

# Liftoff Mars Landing Variant

## Introduction

The original game of Liftoff! described the race to get a man on the moon. This variant asks the question, “What if the goal were to get a man on Mars?” In addition to the new programs and missions necessary to support this, these rules also address the primary difference between a manned Mars mission and a manned Lunar mission: time. The Apollo missions did not really take long from launch to splashdown. It took 3 days each way to get there, and the Astronauts spent anywhere from a couple of hours to a couple of days on the moon, so we are talking 6 to 8 days per mission. Mars is an entirely different matter. Using a low energy orbit, it would take nine months for the capsule to arrive at Mars. They would then have to remain there for 13 months until the next launch window occurs, then face another nine month trip back – a total of 31 months. Such a huge difference in mission lengths demands new rules to cover them.

Note: This variant will take significantly longer to play than the original.

## Turn Sequence

The turn sequence for this variant remains largely unchanged from the original. There are two primary differences: Astronaut Retirement and Continuing Missions. Astronaut Retirement is checked immediately after cards are drawn. Continuing Missions are resolved after mission announcement and before new launches. They are resolved in the order of their original launch.

## Astronaut Retirement

The added duration of this variant means that some astronauts will retire out of the system. The chance of this happening is equal to one fifth the current experience level of the astronaut. Thus, an astronaut with a 10% experience level has a 2% chance of retiring in a given year, while one with the maximum level of 70% has a 14% chance of retiring. Astronaut retirement has no impact on the ability to recruit new astronauts or on the budget.

## Launch Windows

Missions to Mars and the outer planets can only be launched at specific times, depending on the type of propulsion. The standard direct mission can only be launched in even-numbered years and may not be rushed. Missions via Venus can be launched during any year but also may not be rushed. NERVA-based missions may be launched in any year and may be rushed, but each month of rushing increases outbound and homebound travel time by 3 months, and time on Mars by 1 month. Thus, if you rush a NERVA mission by one month, it adds a total of 7 months to the mission. Solar sail and ion drive missions can likewise be launched in any year, and can be rushed. Each month of rushing increases outbound and homebound travel time by 1 month. Thus, rushing by one month increases travel time by 2 months. These numbers apply also in the event that a mission is cut short due to some failure. If the NERVA mission is cut short, the homebound leg is 3 months longer for every month early the crew leaves Mars, and solar sail and ion drive missions spend one extra month on the return trip for every month early they leave.

Outer planet missions also have launch windows. Launches to a single outer planet can be launched at any time and may be rushed up to 1 month. Launches both to Jupiter and Saturn can be made every third year (1960, 1963, etc.) and also may be rushed by up to one month. A “grand tour” of all four outer planets can only be launched in 1977, and may not be rushed, unless it includes an ion drive. In that case, it can be launched in any year evenly divisible by 5, and it may be rushed by up to 1 month.

## Launching Missions from Space Stations

Certain missions may be constructed and launched from a space station. These include most manned Mars missions, and all manned Lunar missions. The only Mars mission that may not be launched from a space station is a NERVA-based mission, due to the radiation danger to the space station. To launch from a space station, all mission components and crew must be launched to the space station, the components must be assembled in orbit, and the crew transferred to the vehicle. When the mission returns from its destination, the crew must then be returned to Earth. Each equipment or crew launch is a separate mission, which must include rendezvous with the space station and can include an assembly step. Such a mission will look like the Station Resupply mission, with the Resupply step replaced by the Assembly step.

## Mission Budget Effects Chart

<u>Mission Type</u>	<u>First Nation Bonus</u>	<u>Second Nation Bonus</u>	<u>Third Nation Bonus</u>	<u>Subsequent Mission Bonus</u>	<u>Failed Mission Penalty</u>
Orbital Satellite	+16	+10	+6	+2	-3
Manned Space Mission	+24	+12	+6	+2	-10

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Manned Orbital	+16	+10	+6	+2	-10
Manned Docking	+11	+7	+4	+1	-2
Space Walk	+11	+7	+4	+1	-2
International Docking (each)	+12	+6	+4	+2	-4
Two-Person Craft	+10	+4	+2	0	-10
Three-Person Craft	+20	+10	+5	0	-10
Four-Person Craft	+30	+16	+10	0	-10
Five-Person Craft	+40	+24	+15	0	-10
Six-Person Craft	+50	+32	+20	0	-10
Re-Usable Shuttle	+30	+16	+10	+4	-10
International Crew (each)	+12	+6	+4	+2	-4
Space Station	+40	+24	+15	0	-10
Space Construction	+11	+7	+4	+1	-2
Medium Term Mission (3 months)	+20	+14	+7	+2	-10
Long Term Mission (6+ months)	+30	+20	+10	+4	-10
Solar Sail	+12	+8	+4	+2	-3
Ion Drive	+12	+8	+4	+2	-3
NERVA Drive	+18	+9	+6	+2	-5
Lunar Fly-by	+6	+4	+3	+2	-3
Mars Fly-by	+8	+6	+4	+2	-3
Venus Fly-by	+8	+6	+4	+2	-3
Jupiter Fly-by	+12	+8	+6	+3	-4
Saturn Fly-by	+12	+8	+6	+3	-4
Uranus Fly-by	+16	+12	+8	+4	-5
Neptune Fly-by	+16	+12	+8	+4	-5
Manned Lunar Pass	+15	+7	+3	+1	-10
Manned Lunar Orbit	+30	+14	+10	+4	-10
Manned Lunar Landing	+45	+21	+15	+6	-10
Lunar Probe Landing	+20	+12	+8	+4	-6
Mars Probe Landing	+30	+18	+12	+6	-8
Rescue Attempt	+12	+12	+12	+12	+8

