regular Leader AP cost is 1AP.

The deployment of a nuclear bomb counts as an addition to an existing mission, not as a distinct mission, unless performed by a Regular Leader. The AP cost represents the preparations for deploying the bomb.

An Atomic Bomb or Fusion Bomb can only be deployed by heavy bomber or ship so the Action must be combined with another Action. If deployed using aircraft then this counts as a Strategic Bombing or Air Support; if deployed by ship or submarine this counts as being left at an enemy Port City or Port Fortress as a Nuclear Depth Bomb.

Delivering the bomb by some other means, such as by cargo ship or railroad requires a regular Leader to move it and probably intel CFs to conceal the dastardly plan.

6.5.2.2 Deploy Nuclear Warhead (DNW)

Regular Leader AP cost is 1AP.

The deployment of a nuclear warhead counts as an addition to an existing mission, not as a distinct mission, unless performed by a Regular Leader. The AP cost represents the preparations for deploying the warhead.

A Nuclear Bomb as a warhead must be deployed by dual-stage rocket and so the Action must be combined with a Bombardment Action.

An ICBM, SLBM and MIRV includes in its costs a Fusion Bomb and so does not require an additional warhead. It can be based anywhere, not just at a Space Port, as its costs include its silo and command and control bunker. This order is not required for ICBM, SLBMs or MIRVs.

6.5.2.3 Mutually Assured Destruction (MAD)

Regular Leader AP cost is 10AP

This order, which should only be entrusted to the head of state, identifies the targets for the nation's nuclear assets in the event of a nuclear attack, especially one that attempts to decapitate the nation by means of a first strike on the capital.

This order specifies the targets to be destroyed by the nuclear assets unleashed by means of a Defend or React order. It assumes that the origin of the attack is identified by radar and/or satellite data allowing a retaliatory attack utilizing bombers, ICBMs, SLBMs and orbital weapons. The head of state should also specify the actions to be taken if the perpetrator is *not* identified…

This list of targets remains as the retaliatory strike doctrine until another MAD order is performed.

6.5.3 Nuclear Weapons On Earth

6.5.3.1 General Effects

The damage caused by a nuclear weapon is divided equally into the components: population loss, pwb loss, Wallpoints, damage to factories and yards and units present at the location.

Table 6-10. Nuclear Weapon Damage

Unit Name	*Damage*
Atomic Bomb	50
Fusion Bomb	100
Tactical Ballistic Missile	50
ICBM	100
SLBM	100
MIRV	4*100
Cruise Missile	75

If a component is totally destroyed then the remaining damage is divided among the remaining components, and again, until no damage points remain. Any railroads using the city or fortress as an anchor point are automatically broken and will require a Level One construction project to repair the tracks. Roads are not affected.

The damage caused is reduced by 25 points per weapon if air raid shelters are available at the location. Wallpoints provide no protection against nuclear attack.

If a nuclear bomb is used in a ground support weapon, the GM must determine the percentages of losses attributed to enemy and friendly forces, including field forts. Nuclear warheads cannot be used in battle until more advanced tactical weapons are developed. The effects of a nuclear bomb in naval warfare are more limited though all sailing and steam ships in the vicinity will be automatically destroyed. Damage against Pre-modern ships is reduced by 25 points per bomb, and by 50 points against modern ships. Due to the effects of EMP the advantages conferred by radio, radar and other electronic systems in the region, sea zone or ocean hex will be halved for the remainder of the turn.

In addition to their direct damage against a city, fortress or armies, nuclear weapons have other dire effects. The detonation of multiple bombs in a relatively short period brings the threat of a Nuclear Winter of varying degree, affecting the continental and possibly global agro production as dust and smoke is thrown up into the atmosphere. It may then be followed by a deadly Nuclear Summer, heralding more damage to plant life and a worsening climate as desertification spreads. In the worst case full ecological collapse is triggered as the food chain dies from the bottom up.

Within the target nation and potentially surrounding nations as wind patterns distribute the fallout, nfp may be depressed for many years due to the effects of radiation and mortality rates from radiation poisoning and birth defects. The early atomic and nuclear bombs and warheads are not *clean*. A major nuclear exchange brings the collapse of national infrastructure, and a likely fall in Tech Level even if the war damage does not herald an endgame scenario.

At Industrial One aircraft and ships carrying nuclear weapons can be engaged by conventional forces. There is no defense against a warhead delivered by rocket.

At Industrial Two Anti-Ballistic Missile systems can be developed.

6.5.3.2 Nuclear Delivery Options and Defense

The following combat and damage applies:

- If a nuclear bomb is delivered by bomber then the normal air combat rules apply, including Naval and Land Point Defense anti-aircraft capability. High altitude jet bombers can also be countered by ABM units.
- If a nuclear bomb is delivered by ship or submarine to an enemy port as 'cargo' then normal combat applies. Should the enemy be conducting a secret attack then defending intel may detect the cowardly act and alert any defenders before the port is destroyed.
- If a nuclear bomb is carried as 'cargo' and used by a warship (or submarine) as a nuclear depth bomb then it inflicts twice its normal damage on any undersea unit or installation as a result of the enormous pressure wave generated. It does not cause any damage to surface units.
- If a submarine delivers a nuclear device (as a nuclear torpedo) then it is liable to be damaged or destroyed by any excess damage once the target is destroyed.
- If a nuclear warhead is delivered by rocket then this high-diver threat can be countered by Space Based Lasers in orbit and then ABM units providing defense coverage to the target on descent.
- If a nation has completed the R&D Satellites project then it can launch nuclear bombs into LEO as satellite bombs to await instruction to either explode in orbit or to re-enter the atmosphere and attack a terrestrial target. These can also be mounted on a space platform or station in LEO. In the descent phase these can be countered by ABM units. An en masse attack on the same target will probably overwhelm the defenses. These satellite bombs are vulnerable themselves to a nuclear detonation in LEO unless they are protected by Hardened Electronics.
- A cruise missile can be countered by a combat air patrol defending the target with one round of combat, and by defending units capable of Naval or Land Point Defense in a further round of combat. It can also be detected and engaged en route so its flight path must be defined on launch. If the cruise missile survives these encounters then it inflicts damage on its target according to its warhead. A nuclear warhead inflicts damage as per the normal nuclear effects with a base effect of 25 and a conventional warhead inflicts 5 points. The default warhead is nuclear. A stream attack of missiles attacking the same target at the same time is liable to overwhelm the defenses ensuring that at least some reach the target.
- If the target of a nuclear attack is a high value naval asset at sea then nuclear damage will be applied to the target with any excess damage being applied to its escort surface units: light units, medium units and finally other units in its battle group. There will also be an EMP effect against all surface units in that sea zone or ocean hex. If the target is in port then this counts as a normal fortress or city strike.

6.5.4 Nuclear Weapons in Space

6.5.4.1 General Effects

A nuclear explosion in LEO will pump up the Van Allen Belt and will also cause EMP damage to the hex beneath the detonation on Earth. If the detonation is not in a specified LEO segment then the GM will determine randomly the

affected area. This will normally be the case as satellites, platforms and stations whiz around in Low Earth Orbit.

The damage generated by a nuclear warhead against a space target outside LEO or a lunar target is reduced by half as there is no atmosphere to carry the shockwave or fallout. Instead the weapon creates a thermal effect. If a nuclear bomb or warhead is delivered by a spacecraft into an enemy installation then normal combat applies. Should the enemy be conducting a secret attack with a spacecraft docking (*the old bomb in a shuttle ploy*) then defending intel may detect this and alert any defenders before it can detonate.

6.5.4.2 Nuclear Delivery Options and Defense

The following combat and damage applies:

- A nuclear warhead can be countered by Space Based Lasers in the same or a neighboring orbit as the target and Space Defense units mounted on the space platform or station or lunar outpost or base. If the warhead survives these encounters then it will detonate causing damage to the target.
- Space platform and station Wallpoints *will* reduce the thermal damage caused by a nuclear warhead. Asteroid Wallpoints provide double protection. Other vessels may be protected by their Siege Rating.
- Interplanetary and mining vessels will also take reduced damage because they include shielded areas for the crew to defend against solar flares.

6.5.4.3 Nuclear Detonations in LEO

The detonation of a nuclear warhead in LEO will energise the lower Van Allen Belt, which will remain excited for between six months to two years after the explosion. The immediate consequences of the detonation will be EMP on the Earth and the failure of all satellites in LEO that are not protected by Hardened Electronics. These satellites are permanently lost as their electronics and solar panels cease to operate.

Whilst the Van Allen Belt remains excited any unprotected satellites launched into LEO will fail to function and are lost.

Manned space missions to LEO will not be possible (though craft can briefly pass through LEO safely to a higher orbit) even if equipped with Hardened Electronics. Manned installations in LEO such as space platforms and stations cannot be built or expanded due to the hazardous levels of radiation. Extravehicular activities are impractical as space suits will not protect against the high doses of radiation.

Table 6-11. LEO High-Altitude EMP Effects

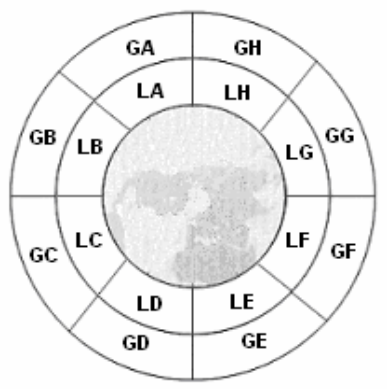
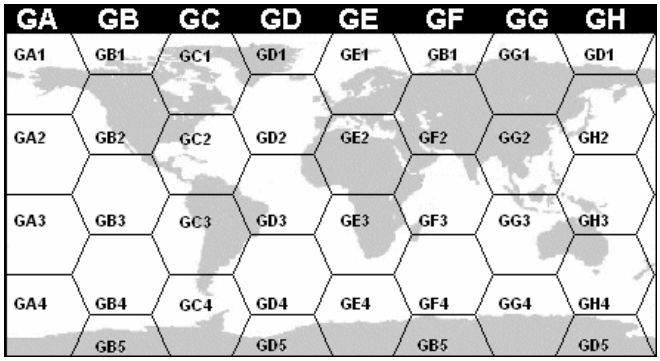


Table 6-12. Large Hex Map for EMP Effects



Transit up and down a space elevator would not be possible as the cargo climbers pass through the Van Allen Belt relatively slowly.

When exploding a fusion bomb in LEO the segment and the exact hex above which the detonation occurs must be identified because of the effects of the high-altitude electromagnetic pulse (HEMP) "pancake" on ground-based systems.

Unless the Hardened Electronics project has been completed:

- Radio and radar systems will be inoperative in that hex for the duration of the turn so any bonuses based on these systems will be lost.
- If the nation has completed the Transistors or Microchips project then its Jet aircraft and rockets will be inoperative in that hex for the duration of the turn. Any jet aircraft, rocketplanes or aero-spaceplanes in flight in the hex at the time of the detonation will be lost. Submarines at sea are not affected.
- If a nation within or partially within that hex has completed the Microchips project it will permanently lose one (1) point of Infra because of serious disruption to utilities, commercial and government communication systems.
- Radio and radar systems, jet aircraft and rockets will be similarly affected in the neighbouring hexes for the duration of the turn. Submarines at sea are not affected.

Units outside the disrupted hex are not affected should they subsequently enter the area. This makes a detonation in LEO very useful when performing a first strike attack...

If the Hardened Electronics project has not been completed:

- A fission or fusion bomb detonation in a GEO segment will destroy all satellites only in that GEO segment. It will not create a HEMP effect on Earth.

A fission or fusion bomb detonation in HEO and above has no effect unless used as a missile against a specified target.

6.6 KINETIC ENERGY WEAPONS

6.6.1 General Effects

Kinetic Energy Weapons such as *thunder rods* and coilguns have a punch equivalent to a small nuclear bomb, but do not cause radioactive fallout or EMP effects.

When directed against a target in space a kinetic energy weapon attacks with its Siege strength in a single round of combat. The more advanced coilgun can be fired repeatably.

When directed against a target on Earth the KEW or coilgun siege strength is used and the damage is divided equally into the components: population loss, pwb loss, Wallpoints, damage to factories and yards and units present at the location. (Air Raid shelters provide no protection as the weapon slams into the ground at hyper-velocity. KEW are more effective than nuclear weapons at destroying underground complexes.)

If a component is totally destroyed then the remaining damage is divided among the remaining components, and again, until no damage points remain. Any railroads using the city or fortress as an anchor point are automatically broken and will require a Level 0.5 construction project to repair the tracks. Roads are not affected.

Wallpoints provide no protection against KEW attack.

6.6.2 Kinetic Kill Options and Defense

Kinetic Energy Weapons can only be unleashed from LEO or fired from Lunar mass-drivers.

- A KEW is a high-diver threat (it falls rather than flies) and can be countered by Space Based Lasers in orbit prior to entering the atmosphere. There is only an opportunity to do this if it has been released in a 'higher' orbit than the SBL. The laser burns off the ablative and control surfaces causing the KEW to make an uncontrolled descent.
- ABM units providing defense coverage to the target can intercept the KEW on descent.
- If the target is a high value naval asset at sea then damage will only be applied to that vessel. Naval: Point Defense is ineffective against the KEW – even if it is hit, such is its velocity that fragments will still hit the target at massive velocity.
- A KEW is of limited use against underwater targets, causing only a quarter damage.

A KEW can also be de-orbited to intercept ICBMs SLBMs or MIRVs or any other type of vertical ascent rocket in their boost-phase. To be used in this fashion the KEW must either be in LEO, or in GEO above the launch point.

Note that used in this mode KEW are highly effective if located above the launch point in GEO as the ballistic missiles are most vulnerable in their boost-phase prior to any opportunity to deploy decoys or multiple warheads. If a KEW is in LEO then its effectiveness against missiles is one eighth of its normal Combat rating.

Example:

The rogue state the Peoples' Republic of Baklovakia unleashes a nuclear attack on the peace-loving Aztec Empire. Fortunately the Aztecs have five KEW in LEO under the command of a leader on the *Ypcalli* space platform. As the three Baklovakian ICBMs boost up on their ballistic trajectory the nearest Kinetic Energy Weapons swoops down upon them. The three ICBMs have a combined Combat Strength of 6.0. The five KEW have a combined combat strength of 25.0 but as there are only five in LEO this becomes 25.0 x 0.625 = 15.625, rounded down to 15.0.

The GM rolls the dice and finds that two ICBMs have been destroyed for the cost of three KEW. The remaining missile traces its path across the Atlantic. Now it's up to the ABM facilities defending Tenochtitlán…

A coilgun can be used in the same way as a KEW, but its projectiles cannot be intercepted by Space Based Lasers. The coilgun itself can be attacked. Its primary functions are as a space-based ABM and orbital bombardment. It can also be used to attack space vehicles, satellites, splat platforms and stations.

6.7 LASER WEAPONS

6.7.1 Space Based Lasers

An SBL achieves missile interception by focusing and maintaining a high powered laser on a target until it achieves catastrophic destruction. SBL are not effective against cruise missiles.

Like a KEW it detects and fires on ballistic missiles and other vertical ascent rockets during their boost-phase but can also attack them during their midcourse phase before the warheads re-enter the Earth's atmosphere. Unlike a KEW a Space Based Laser is fully reusable.

SBL are most effective if located above the launch point in GEO. If an SBL is in LEO then its effectiveness against missiles is one eighth of its normal Combat rating. If an SBL is in GEO above the hex holding the target of the ballistic missiles then its effectiveness is unchanged against ICBMs and SLBMs, but only a quarter against MIRVs because they will have deployed decoys and multiple warheads.

Example:

The Peoples' Republic of Baklovakia unleashes another nuclear attack on the Aztecs using six missiles.

The Aztecs now have an SBL in GEO above Baklovakia and two SBL in GEO above Tenochtitlán.

The SBL above Baklovakia fires on the missiles during their boost-phase with a Combat Strength of 10. The missiles have a Combat Strength of 30.

The GM rolls the dice and finds that the single SBM has had time to destroy four of the Baklovakian missiles, leaving two to head towards the Aztec Empire.

In orbit above Tenochtitlán the two SBL are alerted and ready to engage the missiles as they come over the curve of the Earth. Disaster! The Baklovakian missiles are MIRVs! The two SBL have a Combat Strength against them of 20 x 0.25 = 5. The combined MIRVs have a Combat Strength of 10. One MIRV is destroyed, the other unleashes its four warheads. Now it's up to the ABM systems in the Valley of Mexico or Tenochtitlán will be illuminated by a light thousands of times brighter than the Sun.

An SBL can also be used against targets in space, using its Siege Strength against space platforms and stations, space vehicles and other satellites. It is even more effective against

targets in the vacuum of space than it is against missiles rising up through the Earth's atmosphere.

6.7.1.1 Advanced Space Based Lasers

Advanced Space Based Lasers have both longer range to the earlier space based lasers and can strike at targets lower in the atmosphere: guided by surveillance satellites and targeting data from Earth uplinks they can attack and destroy high altitude aircraft and can also seriously damage aircraft lower in the atmosphere, including cruise missiles.

6.7.1.2 Ground Based Lasers

These are effectively advanced line-of-sight artillery capable of striking any target they can see.

6.8 CHEMICAL WEAPONS

Tactical chemical warfare is assumed to be covered by the standard Artillery QR.

Strategic chemical warfare requires the deployment of bombs or warheads against a city, and consists of the use of deadly nerve agents. It has the benefit over nuclear weapons of killing the population whilst leaving buildings and other facilities undamaged. However, if unleashed by rocket or cruise missile a chemical attack could be mistaken by the target nation as a nuclear attack and may trigger a counter-strike.

These weapons can be built when the R&D Chemical Warfare project has been completed. The weapon can be delivered to target by bomber, rocket or cruise missile. A Chemical Warfare weapon immediately causes 25 points of damage, employed first to the GPv of the target city, and excess points to pwb. The effect may not be total because local weather reduces the effectiveness of the weapon. Wallpoints provide no protection, but an Air Raid Shelter does, reducing damage by 12 points per weapon. A Command Bunker provides protection if it remains sealed. If the GPv of a city is reduced to zero it becomes uncontrolled and cannot be used to base msp or any other action until it has been repopulated. Before an affected city can be reclaimed or expanded the location may need to be thoroughly decontaminated, costing 10 GP per original GPv of the city.

All Industrial Two and Three troops are assumed to be issued with gas masks and other protection against chemical attack. Industrial One troops can be protected by the nation paying the unit GP build cost and noting that they are so equipped. Regional and city populations can be protected by spending 25 GP per GPv to issue all households with gasmasks.

A Chemical Warfare unit is lost once it has been deployed. If delivered by rocket, ICBM, SLBM, MIRV or cruise missile the nation must declare that the unit is replacing any implicit nuclear warhead(s) - any nuclear warhead is lost to prevent the GM from going mad. The chemical weapon replaces any normal damage caused by the missile.

Radio and television from the affected cities will abruptly stop transmitting. If and when news reporters enter the devastated cities, there will be reports of thousands of dead lying where they fell in the streets, schools, homes, offices and factories.

6.9 BIOLOGICAL WEAPONS

Strategic biological warfare requires the deployment of bombs or warheads against a fortress, population center or region. A bioweapon uses existing diseases such as Anthrax, Ebola, Brucellosis, Bubonic Plague, Cholera, Coccidioides Mycosis, Glanders, Influenza, Japanese B Encephalitis, Machupo, Melioidosis, Psittacosis, Q fever, Rift Valley Fever, Rocky Mountain Spotted Fever, Smallpox, Shigella, Tularemia, Typhus, or Yellow Fever. It has the benefit over nuclear weapons of killing the population whilst leaving buildings and other facilities undamaged. However, if unleashed by rocket or cruise missile a bioweapon attack might be mistaken by the target nation as a nuclear attack and may trigger a counter-strike. A biological weapon can be delivered to the target by railroad or ship but such an attack can be detected and prevented by normal intel actions.

These weapons can be built when the R&D Biological Warfare project has been completed. The weapon can be delivered to target by bomber, rocket or cruise missile. A Biological Warfare weapon causes a localised plague attack. The plague is applied to all troops and population in the location. Wallpoints and air raid shelters provide no protection but a Command Bunker does, so long as it remains sealed. If the GPv of a city or region is reduced to zero it becomes uncontrolled and cannot be used to base msp or any other action until it has been repopulated. If used against a region the weapon will reduced the Agro Production of the region as well.

A Genetic Warfare weapon is much more deadly, initiating a virulent man-made plague in the target population. It is usually a genetically modified form of a natural disease. There is a significant chance, for each population center attacked, that the plague will spread onwards into other regions and cities, being propagated as per a natural plague. The plague can pass natural and national borders, also being transmitted by rail and air trade routes, with new hot zones appearing along the line or where the route terminates. As the plague is tailored to a particular Geo Zone its ability to infect populations beyond that geographical area is significantly reduced but there is a chance that the plague will mutate, potentially becoming a universal plague. Whilst the nation employing the bioweapon can immunise its own population against it, this may provide reduced or no protection against a mutated strain. Immunising your own population costs 25GP per GPv or per ten units; if a city or region is not fully immunized then normal plague rules apply.

The nation employing a genetically tailored plague can attempt to design it such that it mutates into a less virulent form after being transmitted from one person to another, reducing the disease vector. Success in tailoring the disease is determined by Tech Level. On a critical failure, the disease is even more virulent!

The Tech Level of the target nation may provide some defense to reduce the impact and propagation of a bioweapon, representing the effects of medical science and the possibility of finding a cure. All Industrial Three troops are assumed to be issued with NBC suits and will be protected from the plague. Creating an exclusion zone around the affected region or city may prevent the onward transmission of the disease but is liable to cause panic and the breakdown of authority in the affected area.

A bioweapon is lost once it has been deployed. If delivered by rocket, ICBM, SLBM, MIRV or cruise missile the nation must declare that the bioweapon is replacing any implicit nuclear warhead(s). The bioweapon replaces any normal damage caused by the missile.

Any nation openly employing a bioweapon is liable to gain very bad press, as reports of the plague become widely known. In the affected cities radio and television stations will transmit the full horror - until they go permanently off air.

7. EMPIRE BUILDING

7.1 RULING WIDE DOMAINS

As per the Modern Era rulebook, the Line of Control and the Control Web remain important in the Space Age.

7.1.1 Tracing the Command Radius

On Earth the Command Control Radius (**CCR**) is modified by the introduction of Radio and the Internet. For regions, cities, fortresses and other installations not directly traceable by controlled territory by land from the capital each complete Trade Conduit counts as one Sea Zone for CCR 'movement', modified by the completion of Radio or Internet.

The usual movement point costs are used for tracing, with some supplemental items, as detailed here:

Table 7-1. Industrial CCR Costs Supplement

Border / Region Type	*CCR Cost*
Controlled land border along a Royal or Postal Road segment	× ½
Controlled land border along a Rail Road segment	x ¼
Controlled land border along a Mag-Lev segment	x ⅛
Unsettled (empty, Barbarian / Pre-Columbian / Nomadic) regions	+1
Any kind of region within the tsetse Fly zone (unless traversed by a Railroad or Mag-Lev)	+1
'Anchored' Trade Conduit	1
'Anchored' Trade Conduit and nation has completed the R&D Radio project	× ⅓
'Anchored' Trade Conduit and nation has built an Internet	x ¼
'Anchored' Trade Conduit passes through seasonal sea ice	X 1.5

7.1.1.1 Submarine Communication Cables

Undersea cables act as an alternative to the 'Anchored' Trade Conduit: Each cable is counted as one CCR regardless of the length of the cable. A cable can only link two port fortresses/cities. The CCR traced onwards from the end of the cable can either be traced by normal means (land or Trade Conduit) or by another cable.

7.1.2 Tracing the Command Radius Underwater

This is treated exactly as per normal CCR tracing on the surface of the sea or ocean. In addition, control must be traced from a controlled port fortress (for underwater installations) or a controlled port city (for underwater cities).

7.1.3 Tracing the Command Radius into Space

For a space platform or space station to be operational the nation must have one Spaceport (or one Air Base if it is using spaceplanes). For a lunar outpost or moon base to be operational the nation must have one Spaceport (or one Air Base if it is using spaceplanes) and usually have at least one operational space platform or space station in orbit about the Earth.

If these conditions are not met, the facility will be abandoned (or the crews defect or die) unless the space facilities grow enough agro to be nominally independent. In this event they may or may not remain loyal to your nation.

Interplanetary space missions in Industrial Two and Three will remain en route whether there is a Spaceport, Air Base or orbital facility to meet them when they hopefully return. The vessel carries all necessary supplies.

Asteroid mining vessels will be lost when their mission duration expires if there is no supporting Spaceport, Air Base or orbital facility to meet them when they return.

7.1.4 Tracing a Line of Communication

When required to establish a Line of Communication, you trace a series of contiguous controlled land regions from the national capital (or homeland, if there is no capital) to the location in question. If the LOC needs to cross a Sea Zone, it must be traced through a controlled, un-besieged, un-blockaded Port City, across the sea zones, to another controlled, un-besieged, un-blockaded Port City and then to the location.

Note that an LOC is not blocked by the presence of an enemy army in a region, if that enemy has not *conquered* and garrisoned the province, thus obviating its control for the tracing power.

8. ESPIONAGE

At Industrial Two and Three a number of existing actions can be modified as a result of new technologies, and new operations are introduced.

8.1 EXISTING ESPIONAGE OPERATIONS

8.1.1 Assault Organization

This action is not limited by the normal Action Range if your nation and the target nation have both completed an internet system and have a trade route.

Your operatives attempt to hack into the systems and databases of the target nation's government departments. If successful a government's Infra or BL will be reduced. It can be prevented by a Counter-Intelligence operation run by the target nation.

8.1.2 Battle Assistance

If your nation has access to spy satellites or space platforms or stations in orbit (or a rocketplane or aero-spacelane that has over flown the target area) then this will provide a bonus to Battle Assistance because your forces have a more accurate view of the disposition of enemy forces.

8.1.3 Cause Unrest

This action is not limited by the normal Action Range if your nation and the target nation have both completed an internet system and have a trade route. Your operatives can cause unrest in a Pacified or Pacified Tributary region by planting stories of brutality and massacres by the target nation. Not as effective as a normal operation.

8.1.4 Conceal Fact

This action is not limited by the normal Action Range if your nation and the target nation have both completed an internet system and have a trade route. Your operatives can bury or plant news stories and create websites intended to spread disinformation, confusing and bewildering the target populace.

8.1.5 Rearrange Expenditures (Optional)

This action is not limited by the normal Action Range if your nation and the target nation have both completed an internet system and have a trade route. Having gained access codes via the infiltration your operatives can hack into government systems, corrupting databases and altering the cash flow to government departments.

8.1.6 Reveal Fact

This action is not subject to the Action Range limit if it utilizes:

- Spy satellites or space platforms or stations in orbit (or a rocketplane or aero-spacelane that has over flown the target area) - but only if it is used to obtain information than can be seen from space.
- The internet - if your nation and the target nation have both completed an internet system and have a trade route. Note however, that using the internet for intelligence gathering is less effective than having an agent on the ground, and is liable to return misinformation, or disinformation planted by the target government, or your agents might be distracted by dodgy websites.

If a traditional RF action is performed then access to relevant spy satellite data may increase the chance of success.

8.1.7 Steal Gold Shipment

This action is not limited by the normal Action Range if your nation and the target nation have both completed an internet system and have a trade route. Your operatives hack into the banking system (the two nations transferring the gold must be known) and divert at least some of the gold to an anonymous off-shore account.

8.1.8 Steal Treasury

This action is not limited by the normal Action Range if your nation and the target nation have both completed an internet system and have a trade route. Your operatives hack into the banking system and steal some portion of the target treasury. Note that performing this action via the internet is less effective and more likely to fail than if it were enacted by agents on the ground.

8.1.9 Steal Technology

This action is not limited by the normal Action Range if your nation and the target nation have both completed an internet system and have a trade route. Your operatives hack into university and industrial sites to gain access to some of the technological secrets of the target nation. This is not as effective as mounting a normal operation, but may return useful material.

If it fails technological misinformation may be recovered, potentially damaging any related R&D projects you are performing, as your scientists are misled by erroneous data. Normal failure will stall a project or increase its duration. A critical failure in stealing technology or a successful Disinformation counter-intelligence op will allow your project to be completed, but with some disastrous consequence when construction (of units or a site) is performed.

Example:
The Baklovakians have apparently stolen secrets pertaining to jet fighters from the Danish Republic and have proudly built a wing of MUG fighters.
Unfortunately the communards have based their project on bad technical data spread by a Disinformation op. When the aircraft first fly the engines burn out, they disintegrate in flight or in some other way fall out of the sky. The units are useless. To recover the situation the Baklovakians must restart their project from scratch. Curses!

8.1.10 Terrorist Attack

This action is not limited by the normal Action Range if your nation and the target nation have completed an internet system and have a trade route.

Your operatives hack into civilian and commercial systems crashing systems, corrupting data or introducing software viruses. Usually this needs a successful Reveal Facts or Infiltration to gain access codes. The target of the attack must be specified:

- Commercial: Companies and small banks go bust as their accounting systems fail or their servers are damaged by denial of service attacks causing unemployment and

reduced national income. The target nation's Tax Rate dips this turn.

- Government: An attack crashes or corrupts government systems. Any census in force is terminated and must be initiated again.
- National Bank: A very successful attack on a National Bank could cause it to Close or Default as records are corrupted. The nation would then have to rebuild the Collapsed Bank.
- Religious: Religious websites are corrupted or vandalized. A random Religious op is lost this turn.
- Stock Exchange: An attack crashes all or part of a national Stock Exchange, causing the target nation's International Trade Value to dip this turn as commercial confidence is damaged.
- University: Library and research systems are crashed or corrupted. TL Points are lost this turn.

It is assumed that military and intelligence systems are either highly encrypted or not linked into the open national internet. To damage either of these systems needs a Critical Success or an Infiltration of the relevant sector:

- Military: One QR dips this turn as orders fail to be received and logistical systems are compromised.
- Intel: One Intel or Assassin Op fails when communication is lost. If the action is being supported by a Leader performing an Espionage action their cover is broken and their presence becomes known.

8.2 NEW ESPIONAGE OPERATIONS

8.2.1 Disinformation (DIS)

A new Intel Op providing a specialized Conceal Fact activity. This allows a nation to propagate disinformation in response to any Battle Assistance, Reveal Fact or Steal Technology action performed via the internet that turn.

If this counter intelligence succeeds then totally false information will be returned, causing even an apparently successful hostile intel action to return bad data that is so convincing that it is used as totally factual. If the enemy nation gains a critical success then they will detect that there is something fishy about the data gathered but will not know exactly what is wrong.

This operation can also be used when providing Technical Assistance to another nation to sabotage their R&D project. Not a very friendly thing to do...

8.2.2 Monitor Internet Traffic (MIT)

A new Intel Op that can be used if a nation has completed an internet system.

It provides a bonus to Crush Revolt and Counter Intelligence ops by monitoring internet traffic to detect suspect activities. It also provides a limited defense to hostile external internet actions - any intel operation being performed by another nation using the internet.

There is also a possibility of detecting foreign internet based intel operations not directed against your nation.

9. CHARTS AND TABLES

9.1 THE STAT SHEET

Table 2-1. Technology Levels

TechLevel	Culture Types
001	Pre-Columbian / Seafaring
002	Pre-Columbian / Barbarian / Nomadic / Seafaring
003	Civilized / Pre-Columbian / Barbarian / Nomadic / Seafaring
004	Civilized / Barbarian / Nomadic / Seafaring
005 – 007	Civilized / Seafaring
008 – 011	The Renaissance
012 – 015	Industrial Stage One
016 – 019	Industrial Stage Two
020 – 022	Industrial Stage Three

Table 2-2. Tech Level Table

TL	*Culture*	*Notes*
1	Precolumbian	Sticks
2	Nomadic	Horseback
2	Barbarian	Agriculture
3	Nomadic	Archery
3	Barbarian	Ironworking
4	Civilized	Literacy
5	Civilized	Medicine
6	Civilized	Crossbow
7	Civilized	Gunpowder
8	Renaissance	Navigation
9	Renaissance	Printing
10	Renaissance	Balloons
11	Renaissance	Steam Engine
12	Industrial 1	Railroads
13	Industrial 1	Combustion
14	Industrial 1	Electricity
15	Industrial 1	Valves
16	Industrial 2	Rocketry
17	Industrial 2	Atomics
18	Industrial 2	Computers
19	Industrial 2	Transistors
20	Industrial 3	Microchips
21	Industrial 3	Spaceplanes
22	Industrial 3	Genetic Engineering

Table 2-3. National Culture Modifiers

Cultural Type	Modifier
Industrial Four	1.4
Industrial Three	1.3
Industrial Two	1.2
Industrial One	1.1
Renaissance	1.0
Seafaring	0.9
Civilized	0.8
Barbarian	0.7
Nomadic	0.6
Pre-Columbian	0.5

Table 2-6. Army Status Troop Support Modifiers

Status	*Description*	*Modifier*
A	Administering	1.0
B	Being Besieged	2.0
C	On Campaign	2.0
E	Sneaking Around...	0.0
G	In Garrison	1.5
M	Mutinious!	0.0
N	Normal	1.0
P	Prisoner	0.0
R	Ruling	1.0
S	Besieging A City	2.0

Table 2-7. Garrison Terrain Modifiers

Culture	*c*	*c 2*	*w*	*s*	*j*	*i*	*d*	*m*	*t*	*o*
PreColumbian	1	1	1	2[c]	1	1	2[c]	1	2	1
Seafaring	1	1	2	2[c]	2	1	2[c]	2	2	1
Civilized	1	1	2	2[c]	2	1	2[c]	2	2	1
Barbarian	2	2	1	2[c]	1	1	2[c]	1	2	2
Nomadic	1	2	2	1[c]	2	1	1[c]	2	2	1
Rena./Indust1	1	1	2	2[c]	1	1	1.5[c]	1	2	1
Indust2/3	1	1	1.5	2[c]	1	1	1.5[c]	1	2	1

Culture	*ai*	*am*	*ap*	*lp*	*lm*	*lt*
Indust1	2	2.5	2	2	1.5	1.5
Indust2/3	2	2	2	2	1	1

Notes

- All regions requiring a cavalry garrison (those marked with a [c]) can be garrisoned with infantry or field forts in twice the cavalry amount. An exception to this applies in the case of regions where there is no Cavalry in use (pre-Cav Count America, or South Africa).
- All listed numbers are factors that are multiplied by the Region Resistance Value.