## Additional Cards

<b>Minor Problem</b>	<b>Minor Problem</b>	<b>Minor Problem</b>																								
There is a minor problem in your Space Station program. Pay 10 or lose 3% on the safety factor of the space station for its next mission.	There is a minor problem in your most advanced Mars Lander. Pay 10 or lose 3% on the safety factor of the space station for its next mission.	There is a minor problem in your most advanced Habitation Module. Pay 10 or lose 3% on the safety factor of the space station for its next mission.																								
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<p align="center"><b>Scientific Breakthrough</b></p> <p>There has been a major scientific breakthrough on your Space Station program. Roll 6 dice and add the result to the safety factor of that program (but not going beyond the Max R&amp;D limit).</p> <table border="1" style="width:100%; text-align:center;"> <tr> <td><i>0-50</i></td> <td><i>51-100</i></td> <td><i>101-150</i></td> <td><i>150+</i></td> </tr> <tr> <td>+15</td> <td>+10</td> <td>+1</td> <td>-20</td> </tr> </table>	<i>0-50</i>	<i>51-100</i>	<i>101-150</i>	<i>150+</i>	+15	+10	+1	-20	<p align="center"><b>Scientific Breakthrough</b></p> <p>There has been a major scientific breakthrough on your most advanced Mars Lander. Roll 6 dice and add the result to the safety factor of that program (but not going beyond the Max R&amp;D limit).</p> <table border="1" style="width:100%; text-align:center;"> <tr> <td><i>0-50</i></td> <td><i>51-100</i></td> <td><i>101-150</i></td> <td><i>150+</i></td> </tr> <tr> <td>+30</td> <td>+7</td> <td>-7</td> <td>-10</td> </tr> </table>	<i>0-50</i>	<i>51-100</i>	<i>101-150</i>	<i>150+</i>	+30	+7	-7	-10	<p align="center"><b>Scientific Breakthrough</b></p> <p>There has been a major scientific breakthrough on your most advanced Habitation Module. Roll 6 dice and add the result to the safety factor of that program (but not going beyond the Max R&amp;D limit).</p> <table border="1" style="width:100%; text-align:center;"> <tr> <td><i>0-50</i></td> <td><i>51-100</i></td> <td><i>101-150</i></td> <td><i>150+</i></td> </tr> <tr> <td>+25</td> <td>+10</td> <td>-5</td> <td>-15</td> </tr> </table>	<i>0-50</i>	<i>51-100</i>	<i>101-150</i>	<i>150+</i>	+25	+10	-5	-15
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<p align="center"><b>Program Setback</b></p> <p>Subtract 10% from the safety factor of your most advanced Habitation Module and from the safety factor of your most advanced Mars Lander.</p> <table border="1" style="width:100%; text-align:center;"> <tr> <td><i>0-50</i></td> <td><i>51-100</i></td> <td><i>101-150</i></td> <td><i>150+</i></td> </tr> <tr> <td>+15</td> <td>+1</td> <td>-10</td> <td>-3</td> </tr> </table>	<i>0-50</i>	<i>51-100</i>	<i>101-150</i>	<i>150+</i>	+15	+1	-10	-3	<p align="center"><b>Fortunate Accident</b></p> <p>A fortunate accident has allowed you to forsee a problem in your most advanced Habitation Module program. Save this card to counter your next Habitation Module failure.</p> <table border="1" style="width:100%; text-align:center;"> <tr> <td><i>0-50</i></td> <td><i>51-100</i></td> <td><i>101-150</i></td> <td><i>150+</i></td> </tr> <tr> <td>+20</td> <td>+3</td> <td>+1</td> <td>-15</td> </tr> </table>	<i>0-50</i>	<i>51-100</i>	<i>101-150</i>	<i>150+</i>	+20	+3	+1	-15	<p align="center"><b>Fortunate Accident</b></p> <p>A fortunate accident has allowed you to forsee a problem in your most advanced Mars Lander program. Save this card to counter your next Habitation Module failure.</p> <table border="1" style="width:100%; text-align:center;"> <tr> <td><i>0-50</i></td> <td><i>51-100</i></td> <td><i>101-150</i></td> <td><i>150+</i></td> </tr> <tr> <td>+25</td> <td>+7</td> <td>+5</td> <td>-10</td> </tr> </table>	<i>0-50</i>	<i>51-100</i>	<i>101-150</i>	<i>150+</i>	+25	+7	+5	-10
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<p align="center"><b>Severe Setback</b></p> <p>Your space program has suffered a severe setback in its most advanced habitation module program. Pay MB's equal to 6 R&amp;D rolls on that program or the habitation module will lose 10% on its safety factor for its next mission.</p> <table border="1" style="width:100%; text-align:center;"> <tr> <td><i>0-50</i></td> <td><i>51-100</i></td> <td><i>101-150</i></td> <td><i>150+</i></td> </tr> <tr> <td>+30</td> <td>+3</td> <td>-7</td> <td>-15</td> </tr> </table>	<i>0-50</i>	<i>51-100</i>	<i>101-150</i>	<i>150+</i>	+30	+3	-7	-15	<p align="center"><b>Production Delay</b></p> <p>The prime contractor for your habitation module and space station programs will not be able to deliver any modules or space stations this year. You may not purchase any habitation modules or space stations this year.</p> <table border="1" style="width:100%; text-align:center;"> <tr> <td><i>0-50</i></td> <td><i>51-100</i></td> <td><i>101-150</i></td> <td><i>150+</i></td> </tr> <tr> <td>+30</td> <td>+1</td> <td>-5</td> <td>-20</td> </tr> </table>	<i>0-50</i>	<i>51-100</i>	<i>101-150</i>	<i>150+</i>	+30	+1	-5	-20	<p align="center"><b>Government Order</b></p> <p>Your nation's highest official demands that you launch a manned space station within the next three years. Increase your budget by 30MB's to reflect the additional support.</p>								
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<b>Government Order</b>	<b>Corporate Investment</b>
Your nation's highest official demands that you will put a man on Mars within the next six years. Increase your budget by 50MB's to reflect the additional support.	Several major corporations want to do research in microgravity. If you have a space station, receive +5MB to your budget for each 3-person capacity of the space station due to corporate leases. If you do not have a space station, but another player does, lose -5MB from your budget to reflect the fact that the investment is going overseas. If no one has a space station, you may buy the program, any equipment, and research at half cost this year, but your budget is unchanged.