Table 2-8. Years per Turn

Tech Level	Years per Turn	Base Tax Rate
1-7	5	100%
8-9	4	80%
10-11	3	60%
12-13	2	40%
14-15	1	20%
16-17	6 months	10%
18-19	3 months	6%
20+	1 month	2%

Table 2-9. Army Energy Consumption Status Modifiers

Code	*Description*	*Support Multiple*
M	Mutinous!	×0.0
P	Prisoner	×0.0
E	Sneaking Around...	×0.25
A	Administering	×0.5
N	Normal	×1.0
G	In Garrison	×0.5
C	On Campaign	×2.0
S	Besieging A City	×1.5
B	Being Besieged	×1.25

Table 2-9. Regional Status Production Multiples

Status	Description	Production multiple
A	Full Ally	0.75
EA	Economic Ally	1.0
F	Friendly	1.0
HM	Homeland	1.0
P	Pacified	1.0
PT	Pacified Tributary	0.5
T	Tributary	0.25

Status	Description	Production multiple
(Others)	All Other Statuses	0.0

Table 2-10. Rectenna Region Terrain Modifiers

Region Terrain	*Modifier*
c2 / c / i/ w/ s	1.0
m / d/ t	0.75
j / m	0.5
Lunar Surface	1.25
Via a Space Elevator	1.2

Table 2-4. Terrain Type Tax Multiples

Terrain	***Culture***							
	I2/3	***I1***	***R***	***C***	***B***	***N***	***S***	***P***
c2	1.5	1.0	1.0	1.0	1.5	2.0	1.0	1.0
C	1.25	1.0	1.0	1.0	1.0	1.5	1.0	1.0
W	0.5	0.5	0.5	0.5	1.0	0.3	0.5	1.0
M	0.5	0.5	0.3	0.3	0.5	0.2	0.2	0.5
S	0.5	0.5	0.3	0.3	0.2	1.0	0.0	0.2
D	0.2	0.2	0.2	0.2	0.2	0.5	0.0	0.2
T	0.2	0.2	0.2	0.2	0.3	0.0	0.0	0.2
I	0.5	0.5	1.0	1.0	1.0	1.0	1.5	1.0
j	0.2	0.2	0.3	0.3	0.5	0.2	1.0	1.0
o	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
lp	1.0	1.0	-	-	-	-	-	-
lm	0.5	0.5	-	-	-	-	-	-
lt	0.75	0.75	-	-	-	-	-	-

Table 2-5. Terrain Troop Support Modifiers

Terr.	*I2/3*	*I1*	*R*	*C*	*B*	*N*	*S*	*P*
M	1.5	1.5	1.75	2.0	1.0	2.0	2.0	1.5
S	1.5	2.0	1.5	2.0	1.5	0.0	2.0	1.5
T	1.5	2.0	2.0	2.0	1.5	2.0	2.0	1.0
D	1.5	2.0	1.75	1.5	1.5	1.0	1.5	1.5
J	1.25	1.5	1.5	1.5	1.0	1.5	1.0	1.0
W	1.0	1.25	1.0	1.5	1.0	1.5	1.5	1.0
C	1.0	1.0	1.0	1.0	1.0	0.1	1.0	1.0
C2	1.0	1.0	1.0	1.0	0.5	0.1	1.0	1.0
I	1.0	1.0	1.0	1.0	1.0	1.0	0.5	1.0
O	2.0	2.0	2.0	2.0	2.0	1.0	2.0	1.5
ai	2.0	2.5	-	-	-	-	-	-
am	3.0	3.5	-	-	-	-	-	-
ap	2.0	2.5	-	-	-	-	-	-
lp	4.0	5.0	-	-	-	-	-	-
lm	2.0	3.0	-	-	-	-	-	-
lt	3.0	4.0	-	-	-	-	-	-

- ai: Ice Shelf
- am: polar mountains
- ap: polar plain
- lp: Lunar polar region
- lm: Lunar maria region
- lt: Lunar terrae region

9.2 THE ORDER FORM

Table 3-1. Max. QRs per Culture and Tech Level

Civilized

Tech	Cavalry	Infantry	Warship	Siege	Artillery
3	5	5	4	5	--
4	7	6	5	7	--
5	8	7	6	8	--
6	9	8	7	10	--
7	10	10	10	12	4

If a Civilized Tech 7 Nation purchases one or more Artillery units from a Renaissance nation they can then begin building Artillery units and investing in their own QR, which starts at one (1).

Seafaring

Tech Level	Cavalry	Infantry	Warship	Siege
1	0	3	4	2
2	1	4	6	4
3	3	5	6	5
4	5	6	7	7
5	6	7	8	8
6	7	8	9	10
7	8	10	12	12

Barbarian

Tech Level	Cavalry	Infantry	Warship	Siege
2	3	4	4	4
3	5	5	4	5
4	7	6	5	7

Nomadic

Tech Level	Cavalry	Infantry	Warship	Siege
2	5	3	2	2
3	7	4	3	3
4	9	5	4	5

Pre-Columbian

Tech Level	Cavalry	Infantry	Warship	Siege
1	0 (1)	3	2	2
2	0 (2)	4	4	4
3	0 (3)	5	4	5

Note: Cavalry is available to Pre-Columbian cultures only after the expiration of the Cavalry Count in that geographic area.

Renaissance

Tech	Cavalry	Infantry	Warship	Siege	Artillery
8	11	12	12	15	6
9	11	14	15	17	9
10	12	15	17	20	11
11	13	16	20	23	13

Industrial One

Tech	Cav	Inf	Naval	Siege	Art	Mech	Air	Rock
12	14	18	27	26	20	--	--	--
13	14	20	30	29	22	5	5	--
14	14	22	34	32	24	10	10	1
15	15	24	37	35	26	15	15	3

Industrial Two

Tech	Cav	Inf	Naval	Siege	Art	Mech	Air
16	15	26	40	38	30	20	25
17	15	28	42	41	32	25	30
18	15	30	46	44	35	30	35
19	15	32	48	47	40	35	40

Tech	Rocket	Nuclear
16	6	2
17	9	4
18	12	6
19	15	8

Industrial Three

Tech	Cav	Inf	Naval	Siege	Art	Mech	Air
20	15	34	50	50	42	40	45
21	15	40	54	53	45	45	50
22	15	50	57	57	50	50	55

Tech	Rocket	Nuclear
20	20	10
21	25	15
22	30	21

Table 3-2. Maximum Public Works

Tech Level	C2	C	Other Terrains	City
12-13	GPv × 30	GPv × 20	No Change	GPv × 15
14-15	GPv × 30	GPv × 25	No Change	GPv × 20
16-17	GPv × 35	GPv × 25	No Change	GPv × 25
18-19	GPv × 40	GPv × 30	No Change	GPv × 25

Table 3-3. City Effect on Regional Cultivation

Tech Level	City Size	C2	C	Other Terrains
16-17	>15	-5% RC	-10% RC	No Change
18-19	>20	-10% RC	-20% RC	No Change

Table 3-4. Arcology Construction & Expansion Costs

	c2/c/i region	w/m/j region	s/d/t region	result
Initial	30gp/20nfp	40gp/25nfp	50gp/30nfp	[1/0]
Increase	20gp/10nfp	25gp/15nfp	25gp/20nfp	[+1/0]

Table 3-5. Mega-Bridge Construction Levels

Level	Tech Level Requirement	City Yard Capacity Cost	Description
4	16	20	Bali Bridge (connecting Bali with Pajajaran).
4	16	15	Hokkaido-Honshu Bridge (connecting Hokkaido and Akita in Japan).
4	16	20	Sicilian Bridge (connecting Sicily with Calabria in Italy).

Table 3-6. Tunnel Construction Levels

Level	Tech Level Requirement	City Yard Capacity Cost	Description
4	16	15	Bosporus Bridge (connecting Thrace with Bithnia Europe/Asia Minor).
4	16	30	Channel Tunnel (connecting Sussex with Ponthieu).
5	16	40	Gibraltar Tunnel (connecting Morocco with Andalusia).
4	16	25	Hokkaido-Honshu Tunnel (connecting Hokkaido and Akita in Japan).

Table 3-7. Polar Base Construction & Expansion Costs

	ap	am	result
Initial	40gp/25nfp	50gp/30nfp	[1/0]

	ap	*am*	*result*
Increase	25gp/15nfp	35gp/20nfp	[+1/0]

Table 3-8. Underwater City Construction & Expansion Costs

	Lake	*Sea Zone*	*Ocean Hex*	*result*
Initial	50gp/20nfp	60gp/25nfp	70gp/30nfp	[1/0]
Increase	25gp/10nfp	30gp/15nfp	35gp/20nfp	[+1/0]

Table 3-23. Space Station & Expansion Costs

	LEO	*GEO*	*Elsewhere*	*result*
Initial	200gp/ 20nfp	220gp/ 25nfp	230gp/ 30nfp	[1/0]
Increase	100gp/ 10nfp	120gp/ 15nfp	125gp/ 20nfp	[+1/0]

Table 3-24. Space Platform Annex Costs

LEO	*GEO*	*Elsewhere*	*result*
100gp/ 10nfp	100gp/ 10nfp	150gp/ 20nfp	[1/0]

Table 3-27. Moon Base & Expansion Costs

	Cost	*Result*
Initial	250gp/ 20nfp	[1/0]
Increase	125gp/ 10nfp	[+1/0]

Table 3-28. Lunar Mag-Lev Railroad Costs

Maria	*Terrae*	*Polar*
100gp/ 10nfp	125gp/ 10nfp	150gp/ 10nfp

Table 3-29. Asteroid Material Processing

Type	*%*	*CPv*	*Processing Cost (GP)*	*Notes*
C-type	75%	0.5	7	Carbonaceous – carbon and hydrated minerals.
S-type	17%	0.25	8	Silicaceous - of metallic nickel-iron mixed with iron- and magnesium-silicates.
M-Type	8%	1.0	4	Metallic - nickel-iron, pure or mixed with stone.

Note: This refers to Inner System Asteroids. This differs from the composition percentages of the Asteroid Belt.

Table 3-30. Lunar Material Processing

Region	*CPv*	*Processing Cost (GP)*
Polar	1.0	5
Maria	0.5	10
Terrae	0.2	8

Table 3-35. Asteroid Wallpoints

Asteroid	*Wallpoints*
S-Type	C/3
M-Type	C/2

Table 3-36. Asteroid Engine Systems

Type	*Drive*	*Bonus ?*	*Range*	*Cost*
Magnetic Nuclear Pulse	15	Nuc QR	60	500gp/ 5nfp
Nuclear Thermal	8	Nuc QR / 2	50	500gp/ 5nfp
Mass-Driver	1	-	6	50gp/ 25nfp

Table 3-37. Asteroid Habitat & Expansion Costs

	Earth Orbit	*Elsewhere*	*Result*
Initial	Cost gp/ 30nfp	Cost gp/ 40nfp	[1/0]
Increase	50gp/ 10nfp	75gp/ 20nfp	[+1/0]

Where Cost = Cargo Mass x 20 gp

9.3 SPACE FLIGHT

Table 3-14. Base Rocket Lift Capability

Rocket Type	Reusable?	Trade?	Launch Rail?
Single-Stage Rocket	No	No	No
Dual-Stage Rocket	No	No	No
Rocketplane	Yes	No	No
Aero-Spaceplane	Yes	No	Yes
Multi-Stage Rocket	No	No	No
ICBM	No	No	No
SLBM	No	No	No
TBM	No	No	No
MIRV	No	No	No
Heavy Lift Rocket	No	No	No
Single Stage to Orbit	Yes	Yes	Yes
Sub-Orbital Dropship	Yes	Yes	Yes
Nuclear Pulse Rocket	No	No	No
Mars Rocket	No	No	n/a
Shuttle	Yes	No	No
Heavy Shuttle	Yes	No	No
Spaceplane	Yes	Yes	Yes
Heavy Spaceplane	Yes	Yes	Yes
Trans-atmospheric Fighter	Yes	No	Yes
Trans-atmospheric Heavy Fighter	Yes	No	Yes
Cybernetic Autonomous Fighter	Yes	No	Yes
Laser Rocket	No	No	No

Table 3-14. Base Rocket Lift Capability

Rocket Type	Reusable?	Trade?	Launch Rail?
Single-Stage Rocket	No	No	No
Dual-Stage Rocket	No	No	No
Rocketplane	Yes	No	No
Aero-Spaceplane	Yes	No	Yes
Multi-Stage Rocket	No	No	No
ICBM	No	No	No
SLBM	No	No	No
TBM	No	No	No
MIRV	No	No	No
Heavy Lift Rocket	No	No	No
Single Stage to Orbit	Yes	Yes	Yes
Sub-Orbital Dropship	Yes	Yes	Yes
Nuclear Pulse Rocket	No	No	No
Mars Rocket	No	No	n/a
Shuttle	Yes	No	No
Heavy Shuttle	Yes	No	No
Spaceplane	Yes	Yes	Yes
Heavy Spaceplane	Yes	Yes	Yes
Trans-atmospheric Fighter	Yes	No	Yes
Trans-atmospheric Heavy Fighter	Yes	No	Yes
Cybernetic Autonomous Fighter	Yes	No	Yes
Laser Rocket	No	No	No

Table 6-8. Operational Ranges for Launch Systems

Rocket Type	Min Range	Max Range	Nuclear Capable	Space port
Single-Stage Rocket	1	3	No	No
Dual-Stage Rocket	2	3 Large Hexes	Yes	Yes
Multistage Rocket	2 Large Hexes	4 Large Hexes	Yes	Yes
Nuclear Pulse Rocket	n/a	n/a	Yes	Yes
Heavy Lift Rocket	3 Large Hexes	Any	Yes	Yes
Single Stage to Orbit Rocket	3 Large Hexes	Any (must land at a Space port)	No	Yes
Sub-Orbital Dropship	3 Large Hexes	Any	No	No
ICBM	5	3 Large Hexes	Yes	No
SLBM	5	2 Large Hexes	Yes	No
MIRV	5	4 Large Hexes	Yes	No
TBM	1	2	Yes	No
ABM	Own Region		No	No
ANM	Own Region		Yes	No
AXM	1	2	No	No
Rocketry: Manned Capsule	--	--	No	Yes
Manned Orbital Capsule	--	--	No	Yes
Rocket plane	1	9 Large Hexes	No	No
Aero-Spaceplane	1	9 Large Hexes	To Orbit	No
Space Shuttle	1 Large Hex	9 Large Hexes	To Orbit	Yes
Heavy Shuttle	1 Large Hex	9 Large Hexes	To Orbit	Yes
Spaceplane	1	Any	To Orbit	No
Heavy Spaceplane	1	Any	To Orbit	No
Trans-atmospheric Fighter	1	Any	No	No
Trans-atmospheric Heavy Fighter	1	Any	Yes	No
Cybernetic Autonomous Fighter	1	Any	No	No
Laser Rocket	--	--	No	Yes

Table 3-15. Planetary Data

Planet	*Mean Distance (millions of km)*	*Mean Distance (AU)*	*Mean Orbital Velocity (km/sec)*	*Orbital Period (Earth years)*
Mercury	57.9	0.387	47.88	0.241
Venus	108.2	0.724	35.02	0.615
Earth	149.6	1	29.79	1.0
Mars	227.9	1.523	24.13	1.88
Jupiter	778	5.2	13.07	11.86
Saturn	1427	9.539	9.67	29.46
Uranus	2870	19.184	6.81	84.01
Neptune	4497	30.06	5.45	164.8
Pluto	5900	39.439	4.74	248.5

- AU = Astronomical Unit (the distance of the Earth from the Sun).
- 1 AU = 149,597,870 kilometers.

Table 3-21. Galilean Satellite Delta-V (km/sec)

Jovian Moon	*km/sec*
Io	17.3
Europa	13.7
Ganymede	10.9
Callisto	8.2

Table 3-16. Hohmann Orbit Delta-V (km/sec)

	Mercury	Venus	Earth	Mars	Jupiter
Mercury		12.548	17.145	21.354	25.643
Venus	12.548		5.202	10.531	17.993
Earth	17.145	5.202		5.593	14.439
Mars	21.354	10.531	5.593		10.154
Jupiter	25.643	17.993	14.439	10.154	

	Asteroid Belt
Mercury	24.574
Venus	15.455
Earth	11.175
Mars	6.091
Jupiter	4.733

- Note: delta-v assumes transit from the orbit of one planet to the orbit of the other. It does not include the delta-v for take-off and landing.
- Asteroid Belt includes only asteroids in the main belt such as Ceres.

Table 3-17. Hohmann Orbit Transfer Times (months)

	Mercury	Venus	Earth	Mars	Jupiter
Mercury		2.5	3.5	5.6	28.4
Venus	2.5		4.8	7.2	31.0
Earth	3.5	4.8		8.6	33.2
Mars	5.6	7.2	8.6		37.5
Jupiter	28.4	31.0	33.2	37.5	

	Asteroid Belt
Mercury	12.0
Venus	14.0
Earth	15.7
Mars	19.1
Jupiter	48.4

Table 3-19. Propulsion Systems

Type	Drive	Bonus ?	Spare Cargo Bonus?	Duration of Burn	Thrust
Magnetic Nuclear Pulse	15	Nuc QR	Yes	Days	High
Nuclear Thermal	8	Nuc QR / 2	Yes	Minutes	Med
Nuclear Electric	7	Nuc QR / 4	Yes	Months	Low
Nuclear Pulse Rocket	10	Nuc QR	No	Days	High
Mars Rocket	5	None	No	Minutes	High
Solar Electric	See Next Table	None	Yes	Months	Low

The effectiveness of the Solar Electric drive is governed by its proximity to the sun. Beyond the orbit of Mars it provides no significant propulsion.

Table 3-20. Solar Electric Drive

	Mercury-Venus	Venus-Earth	Earth-Mars	Mars+
Solar Electric	10.5	8.5	4.5	Not usable

Table 3-22. Propulsion Systems: Range

Type	Range
Magnetic Nuclear Pulse	60
Nuclear Thermal	50
Nuclear Electric	20
Nuclear Pulse Rocket	40
Mars Rocket	30
Solar Electric	10

Table 3-25. Cycler Boost Propulsion Systems

Type	Drive	Bonus?	Cost	Yard Cap
Nuclear Thermal	8	Nuc QR / 2	1000 gp/ 10 nfp	25n/30r
Nuclear Electric	7	Nuc QR / 4	1250 gp/ 8 nfp	30n/30r
Nuclear Pulse Rocket	10	Nuc QR	2000 gp/ 40nfp	35r/25r
Solar Electric	See Next Table	None	1250 gp/ 8 nfp	30r

The effectiveness of the Solar Electric drive is governed by its proximity to the sun.

Table 3-26. Solar Electric Drive

	Mercury-Venus	Venus-Earth	Earth-Mars	Mars+
Solar Electric	10.5	8.5	4.5	Not usable

Table 4-3. Lunar Landing QR Modifiers

Landing Location	QR Adjustment
Maria	-
Terrae	-1
Polar Region	-1
Farside with no satellite or space station in Lunar orbit	-2

Table 5-2. I2#A Interplanetary Mission Costs & Capacity

Unit Name	Code	Cost	Yard Capacity	Cargo	Mission Duration
Nuclear Pulse Rocket	npr	400 gp/ 10 nfp	15r/10n	20	36

The following Mars Landers and rovers can be built to be carried by the interplanetary spacecraft:

Table 5-3. I2 Landers & Other Equipment

Unit Name	Code	Cost	Yard c	Cargo	(Cargo)
Lunar Lander	SLL	100 gp/ 2 nfp	10r	2	-
Mars Lander	NLR	550 gp/ 5 nfp	15r	3	-
Mars Cargo Lander	NCL	500 gp/ 4nfp	15r	2	(1)
Planetary Probe	NPP	50.0 gp/ 1 nfp	2r	0.5	-

- The Lunar and Mars Landers can only make one descent and carries a return stage for a single ascent to the mothership. Can only be built if the nation has completed the Single Stage to orbit project.
- The Mars Cargo Lander consists only of a descent stage to deliver equipment to the surface. Can only be built if the nation has completed the Single Stage to orbit project.
- A Planetary Probe is a short-range probe that can be dropped from orbit to provide data on planetary conditions. Useful for missions to hostile worlds such as Venus where a manned landing is impossible.

Table 5-4. I2#B Interplanetary Mission Costs & Capacity

Unit Name	*Code*	*Cost*	*Yard Capacity*	*Cargo*	*Mission Duration*
Mars Rocket	mrr	200gp / 100 nfp	50 r	4	30

Table 5-5. Long Range Miners - Costs & Capacity

Unit Name	*Code*	*Cost*	*Yard Capacity*	*Cargo*	*Mission Duration*
Nuclear Thermal Miner	dnt	1000 gp/ 10 nfp	25n/30r	15	24
Nuclear Electric Miner	dne	1250 gp/ 8 nfp	30n/30r	14	24
Magnetic Nuclear Pulse Miner	dnp	2000 gp/ 40nfp	35r/25r	15	18
Solar Electric Miner	dse	1250 gp/ 8 nfp	30r	18	24

Table 5-6. I3 Interplanetary Mission Costs & Capacity

Unit Name	*Code*	*Cost*	*Yard Capacity*	*Cargo*	*Mission Duration*
Nuclear Thermal Spacecraft	snt	1000 gp/ 12 nfp	25n/25r	5	24
Robot Nuclear Thermal Spacecraft	rnt	1500 gp/ 12 nfp	25n/25r	5	24
Nuclear Electric Spacecraft	sne	1250 gp/ 10 nfp	30n/25r	4	24
Robot Nuclear Electric Spacecraft	rne	1500 gp/ 10 nfp	30n/25r	4	30
Magnetic Nuclear Pulse Spacecraft	snp	2000 gp/ 50nfp	30r/25r	5	18
Robot Magnetic Nuclear Pulse Spacecraft	rnp	2500 gp/ 50nfp	30r/25r	5	18
Solar Electric Spacecraft	sse	1250 gp/ 10 nfp	25r	8	24
Robot Solar Electric Spacecraft	rse	1500 gp/ 10 nfp	25r	8	36

The following Mars Landers and rovers can be built to be carried by the interplanetary spacecraft:

Table 5-7. I3 Mars Landers & Other Equipment

Unit Name	*Code*	*Cost*	*Yard c*	*Cargo*	*(Cargo)*
Mars Lander	MLR	550 gp/ 5 nfp	15r	3	-
Mars Cargo Lander	MCL	400 gp/ 4nfp	10r	2	(1)
Mars Spaceplane	MSP	600.0 gp/ 4 nfp	25a	5	(1)
Crawler	MCR	50.0 gp/ 1 nfp	5Fc	1	-
Planetary Probe	MPP	50.0 gp/ 1 nfp	2r	0.5	-

- The Mars Lander can only make one descent and carries a return stage for a single ascent to the mothership. Can only be built if the nation has completed the Single Stage to orbit project.
- The Mars Cargo Lander consists only of a descent stage to deliver equipment to the surface. Can only be built if the nation has completed the Single Stage to Orbit project.
- The Mars Spaceplane is a spaceplane adapted to the Martian environment. It can fly in the Martian atmosphere, making several landings and returning to the mothership in orbit to refuel. Can only be built if the nation has completed the Spaceplanes project.
- The Mars Crawler can be used to explore the Martian surface.
- A Planetary Probe is a short-range probe that can be dropped from orbit to provide data on planetary conditions. Useful for missions to hostile worlds such as Venus where a manned landing is impossible.

Table 5-8. I3 Space Cruisers - Costs & Capacity

Unit Name	*Code*	*Cost*	*Yard Capacity*	*Mission Duration*
Nuclear Thermal Space Cruiser	wnt	2000 gp/ 10 nfp	25n/30r	30
Magnetic Nuclear Pulse Space Cruiser	wnp	4000 gp/ 40nfp	35r/30r	24

9.4 MINING AND CONSTRUCTION IN SPACE

Table 2-11. Asteroid Mining Production Multiples

Asteroid Type	*Production Multiple*
C-type	2.0
S-type	0.75
M-Type	0.5

Table 2-12. Lunar Mining Production Multiples

Region Terrain	*Production Multiple*
Polar	2.0
Maria	0.5
Terrae	1.0

Table 3-29. Asteroid Material Processing

Type	*%*	*CPv*	*Processing Cost (GP)*	*Notes*
C-type	75%	0.5	7	Carbonaceous – carbon and hydrated minerals.
S-type	17%	0.25	8	Silicaceous - of metallic nickel-iron mixed with iron- and magnesium-silicates.
M-Type	8%	1.0	4	Metallic - nickel-iron, pure or mixed with stone.

Note: This refers to Inner System Asteroids. This differs from the composition percentages of the Asteroid Belt.

Table 3-30. Lunar Material Processing

Region	*CPv*	*Processing Cost (GP)*
Polar	1.0	5
Maria	0.5	10
Terrae	0.2	8

Table 3-31. Asteroid Natural Siege Strength

Type	*Base Strength*	*Structural Strength Range*	
		Minimum	*Maximum*
C-type	0.1	0.2	1.3
S-type	0.3	0.3	1.5
M-Type	0.5	0.1	2.0

Table 3-32. Asteroid Impact Effects

Structural Strength	*Structure*	*Impact Multiple*	*Effect*
<0.4	Rubble pile	(2)	Airburst in atmosphere (else a cluster of impact craters)
<0.5	Fractured	2	Cluster of impact craters
	Solid	1	Large Impact Crater

Type	*Type Multiple*
C-type	1
S-type	2
M-Type	4

Size	*Size Multiple*	*Effect*
<4	0 (0.25)	No Effect in atmosphere. Burns up in the Earth's Atmosphere. (Effect in vacuum).
<10,000	Size/1000	Megatons of damage: Local Effects
10,000+	Size/500	Million Megatons+ of damage: world wide climatic damage; extinction level event.

Table 3-33. Terrain Impact Effects

Terrain Type	*Terrain Impact Multiple*
m	0.5
w, d, t	0.75
c, c2, s, l, j, o	1.0

Table 3-34. Water Impact Effects

Sea Zones/ Open Ocean Hexes from impact	*Effect*
0-1	Apply full damage to coastal cities and coastal regions (including islands). All shipping in coastal waters is destroyed.
2	Apply half damage to coastal cities and coastal regions (and islands). Half shipping is destroyed in coastal sea zones. In open waters ships ride out the massive waves without damage.
3-4	Apply quarter damage to coastal cities and coastal regions (and islands).
5-8	Apply quarter damage to coastal cities and port areas.
9-16	Apply eighth damage to coastal cities and port areas.

9.5 LEADER ACTIONS

Table 5-1. Operational Ranges for In-flight Refueling

Aircraft Type	**Jet**
Carrier Fighter	4
Fighter / Carrier Bomber	7
Bomber	11
Heavy Bomber	16

Table 6-1. Months Per Year Available For Actions

Culture	**# of Months**
Civilized	6
Seafaring	7
Barbarian	8
Nomadic	8
Pre-Columbian	5
Renaissance Land Units	8
Renaissance Ships	7 + Nav
Industrial One non-Steam Ships	8 + Nav
Industrial One Steamships	See build chart
Industrial One Land Units	9
Industrial Two Land Units	10
Industrial Three Land Units	11

Table 6-2. Unit Type Modifiers

Unit Type	***Modifier***
Leader	+2
Cavalry	+1
Infantry	+0
Siege	+0
Artillery	-1
Tribe Points	-1

Table 6-3. Equipment Type Modifiers

Equipment	***Modifier***
Heavy	-1
Medium	+0
Light	+1

Table 6-4. Unit Training Modifiers

Training	*Modifier*
Elite	+1
Regular	+0
Inexperienced	-1

Table 6-5. Leader Combat Rating Modifiers

Combat Leadership	*Modifier*
1 – 4	-1
5 – 8	+0
9 – 11	+1

Table 6-6. Regional Terrain Action Modifiers

Culture Type	Regional Terrain Type					
	c/c2/i	*w*	*m*	*d/s*	*t*	*j*
Civilized	+0	+1	+2	+1	+2	+2
Seafaring	+0	+1	+2	+2	+2	+2
Barbarian	+0	+0	+1	+1	+1	+1
Nomadic	+0	+1	+2	+0	+2	+2
pre-Columbian	+0	+0	+1	+1	+1	+0
Renaissance	+0	+0	+1	+1	+2	+1
Industrial 1/2	+0	+0	+1	+1	+2	+1
Industrial 3	+0	+0	+0	+0	+1	+0

Culture Type	Regional Terrain Type					
	ai	**am**	**ap**	**lp**	**lm**	**lt**
Industrial 1/2	+6	+8	+7	+0	+1	+0
Industrial 3	+4	+7	+6	+0	+2	+0

Polar movement is difficult because of the hostile terrain and the large scale of the map.

Table 6-7. Operation Leader Types

Type	*Description*
N	Admiralty - Naval Ops Leader
W	Wing Commander - Air Ops Leader
G	General Staff - Army Ops Leader
C	Space Commander – Space Ops Leader

Table 6-10. Nuclear Weapon Damage

Unit Name	*Damage*
Atomic Bomb	50
Fusion Bomb	100
Tactical Ballistic Missile	50
ICBM	100
SLBM	100
MIRV	4*100
Cruise Missile	75

Table 7-1. Industrial CCR Costs Supplement

Border / Region Type	*CCR Cost*
Controlled land border along a Royal or Postal Road segment	× ½
Controlled land border along a Rail Road segment	x ¼
Controlled land border along a Mag-Lev segment	x ⅛
Unsettled (empty, Barbarian / Pre-Columbian / Nomadic) regions	+1
Any kind of region within the tsetse Fly zone (unless traversed by a Railroad or Mag-Lev)	+1
'Anchored' Trade Conduit	1
'Anchored' Trade Conduit and nation has completed the R&D Radio project	× ⅓
'Anchored' Trade Conduit and nation has built an Internet	x ¼
'Anchored' Trade Conduit passes through seasonal sea ice	X 1.5

9.6 EARTH MAPS

Table 2-13. Extent of Winter Sea Ice

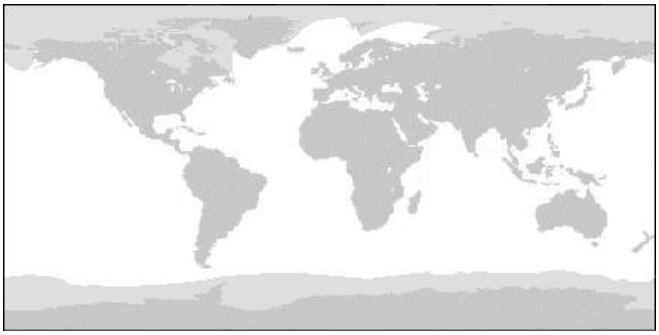


Table 3-13. Latitude Effect on Lift Capability

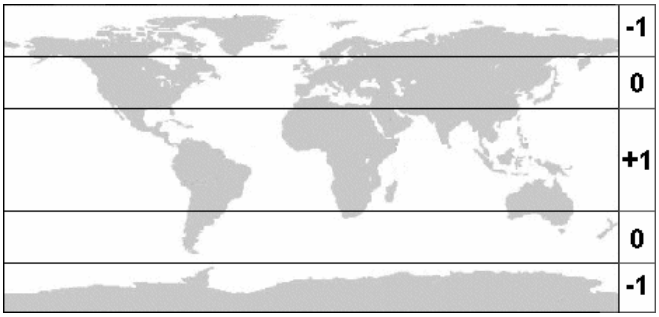


Table 3-11. Geostationary Coverage

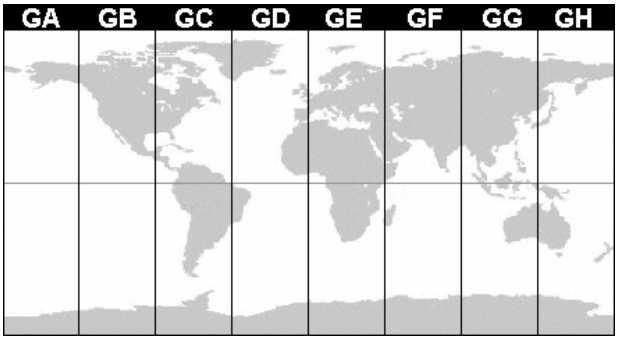


Table 6-9. Large Hex Map for Rockets

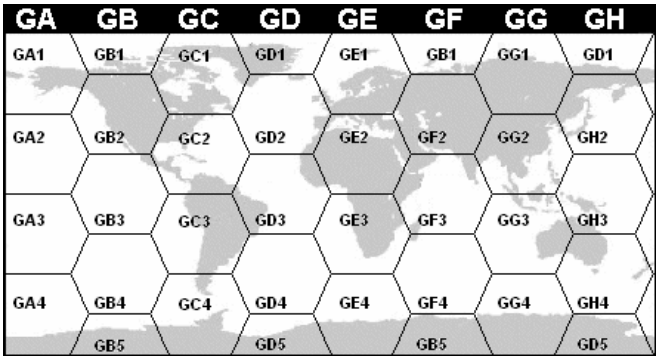


Table 3-9. Earth Lagrange Points

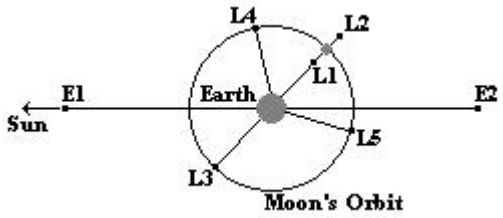


Table 3-10. Earth Orbits

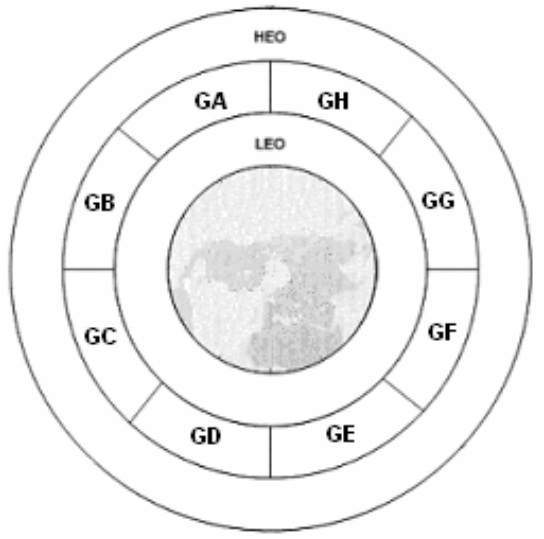
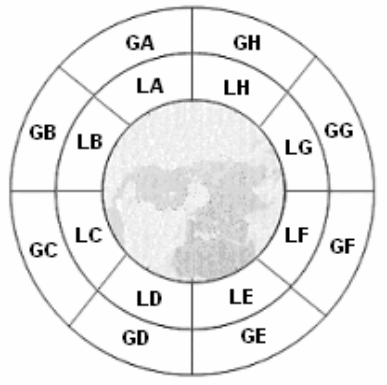


Table 6-11. LEO High-Altitude EMP Effects



9.7 UNIT BUILD CHARTS

Table 9-1. Research & Development Project Summary

Name	Pre-requisites	Advances	Results
Tech Level 16			
Armored Fighting Vehicle: Battle Tank	Heavy Tank	3	Can build Battle units (afb) units.
Flying Machines: Jet Light	Monoplane Light, 20 Aircraft Factories	5	Can build Jet (jf) and (jb) units
Flying Machines: Jet Heavy	Jet Bomber, 30 Aircraft Factories	1	Can build Jet (jct) and (jhb) units.
Helicopters	Fighter, 10 Aircraft Factories	5	Can build Airmobile Infantry (ami).
Rocketry: Dual-Stage Rocket	Single-Stage Rocket, 5 Rocket Factories, Radio	5	Can build Dual-Stage Rocket (dsr) units.
Rocketry: Manned Capsule	Dual-Stage Rocket, 10 Rocket Factories, Spaceport	2	Can build a low orbit manned space vehicle (smr) unit.
Rocketry: Rocketplane	Single-Stage Rocket, Jet Heavy, 5 Rocket Factories, 16 Aircraft Factories, Radio	6	Can build a reusable primitive spaceplane (rpr) unit.
Nuclear: Theoretical Nuclear Physics	None	8	Can build Nuclear Production Factories
Nuclear: Atomic Bomb	Theoretical Nuclear Physics, 5 Nuclear Production Factories	6	Can build Atomic Bomb (nab) units.
Cargo Submarines	Submarines, 4 Sub Yards	2	Can build (sut) units.
Tech Level 17			
Jet Aircraft: In-flight Refueling	Jet Heavy, 20 Aircraft Factories	4	Increased Operational Range for military jets.
Chemical Weapons	None	3	Can build (chm) units.
Rocketry: Manned Orbital Capsule	Manned Capsule, 10 Rocket Factories	2	Can build a manned orbital space vehicle (sor) unit.
Nuclear: Fusion Bomb	Atomic Bomb, 10 Nuclear Production Factories	6	Can build Fusion Bomb (nfb) units.
Rocketry: ICBM	Dual-Stage Rocket, 10 Rocket Factories, Fusion Bomb	3	Can build ICBM (icb) units.
Rocketry: Multistage Rocket	Dual-Stage Rocket, 12 Rocket Factories	4	Can build Multistage Rocket (msr) units.
Rocketry: Spy Satellites	Dual-Stage Rocket, 5 Rocket Factories, Spaceport	3	Can build Satellite (sat) units.
Space Command	Manned Capsule or Spy Satellites	3	Gains one Space Op. Can invest in Space Ops QR.
Underwater Installation	Cargo Submarines, 10 Sub Yards	3	Can build Underwater Installations.
Icebreaker	Improved Engines, 5 Shipyards	3	Can build Icebreaker (ice) units.
Tech Level 18			
Computers: Mainframe	Radio, (Analytical Engine)	6 (5)	Bonus to further R&D projects.
Submarines: Strategic Submarine	Submarines, ICBM, 6 Submarine yards	4	Can build SLBM equipped (ssb) units.
Rocketry: SLBM	ICBM, 10 Rocket Factories	4	Can build (slb) units.
Air Traffic Control	Radar, Mainframe	4	Provides a national bonus to Defense and React
Rocketry: Heavy Lift Rocket	Multistage Rocket, 15 Rocket Factories, Spaceport	4	Can build Heavy Lift Rocket (hlr) units.
Rocketry: Aero-Spaceplane	Rocketplane, 8 Rocket Factories, 30 Aircraft Factories	6	Can build Aero-Spaceplane (apr) units
Rocketry: Space Platform	(Manned Orbital Capsule or Aero-Spaceplane), 15 Rocket Factories	3	Can build Space Platforms.
Rocketry: Nuclear Pulse Rocket	Mainframe, Atomic Bomb, Manned Orbital Capsule, 10 Rocket Factories, 10 Nuclear Production Facilities	4	Can build Nuclear Pulse Rocket (npr) units
Rocketry: Lunar Mission	(Manned Orbital Capsule or Aero-Spaceplane), (Multistage Rocket or Space Platform), 15 Rocket Factories	6	Can build the components of a lunar mission: Space Tug (stg) units and Lunar Lander (sll) units.

Name	Pre-requisites	Advances	Results
Rocketry: Asteroid Mining	(Manned Orbital Capsule or Aero-Spaceplane), (Multistage Rocket or Space Platform), 20 Rocket Factories	6	Can build Asteroid Lander (all) units.
Rocketry: I2#A Interplanetary Mission	(Manned Orbital Capsule or Aero-Spaceplane), Nuclear Pulse Rocket, Space Platform, 15 Nuclear Production Factories, 15 Rocket Factories	6	Can build an I2 Interplanetary Space Vehicle.
Rocketry: I2#B Interplanetary Mission	(Manned Orbital Capsule or Aero-Spaceplane), Lunar Mission, 30 Rocket Factories	6	Can build an I2 Interplanetary Space Vehicle.
Underwater City	Underwater Installation, 15 Sub Yards	4	Can build Underwater Cities.
Tech Level 19			
Biological Weapons	None	5	Can build (bio) units.
ABM: Anti-Ballistic Missiles	Mainframe, Radar, Single-Stage Rocket, 10 Rocket Factories, Spaceport	6	Can build Anti-Ballistic Missile (abm) units
Rocketry: Space Station	Space Platform	4	Can build Space Stations.
Computers: Transistors	Mainframe	6	Necessary for future projects
Nuclear: Tactical Ballistic Missile	Fusion Bomb, 10 Nuclear Production Factories	3	Can build tactical ballistic missile (tbm) units
Nuclear: Nuclear Power	Mainframe, Theoretical Nuclear Physics, Steamships	4	Necessary for future projects.
Rocketry: Satellites	Transistors, Spy Satellites, 5 Rocket Factories, Spaceport	3	Can build (stt) units.
Rocketry: Interplanetary Probe	Satellites, 10 Rocket Factories, Spaceport	4	Can build (rip) units.
Nuclear Submarine	Nuclear Power, Transistors, Strategic Submarines, 10 Submarine yards	5	Can build nuclear submarine (nsb) units
Nuclear Carrier	Nuclear Power, Transistors, Aircraft Carrier, 10 shipyards	4	Can build nuclear aircraft carrier (ncv) units
Nuclear Icebreaker	Icebreaker, Nuclear Power, 8 shipyards	3	Can build nuclear icebreaker (nce) units.
Submarines: Hunter-Killers	Strategic Submarines, 5 Submarine yards, Sonar, Mainframe	4	Can build hunter-killer submarine (hks) units.
Hardened Electronics	Transistors	5	Protects your electronics from the EMP effects of nuclear weapons.
Cruise Missile	Jet Fighter, Transistors, Fusion Bomb, 20 Aircraft Factories, 5 Rocket Factories, 5 Nuclear Production Facilities	6	Can build cruise missile (crm) units.
Naval: Point Defense	Radar, Transistors, Single-Stage Rockets	5	Provides a bonus to the Anti-Air Strength of Naval units.
Rocketry: Local Space Defense	Space Platform, Hardened Electronics, 15 Rocket Factories	3	Can build Local Space Defense (lsd) units.
Rocketry: Lunar Outpost	Lunar Mission, Nuclear Power, Space Platform, 20 Rocket Factories	4	Can build Lunar Outposts and Heavy Lander (SHL) units.
Rocketry: Kinetic Energy Weapon	Satellites, 10 rocket factories, Spaceport	3	Can build kinetic kill weapon (kew) units.
Tech Level 20			
Computers: Microchips	Transistors	6	Necessary for future projects.
Land: Point Defense	Naval: Point Defense, Microchips	5	Provides a bonus to the Anti-Air Strength of Mechanized units.
Advanced Torpedoes	Torpedo, Single-Stage Rocket, Microchips	5	Provides a bonus for Torpedo attacks.
Advanced Sonar	Sonar, Microchips	5	Provides a bonus in combat between or against submarines.
Rocketry: Decoy	ICBM, 10 Rocket Factories	3	Provides a bonus to missile attacks.
Rocketry: MIRV	ICBM, Microchips, 10 Rocket Factories, 10 Nuclear Production Factories	3	Can build (mrv) units.
Rocketry: Interplanetary Rover	Microchip, Interplanetary Probe, 10 Rocket Factories, Spaceport	4	Can build (rov) units.
ABM: Neutron Warhead	Fusion Bomb, Anti-Ballistic Missiles,15 Nuclear Production Factories, 10 Rocket Factories	5	Can build (anm) units.
ABM: Advanced ABM	Anti-Ballistic Missiles, Microchips, 15 Rocket Factories	6	Can build (axm) units.
Rocketry: Lunar Base	Lunar Outpost, 25 Rocket	5	Can build Lunar Bases.

Name	Pre-requisites	Advances	Results
	Factories		
AFV: Lunar Crawler	Lunar Base, Heavy Tank	3	Can build (lcr) units.
Flying Machines: Stealth	Jet Fighter, Microchips, Radar, 20 Aircraft Factories	6	Provides a Combat bonus to aircraft.
Rocketry: Space Shuttle	(Aero-Spaceplane) or (Jet Fighter & Multistage Rocket), 15 Rocket Factories, Spaceport, 15 Aircraft Factories	3/5	Can build (spt) and (sht) units.
Command & Control	Microchips	3	Provides a bonus to naval, land and air Combat.
Laser	Hardened Electronics	4	Necessary for future projects.
Rocketry: Single Stage to Orbit	Heavy Lift Rocket, 20 Rocket Factories, Spaceport	6	Can build (sso) units.
Precision Weaponry	Laser, Command & Control, Radar	4	Provides a bonus when attacking specific items.
Rocketry: Advanced Asteroid Mining	Microchips, Asteroid Mining, 25 Rocket Factories	5	Can build Asteroid Mining Vehicles (amv) units.
Tech Level 21			
Subsurface Guns	Advanced Torpedoes, Advanced Sonar, Naval Point Defense	3	Provides a bonus to subsurface combat.
Rocketry: Spaceplane	(Space Shuttle or Aero-spaceplane)), 15 Rocket Factories, Spaceport, 20 Aircraft Factories	5/4	Can build (spl) and (hpl) units.
Rocketry: Trans-atmospheric Fighter	Spaceplane, Jet Fighter, Precision Weaponry, 15 Rocket Factories, 15 Aircraft Factories	5	Can build (spf) units.
Rocketry: Trans-atmospheric Heavy Fighter	Trans-atmospheric Fighter, 20 Rocket Factories, 20 Aircraft Factories	4	Can build (spb) units.
Rocketry: Sub-Orbital Dropship	Single Stage to Orbit, Local Space Defense, 25 Rocket Factories	5	Can build (sdr) units.
Solar Power Satellites	Space Platform, 15 Rocket Factories	4	Can build Solar Power Satellites.
Battlesuit	Command & Control	4	Can build (bsi) units.
Rocketry: Space Based Laser	Laser, Local Space Defense, Command and Control, 15 Rocket Factories	5	Can build (sbl) units.
Rocketry: Battlespace Fighter	Local Space Defense, Precision Weaponry, Space Platform, 10 Rocket Factories	4	Can build (sbf) units
Rocketry: Orbital Coil Gun	Kinetic Energy Weapon, Precision Weaponry, 15 Rocket Factories	4	Can build (ocg) units.
Nuclear Thermal Propulsion	Nuclear Power, 15 Nuclear Production Facilities, Microchips	5	Can build manned interplanetary space vehicles using this propulsion system.
Nuclear Electric Propulsion	Nuclear Power, 20 Nuclear Production Facilities, Microchips	4	Can build manned interplanetary space vehicles using this propulsion system.
Solar Electric Propulsion	Solar Power Satellites, 30 Rocket Factories, Microchips	3	Can build manned interplanetary space vehicles using this propulsion system.
Rocketry: Long Range Asteroid Mining	Asteroid Mining, Space Based Laser, Space Platform, (Nuclear Thermal Propulsion or Nuclear Electric Propulsion or Magnetic Nuclear Pulse Propulsion or Solar Electric), Hardened Electronics	3	Can build I3 Asteroid Mining Vehicles.
Rocketry: I3 Interplanetary Mission	Interplanetary Probe, Space Platform, (Nuclear Thermal Propulsion or Nuclear Electric Propulsion or Magnetic Nuclear Pulse Propulsion or Solar Electric), (Spaceplane or Single Stage to Orbit), Command and Control, Hardened Electronics	3	Can build an I3 Interplanetary Space Vehicle.
Tech Level 22			
Magnetic Nuclear Pulse Propulsion	(Nuclear Pulse Rocket or Nuclear Power), 30 Nuclear Production Facilities, Microchips	4/5	Can build manned interplanetary space vehicles using this propulsion system.
Rocketry: I3 Space Cruiser	Space Based Laser, Coilgun, Space Platform, (Nuclear Thermal Propulsion or Magnetic Nuclear Pulse Propulsion), Hardened Electronics,	5	Can build I3 Space Cruisers.

Name	Pre-requisites	Advances	Results
	Battlespace Fighter		
Genetic Engineering	Microchips	4	Provides an increase in Agro Production
Advanced Biological Weapons	Genetic Engineering, Biological Weapons	5	Can build (gen) units.
Human Hibernation	None	6	Allows an increase in Interplanetary Mission Duration.
Powered Armor	Battlesuit	4	Can build (psi) units.
Particle Accelerator	Laser, Nuclear Power	5	Necessary for future projects.
ABM Laser	Anti-Ballistic Missiles, Space Based Lasers, Nuclear Power	5	Can build (gbl) units.
Advanced Space Based Laser	ABM Laser, Space Based Lasers	3	Can build (abl) units.
Rocketry: Laser Rocket	ABM Laser, Single Stage to Orbit, 25 Rocket Factories	5	Can build (lrr) units
Computers: AI	Microchips, Hardened Electronics	6	Leads to many other projects.
Cybernetic AFV	AI, Battle Tank	4	Can build (cfv) units.
Cybernetic Autonomous Fighter	AI, Trans-atmospheric Fighter, 20 Rocket Factories, 20 Aircraft Factories	5	Can build (cpf) units.
Cybernetic Battlespace Fighter	AI, Battlespace Fighter, 20 Rocket Factories	5	Can build (cbf) units.
Cybernetic Space Vehicle	AI, I3 Interplanetary Mission	4	Can build I3 Cybernetic Space Vehicles.
Cybernetic Asteroid Mining	AI, Advanced Asteroid Mining, I3 Interplanetary Mission	5	Can build cybernetic long range mining vessels.

Table 9-2. Industrial Build Chart

Unit Name	*Code*	*GPc*	*NFPc*	*Indust C*	*AP*	*Cargo*	*Support*	*Combat*	*Siege*	*Build At…*
Cavalry										
Cavalry	C	9.0	1	1	9	4	0.6	2.3	0.8	Fc
Heavy Elite Cavalry	HEC	17.0	2	2	10	4	1.1	3.4	1.1	Fc
Light Cavalry	XC	7.0	1	1	11	2	0.4	0.8	0.3	Hm,Fc,Csr
Light Elite Cavalry	XEC	15.0	2	1	12	2	0.9	1.1	0.4	Fc
Artillery										
Artillery	G	6	1	2	8	5	0.6	3.0	2.0	Fc
Siege Artillery	SG	12	1	3	6	9	1.2	2.0	4.0	Fc
Project: Super-Heavy Artillery										
Super-Heavy Artillery	SHG	25.0	2	6	--	10	2.5	(10.0)	10.0	Fc
Project: Motorized Transport										
Motorized Field Artillery	TFG	8.0	2	5	14	5	2.0	4.0	3.0	Fc
Motorized Siege Artillery	TSG	10.0	2	5	14	5	2.0	2.0	5.0	Fc
Infantry										
Heavy Elite Infantry	HEI	7.0	2	2	9	3	0.7	2.3	3.4	Fc
Infantry	I	4.0	1	1	8	3	0.4	1.5	2.3	Fc
Inexperienced Infantry	II	1.5	1	-	8	2	0.15	0.5	0.8	Hm,Fc
Light Elite Infantry	XEI	5.0	2	1	11	1	0.5	0.8	1.1	Fc
Light Infantry	XI	2.0	1	1	10	1	0.2	0.5	0.8	Hm,Fc,Crh
Project: Motorized Transport										
Motorized Infantry	TI	9.0	2	4	15	4	1.2	2.0	2.3	Fc
Project: Mechanized Troops										
Mechanized Infantry	MI	12.0	2	5	20	5	2.4	4.0	2.5	Fc
Project: Parachute Infantry										
Parachute Infantry	PI	4.0	2	2a	6	1	0.4	0.8	1.0	Fc + Aircraft Factory
Project: Helicopters										
Airmobile Infantry	AMI	15.0	2	3g / 2a	25	5	3.0	3.0	1.5	Fc + Aircraft Factory
Space Age Infantry										
Project: Battlesuit										
Battlesuit Infantry	BSI	40.0	2	5	20	4	4.0	8.0	10.0	Fc
Project: Powered Armor										
Powered Armor Infantry	PSI	75.0	2	9	30	6	7.5	15.0	15.0	Fc
Civilians										
Force Point (Colonists)	NFP	N/A	N/A	-	8	2	1.0	6.0	-	Fr
Refugees (Tribal) Point	TBL	N/A	N/A	-	9	10	9.0	5.0	-	Cannot be built.
Forts and Engineers										
Field Fort	F	5.0	1	-	-	-	0.3	5.0	5.0	Cr
Wall Point	WP	8.0	1	1	-	-	0.5	-	10.0	Cc
Siege Engineers	S	4.0	1	2	9	2	0.4	0.5	4.0	Fc
Project: Motorized Transport										
Motorized Engineers	TS	12.0	2	4	15	5	1.6	1.0	5.0	Fc

Unit Name	Code	GPc	NFPc	Industr C	AP	Cargo	Support	Combat	Siege	Build At…
Project: Mechanized Troops										
Mechanized Engineers	MS	15.0	2	5	20	6	3.2	2.0	7.0	Fc
Mechanized										
Project: Light Tank										
Light Tank	AFX	8.0	1	4	9	3	1.6	2.0	0.5	Fc
Project: Medium Tank										
Medium Tank	AFV	12.0	1	5	9	4	2.4	4.0	1.0	Fc
Project: Heavy Tank										
Heavy Tank	AFH	15.0	1	6	9	5	3.0	8.0	1.5	Fc
Project: Battle Tank										
Battle Tank	AFB	18.0	1	6	12	6	4.0	12.0	2.0	Fc
Project: Lunar Crawler										
Lunar Crawler	LCR	50.0	1	5	6	4	5.0	2.0	2.0	Fc
Project: Cybernetic AFV										
Cybernetic AFV	CVF	25.0	1	8	12	6	5.0	15.0	5.0	Fc
Sailing Ships										
Ordinary Transports	T	4	0.1	1	18+Nav	(3)	0.4	(0.0)	(0.0)	HBZ Pa
Light Transports	XT	3	0.1	1	18+Nav	(1)	0.3	(0.0)	(0.0)	HBZ Pa
Prerequisite - Navigation 4+										
Ship of the Line - 1st Rank	HW	66	2.5	16	18+Nav	(2)	6.6	11	11	Dockyard
Ship of the Line - 3rd Rank	FW	54	1.5	8	18+Nav	(2)	5.4	9.0	9.0	Dockyard
Galleon	EW	24	1	4	18+Nav	(2)	2.0	4.0	4.0	Dockyard
Frigate	GFW	18	0.8	4	24+Nav	(1)	1.8	3.0	3.0	HBZ Pc
Corvette	LW	3	0.2	1	21+Nav	0	0.3	0.5	0.5	HBZ Pc
Prerequisite - Navigation 5+										
Heavy Frigate	HFW	42	1	4	24+Nav	(2)	4.2	7.0	7.0	Dockyard
Steamship Era (TL11 Hybrid Sail/Steam) Naval Units										
Project: Steamships										
Wooden Steam Battleship	XSW	70	2.5	1	32+Nav	(2)	7.0	12	24	Shipyard
Wooden Steam Cruiser	SCW	50	1	1	36+Nav	(1)	5.0	8.0	16	Shipyard
Wooden Steam Transport	ST	10	0.1	1	32+Nav	(5)	1.0	(0.0)	(0.0)	Shipyard
Gunboat	GB	10	0.2	1	32+Nav	0	1.0	1.0	0.6	Dockyard/Shipyard
Ironclad Era (TL12 Hybrid Sail/Steam) Naval Units										
Project: Ironclads										
Ironclad Cruiser	SFW	60	1	2	36+Nav	(1)	6.0	12	20	Shipyard
Ironclad Battleship	SW	80	2	3	32+Nav	(2)	8.0	16	30	Shipyard
Project: Battleships										
Steel Hulled Battleship	HSW	90	2	5	32+Nav	(2)	9.0	16	30	Shipyard
Metal Hulled Transport	MT	10	0.1	1	32+Nav	(6)	1.0	(0.0)	(0.0)	Shipyard
Pre-modern Era (TL13 Coal Fired/Multi-Caliber) Naval Units										
Project: Naval Architecture										
Battleship	BW	120	2	8	36+Nav	(2)	12	24	36	Shipyard
Armored Cruiser	AC	100	1.5	6	36+Nav	(2)	10	20	32	Shipyard
Protected Cruiser	PC	50	1	2	40+Nav	(1)	5.0	16	20	Shipyard
Steel Transport	MS	10	0.1	2	32+Nav	(8)	1.0	(0.0)	(0.0)	Shipyard
Project: Torpedoes										
Torpedo Boat Destroyer	TBD	40	1	1	40+Nav	0	4.0	4.0	1.0	Shipyard
Torpedo Boat	XTB	20	0.5	1	40+Nav	0	2.0	2.0	0.8	Dockyard/Shipyard
Project: Submersible										
Submersible	SB	10	0.2	1	24+Nav	0	1.0	1.0	0.0	Sub Yard
Modern (TL14 Diesel Oil or Coal / Single Caliber) Naval Units										
Project: Improved Engines										
Modern Merchantship	MM	10	0.1	3	32+Nav	(10)	1.0	(0.0)	(0.0)	Shipyard
Project: Modern Warships										
Modern Battleship	BB	200	5	16	40+Nav	(3)	20	48	36	Shipyard
Battlecruiser	BC	150	4	14	44+Nav	(2)	15	40	32	Shipyard
Heavy Cruiser	CA	100	3	10	44+Nav	(2)	10	30	24	Shipyard
Light Cruiser	CL	80	2	6	48+Nav	(1)	8.0	20	20	Shipyard
Destroyer	DD	40	1	3	40+Nav	0	4.0	8.0	10	Shipyard
Project Submarines										
Submarine	SS	15	0.2	2	24+Nav	0	1.5	2.0	0.0	Sub Yard
Project: Aircraft Carrier										
Aircraft Carrier	CV	200	8	12	42+Nav	4a/c	20	19	0.0	Shipyard
Light Carrier	CVL	100	4	6	48+Nav	3a/c	10	8.0	0.0	Shipyard
Modern (TL15 Diesel Oil or Coal / Single Caliber) Naval Units										
Project: Aircraft Carrier										
Fleet Carrier	CVA	300	12	15	42+Nav	5a/c	25	26	0.0	Shipyard
Project: Amphibious Warfare Vessel										
Amphibious Assault Ship	LPH	80	1	6	40+Nav	(10)	8.0	(8.0)	(4.0)	Shipyard
Project: Cargo Submarines										
Cargo Submarine	SUT	20	0.5	3	24+Nav	(2)	2.0	1.5	0.0	Sub Yard

Unit Name	Code	GPc	NFPc	Indust C	AP	Cargo	Support	Combat	Siege	Build At…
Project: Icebreaker										
Icebreaker	ICE	50	1	5	40+Nav	(8)	5.0	(1.0)	(0.0)	Shipyard
Space Age (TL18 Nuclear Age) Naval Units										
Project Strategic Submarines										
Strategic Submarine	SSB	150	2	4	24+Nav	3m	15.0	2.0	0.0	Sub Yard
Space Age (TL19 Nuclear Age) Naval Units										
Project: Nuclear Submarine										
Nuclear Submarine	NSB	300	8	8s/10n	30+Nav	8m	30.0	3.0	0.0	Sub Yard Nuclear Production Facility
Project: Nuclear Carrier										
Nuclear Carrier	NCV	500	15	20s/10n	44+Nav	10a/c	50.0	30	0.0	Shipyard Nuclear Production Facility
Project Nuclear Icebreaker										
Nuclear Icebreaker	NCE	400	10	10s/8n	44+Nav	(12)	40.0	(5.0)	(0.0)	Shipyard Nuclear Production Facility
Project: Hunter-Killers										
Hunter-Killer Submarine	NKS	200	3	6	30+Nav	0	20.0	4.0	0.0	Sub Yard
Aircraft										
Project: Biplane										
Biplane Fighter	BF	5.0	1	1	Range 1	2	1.0	1.0	0.1	Aircraft Factory
Biplane Bomber	BIB	8.0	1	2	Range 1	4	1.6	(1.0)	1.5	Aircraft Factory
Biplane Cargo Transport	BIT	6.0	1	1	Range 1	2 or (1)	1.2	(1.0)	-	Aircraft Factory
Project: Carrier Aircraft										
Biplane Carrier Fighter	BCF	6.0	1	2	Range 0	2	1.2	1.0	0.1	Aircraft Factory
Biplane Carrier Bomber	BCB	9.0	1	3	Range 1	4	1.8	(1.0)	1.0	Aircraft Factory
Carrier Fighter	CVF	6.0	1	2	Range 1	2	1.2	1.5	-	Aircraft Factory
Carrier Bomber	CVB	9.0	1	3	Range 2	4	1.8	(1.5)	2.0	Aircraft Factory
Jet Carrier Fighter	JCF	6.0	1	3	Range 3	2	1.2	3.0	1.0	Aircraft Factory
Jet Carrier Bomber	JCB	9.0	1	4	Range 5	4	1.8	(3.0)	4.0	Aircraft Factory
Project: Monoplane Light										
Fighter	AF	5.0	1	2	Range 2	2	1.0	2.0	1.0	Aircraft Factory
Bomber	AB	8.0	1	4	Range 4	4	1.6	(2.0)	3.0	Aircraft Factory
Project: Monoplane Heavy										
Cargo Transport	ACT	6.0	1	2	Range 4	2 or (1)	1.2	(1.0)	-	Aircraft Factory
Heavy Bomber	AHB	12.0	1	8	Range 6	6	2.4	(3.0)	6.0	Aircraft Factory
Project: Jet Light										
Jet Fighter	JAF	5.0	1	2	Range 5	2	1.0	4.0	1.0	Aircraft Factory
Jet Bomber	JAB	8.0	1	4	Range 8	4	1.6	(4.0)	5.0	Aircraft Factory
Project: Jet Heavy										
Jet Cargo Transport	JCT	6.0	1	4	Range 8	2 or (1)	1.2	(2.0)	--	Aircraft Factory
Jet Heavy Bomber	JHB	12.0	1	16	R.12	6	2.4	(6.0)	10.0	Aircraft Factory
Rockets										
Project: Single-Stage Rocket										
Single-Stage Rocket	SSR	10.0	1	2	R 1-3	4	1.0	(1.0)	5.0	Rocket Factory
Project: Dual-Stage Rocket										
Dual-Stage Rocket	DSR	100.0	2	5	R 2-3LH	7 (1)	10.0	(2.0)	10.0	Rocket Factory
Project: Multistage Rocket										
Multistage Rocket	MSR	200.0	3	10	Any	(2/1)	20.0	(2.0)	15.0	Rocket Factory
Project: Heavy Lift Rocket										
Heavy Lift Rocket	HLR	250.0	4	15	Any	(3/2/1)	25.0	(1.0)	20.0	Rocket Factory
Project: Nuclear Pulse Rocket										
Nuclear Pulse Rocket	NPR	400.0	10	15r/10n	R50	(40)	30.0	(3.0)	-	Rocket Factory Nuclear Production Factories
Project: Single Stage to Orbit										
Single Stage to Orbit Rocket	SSO	500.0	5	20	Any	(4)	50.0	(2.0)	-	Rocket Factory
Project: Sub-Orbital Dropship										
Sub-Orbital Dropship	SDR	750.0	6	25	Any	(5)	75.0	5.0	-	Rocket Factory
Project: Laser Rocket										
Laser Rocket	LRR	20.0	1	2	Orbit	(2)	2.0	-	-	Rocket Factory
Space Capsules										
Project: Manned Capsule										
Manned Space Capsule	SMR	50.0	2	6	R2	1	5.0	(2.0)	-	Rocket Factory
Project: Manned Orbital Capsule										

Unit Name	Code	GPc	NFPc	Industr C	AP	Cargo	Support	Combat	Siege	Build At…
Manned Orbital Capsule	SOR	75.0	2	8	R5	2	7.5	(2.0)	-	Rocket Factory
Trans-Atmospheric Craft										
Project: Rocketplane										
Rocketplane	RPR	250.0	2	5r/16a	1-9LH	5	25.0	(3.0)	-	Rocket Factory + Aircraft Factory
Project: Aero-Spaceplane										
Aero-Spaceplane	APR	500.0	3	8r/20a	1-9LH	(1)	50.0	(3.0)	-	Rocket Factory + Aircraft Factory
Project: Shuttle										
Space Shuttle	SPT	400.0	4	15r/15a	1-9LH	(2)	40.0	(3.0)	-	Rocket Factory + Aircraft Factory
Heavy Shuttle	SHT	600.0	5	20r/15a	1-9LH	(4)	60.0	(3.0)	-	Rocket Factory + Aircraft Factory
Project: Spaceplane										
Spaceplane	SPL	600.0	4	20	Any	(3)	60.0	2.0	2.0	Aircraft Factory
Heavy Spaceplane	HPL	800.0	5	25	Any	(4)	80.0	1.5	3.0	Aircraft Factory
Project: Trans-atmospheric Fighter										
Trans-atmospheric Fighter	SPF	500.0	2	15	Any	2	50.0	20.0	5.0	Aircraft Factory
Project: Trans-atmospheric Heavy Fighter										
Trans-atmospheric Heavy Fighter	SPH	600.0	3	20	Any	(1)	60.0	15.0	15.0	Aircraft Factory
Project: Cybernetic Autonomous Fighter										
Cybernetic Autonomous Fighter	CPF	500.0	2	15	Any	2	50.0	25.0	5.0	Aircraft Factory
Missiles										
Rocketry: ICBM										
ICBM	ICM	100.0	2	5r/8n	R 5-3LH	7	10.0	(2.0/20)	100	Rocket Factory/Nuclear Production Factory
Project: SLBM										
SLBM	SLM	120.0	2	5r/8n	R 5-2LH	5	12.0	(2.0)	100	Rocket Factory/Nuclear Production Factory
Rocketry: MIRV										
MIRV	MRV	250.0	3	10r/10n	R 5-4LH	8	25.0	(5.0/30)	4*100	Rocket Factory/Nuclear Production Factory
Project: Cruise Missile										
Cruise Missile	CRM	100.0	1	5n/ta	R 1-8	1	10.0	(1.0)	75.0	Nuclear Production Facility Aircraft Factory
Anti-Missile Systems										
Project: Anti-Ballistic Missiles										
Anti-Ballistic Missile	ABM	200.0	4	5	-	10	20.0	10.0	-	Rocket Factory
Nuclear: Neutron Warhead										
Neutron Warhead ABM	ANM	300.0	5	8n/8r	-	12	30.0	25.0	-	Rocket Factory Nuclear Production Factories
Project: Advanced ABM										
Advanced ABM	AXM	300.0	5	8	-	15	30.0	10.0	-	Rocket Factory
Satellites and Space Probes										
Project: Spy Satellite										
Spy Satellite	SAT	20.0	1	2	--	1	0.2	(1.0)	-	Rocket Factory
Project: Satellite										
Satellite	STT	50.0	1	4	--	1	0.5	(2.0)	-	Rocket Factory
Project: Interplanetary Probe										
Interplanetary Probe	RIP	150.0	2	5	--	1	15.0	-	-	Rocket Factory
Project: Interplanetary Rover										
Interplanetary Rover	ROV	250.0	2	5	--	2	25.0	-	-	Rocket Factory
Space Vehicles										
Project: Lunar Mission										
Space Tug	STG	100	2	10	R30	(2)	10.0	(2.0)	-	Rocket Factory
Lunar Lander	SLL	100	2	10	R4	1	10.0	(2.0)	-	Rocket Factory
Project: Asteroid Mining										
Asteroid Lander	ALL	150	2	15	R30	(4*)	15.0	(2.0)	2.0	Rocket Factory
Project: Advanced Asteroid Mining										
Asteroid Mining Vehicle	AMV	300.0	3	20	R40	(10*)	30.0	(4.0)	2.0	Rocket Factory
Project: Local Space Defense										

Unit Name	Code	GPc	NFPc	Indust C	AP	Cargo	Support	Combat	Siege	Build At…
Local Space Defense	LSD	50.0	1	5	-	1	5.0	5.0	5.0	Rocket Factory
Project: Lunar Outpost										
Heavy Lunar Lander	SHL	150.0	2	10	R40	(4)	15.0	2.0	1.0	Rocket Factory
Project: Battlespace Fighter										
Battlespace Fighter	SBF	150.0	2	10	R40	2	15.0	10.0	10.0	Rocket Factory
Project: Cybernetic Battlespace Fighter										
Cybernetic Battlespace Fighter	CBF	150.0	2	10	R40	2	15.0	20.0	10.0	Rocket Factory
Rocketry: Interplanetary Space Vehicle										
Interplanetary Space Vehicle		variable	25	variable	variable	10	variable	(5.0)	-	variable
NBC Weapons										
Project: Atomic Bomb										
Atomic Bomb	NAB	100.0	2	5	--	1	10.0	--	50	Nuclear Production Factories
Project: Fusion Bomb										
Fusion Bomb	NFB	100.0	2	8	--	1	15.0	--	100	Nuclear Production Factories
Project: Tactical Ballistic Missile										
Tactical Ballistic Missile	TBM	100.0	1	5n/5	12	6	10.0	4.0	50/2.0	Nuclear Production Factories Fc
Project: Chemical Weapons										
Chemical Weapon	CHM	25.0	1	5	-	1	2.5	--	25.0	Fc
Project: Biological Weapons										
Biological Weapon	BIO	30.0	1	5	-	1	6.0	--	Plague	Fc
Project: Advanced Chemical Weapons										
Advanced Biological Weapon	GEN	40.0	2	10	-	1	8.0	--	Plague	Fc
Exotic Weapons										
Project: Space Based Lasers										
Space Based Laser	SBL	300.0	5	15	-	2	30.0	10.0	12.0	Rocket Factory
Project: Kinetic Energy Weapon										
Kinetic Energy Weapon	KEW	25.0	1	5r/LM-D	Any	1	2.5	(5.0)	25	Rocket Factory/Lunar Mass-Driver
Project: Orbital Coil Gun										
Orbital Coil Gun	OCG	100.0	2	10	--	2	10.0	10.0	5.0	Rocket Factory
Project ABM Lasers										
ABM Lasers	GBL	400.0	5	15	-	2	40.0	10.0	12.0	Rocket Factory
Project Advanced Space Based Lasers										
Advanced SBL	ABL	500.0	5	20	-	2	50.0	40.0	20.0	Rocket Factory
Miscellaneous										
Stratospheric Aerostat	AER	100.0	50.0	50	10	10 a/c	10.0	2.0	2.0	Fc

Notes

- **HM** : Unit can be built in the Homeland of the Nation, regardless of wether there is a city there or not.
- **FC :** Unit can be built at a Friendly city within the Homeland Build Zone of the nation.
- **CSR :** Unit type can be built at a controlled Steppe region within the nation. This region does not have to be within the Homeland Build Zone of the nation.
- **« None »** : Unit cannot be built by normal means, but appear as a result of Holy Wars and Crusades.
- **CRH** : Unit can be built in a controlled region within the Homeland Build Zone of the nation.
- **PA** : Unit type can be built in a Port Area within the Homeland Build Zone of the nation.
- **PC** : Unit type can be built at a Port City within the Homeland Build Zone of the nation.
- **FA** : Unit type can be built at a controlled Ferry Arrow.
- **(Cargo**): Carrying capacity of a ship, airship or aircraft unit.
- **Cargo**: Cost of the unit to be carried by a ship, airship or aircraft unit.
- **Marines**: Infantry carried on a warship (but not on transports) fight in any boarding actions and close combat as marines. No other unit type can fight aboard a ship.
- **Galleon:** A Galleon represents a 'Great Ship' and a Ship of the Line 4th Rank.
- **Frigate:** A frigate represents a Ship of the Line 5th Rank.
- **Asteroid Vehicles:** these can only carry a cargo of raw or processed rock – the cargo space is not pressurized.

Note: Ship unit actual movements rates units are calculated by adding the Navigation Rating of your nation to the shown AP rate.

Yard Cost Type	Source of Capacity
Dockyard	Dockyard + Pc
Airship	Airship Factories
Steamship or Improved Engines Ship	Shipyard
Submarine or Submersible	Submarine Yard
Ship	Port City generic Yard
Heavy Unit	Friendly City generic Yard
Artillery	Friendly City generic Yard
Mechanized, Motorized and AFV	Friendly City generic Yard
Aircraft	Aircraft Factories
Rockets	Rocket Factories
Nuclear Weapons	Nuclear Production Facilities

Table 9-3. Optional Unit Construction Chart

Unit Name	*Code*	*GPc*	*NFPc*	*Industc*	*AP*	*Cargo*	*Support*	*Combat*	*Siege*	*Build At…*
Artillery										
Prerequisite - TL 9										
Elephant Artillery	ELG	8.0	1	1	7	5	0.6	2.0	2.0	Fc
Hussite War Wagon	WW	9.0	1	1	8	4	0.5	2.5	0.5	Hm, Fc
Horse Artillery	HG	6	1	1	9	7	0.6	2	1	Fc
Project: Mechanized Troops										
Mechanized Artillery	MFG	10.0	2	5	18	6	4.0	5.0	4.0	Fc
Project: Medium Tank										
Mechanized Siege Artillery	MSG	14.0	2	5	18	6	4.1	3.0	6.0	Fc
Ships										
Prerequisite – TL 9, Navigation 4+										
Ship of the Line - 2nd Rank	GW	60	2	12	18+Nav	(2)	6.0	10	10	Dockyard
Frigate – 6th Rank	FFW	9	0.5	2	24+Nav	(1)	0.9	1.5	1.5	HBZ Pc
Frigate – 7th Rank	EFW	6	0.3	1	24+Nav	0	0.6	1.0	1.0	HBZ Pc
Project: Airship Carrier										
Airship Carrier	ACW	60	1.5	2	40+Nav	2zs/1z	6.0	0.0	0.0	Shipyard
Project: Modern Warships										
Anti-aircraft Cruiser	CLA	80	2	8	48+Nav	(1)	8.0	16	15	Shipyard
Destroyer Escort	DE	30	0.5	2	40+Nav	0	3.0	6.0	8.0	Shipyard
Modern Corvette	CE	20	0.2	1	48+Nav	0	2.0	4.0	6.0	Shipyard
Project: Aircraft Carrier										
Escort Carrier	CVE	40	1.5	2	36+Nav	1a/c	4.0	4.0	0.0	Shipyard
TL15, Project: Aircraft Carrier										
Battle Carrier	CAB	250	8	12	42+Nav	4a/c	20	25	0.0	Shipyard
TL15, Project: Amphibious Warfare Vessel										
Attack Cargo Ship	LKA	40	0.1	3	32+Nav	(8)	2.5	(4.0)	(2.0)	Shipyard
Airships										
Project: Airships										
Airship	Z	10	0.1	2	Range 4	0	1.0	3.0	3.0	Airship Yard
Scout Airship	ZS	5	0.1	1	Range 3	0	0.5	1.0	0.0	Airship Yard
Projects: Large Airships										
Heavy (Bomber) Airship	ZH	15	0.1	3	Range 6	0	1.5	6.0	9.0	Airship Yard
Transport Airship	ZT	15	0.1	3	Range 8	(1)	1.5	(1.0)	(0.0)	Airship Yard

- Elephant units are particularly effective against cavalry.

Table 9-4. Artillery Unit Capabilities

Unit Name	Code	Armor	Anti-Aircraft Strength	Combat	Siege	Ranged
Bombard	BG	0	0	0.5	2.0	0.0
Horse Artillery	HG	0	0	2.0	1.0	0.0
Siege Artillery	SG	0	0	2.0	4.0	0.0
Artillery	G	0	1	3.0	2.0	1.0
Super-Heavy Artillery	SHG	0	0	(10.0)	10.0	(10.0)
Motorized Field Artillery	TFG	0	2	4.0	3.0	4.0
Motorized Siege Artillery	TSG	0	0	2.0	5.0	2.0
Mechanized Artilery	MFG	3	3	5.0	4.0	5.0
Mechanized Siege Artillery	MSG	3	0	3.0	6.0	3.0

- The Armor represents the combination of armor and structural strength.
- Siege artillery consists of heavy guns – howitzers and heavy mortars.
- Motorized artillery consists of towed guns. Mechanized are self-propelled.

Table 9-5. Infantry and Engineer Unit Capabilities

Unit Name	Code	Armor	Anti-Aircraft Strength	Combat	Siege	Ranged	Scouting Factor
Heavy Elite Infantry	HEI	0	0	2.3	3.4	0.0	0
Infantry	I	0	0	1.5	2.3	0.0	0
Inexperienced Infantry	II	0	0	0.5	0.8	0.0	0
Light Elite Infantry	XEI	0	0	0.8	1.1	0.0	0
Light Infantry	XI	0	0	0.5	0.8	0.0	0
Motorized Infantry	TI	0	0	2.0	2.3	0.0	0
Mechanized Infantry	MI	3	1	4.0	2.5	0.0	1
Parachute Infantry	PI	0	0	0.8	1.0	0.0	0
Airmobile Infantry	AMI	0	0	3.0	1.5	3.0	2
Siege Engineers	S	0	0	0.5	4.0	0.0	0
Motorized Engineers	TS	0	0	1.0	5.0	0.0	0
Mechanized Engineers	MS	2	1	2.0	7.0	0.0	0
Battlesuit Infantry	BSI	1	1	8.0	10.0	1.0	0
Powered Armor Infantry	PSI	3	2	15.0	15.0	3.0	1

- The Armor represents the combination of armor and structural strength.
- Ranged indicates the long range Combat factor of the unit.
- Scouting Factor in the Modern Era is a function of Helicopter units offering an overview of the battlefield. It does not include the effects of radar if present.

Table 9-6. Ship Unit Capabilities

Unit Name	Code	Armor	Torpedo Attack	Anti-Aircraft Strength	Combat	Siege	Ranged	Scouting Factor
Cog	CT	0.5	0	0	(0.0)	(0.0)	(0.0)	-1
Light Transports	XT	0.5	0	0	(0.0)	(0.0)	(0.0)	-1
Light Warship	XW	0.5	0	0	0.5	0.5	0.0	-1
Nordic Longship	NRW	0.5	0	0	1.0	0.0	0.0	-1
Roman Roundship	RRT	0.5	0	0	(0.0)	(0.0)	(0.0)	-3
Trireme	RW	0.6	0	0	1	0.0	0.0	-2
Bireme	XRW	0.5	0	0	0.5	0.0	0.0	-1
Caravel	W	0.6	0	0	2.0	1.0	0.0	-2
Galleass	HRW	0.5	0	0	1.0	1.0	0.0	-2
Dromon	DW	0.5	0	0	(1.5)	(0.5)	(0.0)	-3
Carrack	CW	0.7	0	0	4.0	3.0	0.0	-2
Ship of the Line - 1st Rank	HW	4	0	0	11	11	0.0	-2
Ship of the Line - 2nd Rank	GW	4	0	0	10	10	0.0	-2
Ship of the Line - 3rd Rank	FW	4	0	0	9.0	9.0	0.0	-2
Galleon	EW	3	0	0	9.0	2.4	0.0	-2
Heavy Frigate	HFW	3	0	0	7.0	7.0	0.0	-1
Frigate	GFW	2	0	0	3.0	3.0	0.0	-1
Frigate – 6th Rank	FFW	1	0	0	1.5	1.5	0.0	-1
Frigate – 7th Rank	EFW	1	0	0	1.0	1.0	0.0	-1
Corvette	LW	1	0	0	0.5	0.5	0.0	0
Ordinary Transports	T	1	0	0	(0.0)	(0.0)	(0.0)	-1
Light Transports	XT	0.5	0	0	(0.0)	(0.0)	(0.0)	-1
Wooden Steam Battleship	XSW	4	0	0	12	24	6.0	-1
Wooden Steam Cruiser	SCW	2	0	0	6.0	16	3.0	0

Unit Name	Code	Armor	Torpedo Attack	Anti-Aircraft Strength	Combat	Siege	Ranged	Scouting Factor
Wooden Steam Transport	ST	1	0	0	(0.0)	(0.0)	(0.0)	0
Gunboat	GB	1	0	0	1.0	0.6	0.5	1
Ironclad Cruiser	SFW	9	0	1	12	20	12	0
Steel Hulled Battleship	HSW	12	0	0	16	30	12	-1
Ironclad Battleship	SW	10	0	0	16	30	12	-1
Metal Hulled Transport	MT	1	0	0.6	(0.0)	(0.0)	(0.0)	0
Battleship	BW	16	0	2	24	36	24	0
Armored Cruiser	AC	12	1	2	20	32	20	0
Protected Cruiser	PC	6	1	1	16	20	16	0
Steel Transport	MS	2	0	0.7	(0.0)	(0.0)	(0.0)	0
Airship Carrier	ACW	2	0	0.7	0.0	0.0	0.0	1
Torpedo Boat Destroyer	TBD	2	3	1	4.0	1.0	4.0	1
Torpedo Boat	XTB	2	3	1	2.0	0.8	2.0	1
Submersible	SB	1	8	0.6	1.0	0.0	0.0	0
Modern Merchantship	MM	2	0	0.7	(0.0)	(0.0)	(0.0)	0
Modern Battleship	BB	24	0	5	48	36	48	0
Battlecruiser	BC	20	0	4	40	32	40	1
Heavy Cruiser	CA	16	8	3	30	24	30	0
Light Cruiser	CL	12	8	2	20	20	20	1
Anti-aircraft Cruiser	CLA	12	6	5	16	15	16	1
Destroyer	DD	6	6	1	8.0	10	8.0	1
Destroyer Escort	DE	4	4	1	6.0	8.0	6.0	1
Modern Corvette	CE	2	0	1	4.0	6.0	4.0	1
Submarine	SS	2	12	0.7	2.0	0.0	0.0	1
Strategic Submarine	SSB	2	12	0.7	2.0	0.0	0.0	0
Aircraft Carrier	CV	14	0	3	16	0.0	16	6
Light Carrier	CVL	10	0	2	8.0	0.0	8.0	5
Escort Carrier	CVE	6	0	1	4.0	0.0	4.0	4
Battle Carrier	CAB	24	0	5	25	0.0	16	6
Fleet Carrier	CVA	15	0	4	26	0.0	20	7
Attack Cargo Ship	LKA	2	0	1	(4.0)	(2.0)	(0.0)	0
Amphibious Assault Ship	LPH	12	0	2	(8.0)	(4.0)	(6.0)	1
Cargo Submarine	SUT	12	10	0.0	1.5	0.0	0.0	0
Icebreaker	ICE	14	0	0.0	(1.0)	0.0	0.0	0
Strategic Submarine	SSB	14	12	0.8	2.0	0.0	0.0	1
Nuclear Submarine	NSB	16	14	1.0	3.0	0.0	0.0	2
Nuclear Carrier	NCV	18	0	8	30	0.0	30	8
Nuclear Icebreaker	NCE	20	0	1	(5.0)	0.0	0.0	2
Hunter-Killer Submarine	NKS	16	20	2.0	4.0	0.0	2.0	3

- The Armor represents the combination of armor, structural strength, compartmentalization, damage control, etc., as it applies to gunnery, torpedoes and bombing.
- The Torpedo Attack Factor is gained with the completion of the **R&D: Torpedoes** project
- Scouting Factor in the Modern Era is a function of shipboard aviation (scout planes) which all ships of cruiser class and above are assumed to possess. Aircraft Carriers are assumed to possess one or more scout planes or to devote one or more of their attack plane compliment to scouting duties. It does not include the effects of radar if present.
- Ranged indicates the long range Combat factor of the unit.

Table 9-7. Mechanized Unit Capabilities

Unit Name	Code	Armor	Anti-Aircraft Strength	Combat	Siege	Ranged	Scouting Factor
Light Tank	AFX	3	1	2.0	0.5	2.0	1
Medium Tank	AFV	5	2	4.0	1.0	4.0	0
Heavy Tank	AFH	7	3	8.0	1.5	8.0	0
Battle Tank	AFB	10	4	12.0	2.0	12.0	0
Mechanized Artilery	MFA	3	3	5.0	4.0	5.0	0
Mechanized Siege Artillery	MSG	3	0	3.0	6.0	3.0	0
Mechanized Infantry	MI	3	1	4.0	2.5	0.0	1
Mechanized Engineers	MS	2	1	2.0	7.0	0.0	0
Lunar Crawler	LCR	5	1	2.0	2.0	0.0	0
Cybernetic AFV	CVF	20	5	15.0	5.0	20.0	0

- The Armor represents the combination of armor and structural strength.
- Ranged indicates the long range Combat factor of the unit.

Table 9-8. Airship, Aircraft & Trans-Atmospheric Unit Capabilities

Unit Name	Code	Combat	Siege	Scouting Factor
Draken	D	0.0	0.0	0.5
Airship	Z	3.0	3.0	1
Scout Airship	ZS	1.0	0.0	2
Heavy (Bomber) Airship	ZH	6.0	9.0	0
Transport Airship	ZT	(1.0)	(0.0)	1
Biplane Fighter	BF	1.0	0.1	1
Biplane Bomber	BIB	(1.0)	1.5	1
Biplane Cargo Transport	BIT	(1.0)	-	1
Biplane Carrier Fighter	BCF	1.0	-	1
Biplane Carrier Bomber	BCB	(1.0)	1.0	1
Fighter	AF	2.0	1.0	2
Bomber	AB	(2.0)	3.0	1
Cargo Transport	ACT	(1.0)	-	2
Carrier Fighter	CVF	1.5	0.1	2
Carrier Bomber	CVB	(1.5)	2.0	1
Heavy Bomber	AHB	(3.0)	6.0	1
Jet Fighter	JAF	4.0	1.0	3
Jet Bomber	JAB	(4.0)	5.0	2
Jet Cargo Transport	JCT	(2.0)	--	3
Jet Carrier Fighter	JCF	3.0	1.0	3
Jet Carrier Bomber	JCB	(3.0)	4.0	2
Jet Heavy Bomber	JHB	(6.0)	10.0	2
Rocketplane	RPR	(3.0)	-	5
Aero-Spaceplane	APR	(3.0)	-	4
Space Shuttle	SPT	(3.0)	-	3
Heavy Shuttle	SHT	(3.0)	-	3
Spaceplane	SPL	2.0	2.0	3
Heavy Spaceplane	HPL	1.5	3.0	3
Trans-atmospheric Fighter	SPF	20.0	5.0	4
Trans-atmospheric Heavy Fighter	SPH	15.0	15.0	4
Cybernetic Autonomous Fighter	CPF	25.0	5.0	4
Stratospheric Aerostat	AER	2.0	2.0	5

- Scouting Factor is the function of airships or aircraft offering an overview of the battlefield. It does not include the effects of radar if present.

Table 9-9. ABMs and Exotic Unit Capabilities

Unit Name	Code	Combat	Siege	Ranged
Anti-Ballistic Missile	ABM	10.0	-	10.0
Neutron Warhead ABM	ANM	25.0	-	25.0
Advanced ABM	AXM	10.0	-	10.0
Space Based Laser	SBL	10.0	12.0	5.0
Kinetic Energy Weapon	KEW	(5.0)	25	5.0
Orbital Coil Gun	OCG	10.0	5.0	10.0
ABM Lasers	GBL	10.0	12.0	10.0
Advanced SBL	ABL	40.0	20.0	10.0
Local Space Defense	LSD	5.0	5.0	0.0

Table 9-10. Rocket and Missile Unit Capabilities

Unit Name	Code	Combat	Siege	Nuclear Capable	Space Port
Single-Stage Rocket	SSR	(1.0)	5.0	No	No
Dual-Stage Rocket	DSR	(2.0)	10.0	Yes	Yes
Multistage Rocket	MSR	(2.0)	15.0	Yes	Yes
Heavy Lift Rocket	HLR	(1.0)	20.0	Yes	Yes
Nuclear Pulse Rocket	NPR	(1.0)	20.0	Yes	Yes
Single Stage to Orbit Rocket	SSO	(2.0)	-	No	Yes
Sub-Orbital Dropship	SDR	5.0	-	No	No
Laser Rocket	LRR	-	-	No	Yes
ICBM	ICM	(2.0/20)	100	Yes	No
SLBM	SLM	(2.0)	100	Yes	No
MIRV	MRV	(5.0/30)	4*100	Yes	No
Tactical Ballistic Missile	TBM	4.0	50/2.0	Yes	No
Cruise Missile	CRM	(1.0)	75.0	Yes	No

Table 9-11. Space Capsules and Vehicles

Unit Name	Code	Combat	Siege	Ranged
Manned Space Capsule	SMR	(2.0)	-	0
Manned Orbital Capsule	SOR	(2.0)	-	0
Space Tug	STG	(2.0)	-	0
Lunar Lander	SLL	(2.0)	-	0
Heavy Lunar Lander	SHL	2.0	1.0	1
Battlespace Fighter	SBF	10.0	10.0	10
Cybernetic Battlespace Fighter	CBF	20.0	10.0	10
Asteroid Lander	ALL	(2.0)	2.0	0
Asteroid Mining Vehicle	AMV	(4.0)	2.0	1
Nuclear Thermal Miner	DNT	(10.0)	(12.0)	50
Nuclear Electric Miner	DNE	(10.0)	(12.0)	20
Magnetic Nuclear Pulse Miner	DNP	(10.0)	(12.0)	60
Solar Electric Miner	DSE	(5.0)	(12.0)	10
Cybernetic Nuclear Thermal Miner	CNT	(10.0)	(5.0)	50
Cybernetic Nuclear Electric Miner	CNE	(10.0)	(5.0)	20
Cybernetic Magnetic Nuclear Pulse Miner	CNP	(10.0)	(5.0)	60
CyberneticSolar Electric Miner	CSE	(5.0)	(5.0)	10
Nuclear Thermal Spacecraft	SNT	(3.0)	(2.0)	50
Robot Nuclear Thermal Spacecraft	RNT	(3.0)	(0.0)	50
Muclear Electric Spacecraft	SNE	(3.0)	(2.0)	20
Robot Nuclear Electric Spacecraft	RNE	(3.0)	(0.0)	20
Magnetic Nuclear Pulse Spacecraft	SNP	(3.0)	(2.0)	60
Robot Magnetic Nuclear Pulse Spacecraft	RNE	(3.0)	(0.0)	60
Solar Electric Spacecraft	SSE	(1.0)	(1.0)	10
Robor Solar Electric Spacecraft	RSE	(0.0)	(0.0)	10
Nuclear Thermal Space Cruiser	WNT	40.0	30.0	50
Magnetic Nuclear Pulse Space Cruiser	WNP	60.0	30.0	60

Table 9-12. Unit Class and Effects

Unit Name	Code	Weight
Cog	CT	M
Light Transports	XT	XX
Light Warship	XW	XX
Caravel	W	M
Galleass	HRW	M
Dromon	DW	M
Carrack	CW	M
Ordinary Transports	T	M
Ship of the Line - 1st Rank	HW	H
Ship of the Line - 2nd Rank	GW	H
Ship of the Line - 3rd Rank	FW	M
Galleon	EW	M
Frigate	GFW	X
Frigate – 6th Rank	FFW	X
Frigate – 7th Rank	EFW	X
Corvette	LW	XX
Heavy Frigate	HFW	M
Wooden Steam Battleship	XSW	H
Wooden Steam Cruiser	SCW	M
Wooden Steam Transport	ST	M
Gunboat	GB	XX
Ironclad Cruiser	SFW	M
Steel Hulled Battleship	HSW	H
Ironclad Battleship	SW	H
Metal Hulled Transport	MT	M
Battleship	BW	H
Armored Cruiser	AC	M
Protected Cruiser	PC	M
Steel Transport	MS	M
Airship Carrier	ACW	H
Torpedo Boat Destroyer	TBD	X
Torpedo Boat	XTB	XX
Submersible	SB	X
Modern Merchantship	MM	M
Modern Battleship	BB	H

Unit Name	Code	Weight
Battlecruiser	BC	H
Heavy Cruiser	CA	H
Light Cruiser	CL	M
Anti-aircraft Cruiser	CLA	M
Destroyer	DD	X
Destroyer Escort	DE	M
Modern Corvette	CE	M
Submarine	SS	M
Strategic Submarine	SSB	H
Aircraft Carrier	CV	H
Light Carrier	CVL	M
Escort Carrier	CVE	M
Battle Carrier	CAB	H
Fleet Carrier	CVA	HH
Attack Cargo Ship	LKA	M
Amphibious Assault Ship	LPH	H
Cargo Submarine	SUT	M
Icebreaker	ICE	H
Strategic Submarine	SSB	H
Nuclear Submarine	NSB	HH
Nuclear Carrier	NCV	HH
Nuclear Icebreaker	NCE	HH
Hunter-Killer Submarine	NKS	M

Weight Classification	Code
Super-Light	XX
Light	X
Medium	M
Heavy	H

Weight Classification	Code
Super-Heavy	HH

Notes:

- **Riverine Traffic**: Only "XX" and "X" class ships can move up Rivers. This includes Transports assigned to inter-nation or inter-city trade.
- **Canals**: Only "XX", "X" and "M" class ships may pass through the Lower Nile/Nile Canal sea zone between Gulf of Cyprus and Red Sea and the Panama Canal in Guayami between Gulf of Venezuela and Sea of Panama.
- **The Panama Canal Upgrade**: To allow the passage of "H" and "HH" class ships through the Panama Canal, it must be substantially upgraded to larger locks, deeper drafts in the channel bottoms and so on. This is a level three (3) Megalithic Project, during which time the Canal is closed to all traffic.
- **The Queta Canal Upgrade**: To allow the passage of "H" and "HH" class ships through the Queta Canal, it must be substantially upgraded to larger locks, deeper drafts in the channel bottoms and so on. This is a level two (2) Megalithic Project, during which time the Canal is closed to all traffic.
- **The Suez Canal**: The Suez Canal can carry all kinds of ship traffic.

Table 9-13. 24 AP Renaissance Action Chart

AP	J	F	M	A	M	J	J	A	S	O	N	D
1							X					
2						X	X					
3					X	X	X					
4					X	X	X	X				
5				X	X	X	X	X				
6				X	X	X	X	X	X			
7			X	X	X	X	X	X	X			
8			X	X	X	X	X	X	X	X		
9			X	X	X	X	X	X	X	X	X	
10		X	X	X	X	X	X	X	X	X	X	
11		X	X	X	X	X	X	X	X	X	X	X
12	X	X	X	X	X	X	X	X	X	X	X	X
13	X	X	X	X	X	X	X	X	X	X	X	X
14	X	X	X	X	X	X	X	X	X	X	X	X
15	X	X	X	X	X	X	X	X	X	X	X	X
16	X	X	X	X	X	X	X	X	X	X	X	X
17	X	X	X	X	X	X	X	X	X	X	X	X
18	X	X	X	X	X	X	X	X	X	X	X	X
19	X	X	X	X	X	X	X	X	X	X	X	X
20	X	X	X	X	X	X	X	X	X	X	X	X
21	X	X	X	X	X	X	X	X	X	X	X	X
22	X	X	X	X	X	X	X	X	X	X	X	X
23	X	X	X	X	X	X	X	X	X	X	X	X
24	X	X	X	X	X	X	X	X	X	X	X	X

Table 9-14. 48AP Renaissance and Early Industrial Action Chart

AP	J			F			M			A			M			J			J			A			S			O			N			D		
1																			X																		
2																X			X																		
3													X			X			X																		
4													X			X			X			X															
5										X			X			X			X			X															
6										X			X			X			X			X			X												
7							X			X			X			X			X			X			X												
8							X			X			X			X			X			X			X			X									
9							X			X			X			X			X			X			X			X			X						
10				X			X			X			X			X			X			X			X			X			X						
11				X			X			X			X			X			X			X			X			X			X			X			
12	X			X			X			X			X			X			X			X			X			X			X			X			
13	X			X			X			X			X			X		X	X			X			X			X			X			X			
14	X			X			X			X			X		X	X		X	X			X			X			X			X			X			
15	X			X			X			X			X		X	X		X	X		X			X			X			X			X			
16	X			X			X			X		X	X		X	X		X	X		X	X		X			X			X			X			
17	X			X			X			X		X	X		X	X		X	X		X	X	X	X			X			X			X			
18	X			X			X		X	X		X	X		X	X		X	X		X	X		X			X			X			X			
19	X			X			X		X	X		X	X		X	X		X	X		X	X		X		X	X			X			X			
20	X			X		X	X		X	X		X	X		X	X		X	X		X	X		X		X	X			X			X			
21	X			X		X	X		X	X		X	X		X	X		X	X		X	X		X		X	X		X	X			X			
22	X		X	X		X	X		X	X		X	X		X	X		X	X		X	X		X		X	X		X	X			X			
23	X		X	X		X	X		X	X		X	X		X	X		X	X		X	X		X		X	X		X	X		X	X			
24	X		X	X		X	X		X	X		X	X		X	X		X	X		X	X		X		X	X		X	X		X	X		X	
25	X		X	X		X	X		X	X		X	X		X	X		X	X	X	X	X		X		X	X		X	X		X	X		X	
26	X		X	X		X	X		X	X		X	X		X	X	X	X	X	X	X	X		X		X	X		X	X		X	X		X	
27	X		X	X		X	X		X	X		X	X		X	X	X	X	X	X	X	X		X		X	X		X	X		X	X		X	
28	X		X	X		X	X		X	X		X	X		X	X	X	X	X	X	X	X		X		X	X		X	X		X	X		X	
29	X		X	X		X	X		X	X		X	X		X	X	X	X	X	X	X	X	X	X		X	X		X	X		X	X		X	
30	X		X	X		X	X		X	X		X	X		X	X	X	X	X	X	X	X	X	X		X	X		X	X		X	X		X	
31	X		X	X		X	X		X	X		X	X		X	X	X	X	X	X	X	X	X	X	X	X	X		X	X		X	X		X	
32	X		X	X		X	X		X	X		X	X		X	X	X	X	X	X	X	X	X	X	X	X	X		X	X		X	X		X	
33	X		X	X		X	X		X	X		X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X		X	
34	X		X	X		X	X		X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X		X	
35	X		X	X		X	X		X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X		X	
36	X		X	X		X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X		X	
37	X		X	X		X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	
38	X		X	X		X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	
39	X		X	X		X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	
40	X		X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	
41	X		X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	
42	X		X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	
43	X		X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	
44	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	
45	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	
46	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	
47	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X
48	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X

Table 9-15. 60AP Industrial Action Chart (Partial)

AP	M						J					J						A				
1												X										
2							X					X										
3	X						X					X										
4	X						X					X						X				
5	X						X					X						X				
6	X						X					X						X				
7	X						X					X						X				
8	X						X					X						X				
9	X						X					X						X				
10	X						X					X						X				
11	X						X					X						X				
12	X						X					X						X				
13	X						X			X		X						X				
14	X			X			X			X		X						X				
15	X			X			X			X		X			X			X				
16	X			X			X			X		X			X			X				
17	X			X			X			X		X			X			X			X	
18	X			X			X			X		X			X			X			X	
19	X			X			X			X		X			X			X			X	
20	X			X			X			X		X			X			X			X	
21	X			X			X			X		X			X			X			X	
22	X			X			X			X		X			X			X			X	
23	X			X			X			X		X			X			X			X	
24	X			X			X			X		X			X			X			X	
25	X			X			X			X		X		X	X			X			X	
26	X			X			X			X		X		X	X			X			X	
27	X			X			X			X		X		X	X		X	X			X	
28	X			X			X		X	X		X		X	X		X	X			X	
29	X			X			X		X	X		X		X	X		X	X		X	X	
30	X			X		X	X		X	X		X		X	X		X	X		X	X	
31	X			X		X	X		X	X		X		X	X		X	X		X	X	X
32	X		X	X		X	X		X	X		X		X	X		X	X		X	X	X
33	X		X	X		X	X		X	X		X		X	X		X	X		X	X	X
34	X		X	X		X	X		X	X		X		X	X		X	X		X	X	X
35	X		X	X		X	X		X	X		X		X	X		X	X		X	X	X
36	X		X	X		X	X		X	X		X		X	X		X	X		X	X	X
37	X		X	X		X	X		X	X		X		X	X		X	X		X	X	X
38	X		X	X		X	X		X	X		X		X	X		X	X		X	X	X
39	X		X	X		X	X		X	X		X		X	X		X	X		X	X	X
40	X		X	X		X	X		X	X		X		X	X		X	X		X	X	X
41	X		X	X		X	X		X	X		X		X	X		X	X		X	X	X
42	X		X	X		X	X		X	X		X		X	X		X	X		X	X	X
43	X		X	X		X	X		X	X		X		X	X		X	X		X	X	X
44	X		X	X		X	X		X	X		X		X	X		X	X		X	X	X
45	X		X	X		X	X		X	X		X		X	X		X	X		X	X	X
46	X		X	X		X	X		X	X		X		X	X		X	X		X	X	X
47	X		X	X		X	X		X	X		X		X	X		X	X		X	X	X
48	X		X	X		X	X		X	X		X		X	X		X	X		X	X	X
49	X		X	X		X	X		X	X		X	X	X	X		X	X		X	X	X
50	X		X	X		X	X		X	X	X	X	X	X	X		X	X		X	X	X
51	X		X	X		X	X		X	X	X	X	X	X	X		X	X		X	X	X
52	X		X	X		X	X		X	X	X	X	X	X	X	X	X	X		X	X	X
53	X		X	X		X	X		X	X	X	X	X	X	X	X	X	X		X	X	X
54	X		X	X		X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X
55	X		X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
56	X		X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
57	X		X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
58	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
59	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
60	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

For clarity only the May to the end of August portion of the 60AP Action Chart is shown above.

(end of c:\documents and settings\martin helsdon\my documents\rulebooks\lote_fut_6.doc)