## Research and Development Worksheet

Program	Initial Cost	Unit Cost	Unit Weight	Max Payload	Initial Safety Factor	R&D Cost per Die	Max R&D	Max Safety	Special Starting Safety
1-Orbital Satellite	6	1	300	N/A	40%	1	95%	98%	2-50%, 3-60%, 5-65%
2-Interplanetary Satellite	24	4	600	N/A	40%	3	90%	93%	1-45%, 3-50%, 5-55%
3-Lunar Probe	30	6	1200	N/A	40%	4	85%	88%	1-45%, 2-50%, 5-55%
4-Docking Module	18	2	300	N/A	45%	N/A	N/A	98%	N/A
5-Mars Probe	60	8	1500	N/A	40%	5	85%	88%	1,2-45%, 3-50%
A-One Stage Rocket	24	3	N/A	500	10%	2	85%	98%	B,C,D,G,H-35%, I-40%
B-Two Stage Rocket	60	12	N/A	1500	10%	4	90%	98%	A,D,H-25%, C,G,I-40%, (A,D,H)&(C,G,I)-65%
C-Three Stage Rocket	84	18	N/A	3200	5%	6	95%	98%	A,D,H-15%, B,G,I-35%, (A,D,H)&(B,G,I)-60%
D-Liquid Fuel Strap-ons	12	3	N/A	1000	10%	2	85%	98%	A,B,C,G,H-30%
F-Kicker	12	3	300	N/A	10%	1	95%	98%	A,B,C,D,G,H,I-25%
G-"Mega" Stage Rocket	150	30	N/A	4800	5%	7	95%	98%	A,D,H-10%, B,C,I-25%, (A,D,H)&(B,C,I)-35%
H-Solid Rocket Boosters	18	5	N/A	2000	5%	4	80%	95%	A,B,C,D,F,G-25%
I-NERVA Rocket	180	25	N/A	6000	5%	10	80%	90%	C-10%, G-15%
J-Ion Engine	90	20	800	N/A	5%	7	85%	98%	F-10%
K-Solar Sail	30	4	200	N/A	10%	3	95%	98%	N/A
EVA Suits	18	N/A	N/A	N/A	30%	1	98%	98%	N/A
a-One Person Capsule	18	2	500	N/A	10%	1	80%	93%	b,c,h,i,j,k-40%
b-Two Person Capsule	24	6	700	N/A	10%	2	85%	98%	a-20%, c,h,i,j,k-40%
c-Three Person Capsule	36	12	1300	N/A	10%	5	90%	98%	a-20%, b-30%, a&b,h,i,j,k-40%
d-Two Person Module	30	8	1500	N/A	10%	2	90%	98%	e-30%, h,n,o-40%
e-One Person Module	42	8	700	N/A	10%	4	90%	98%	d-30%, h,n,o-40%
f-Three Person Minishuttle	60	30	1000	N/A	5%	7	95%	98%	m-40%
h-Four Person Cap/Module	60	30	4300	N/A	5%	7	90%	98%	a-10%, b-15%, c,i,j,k-25%, (a,b,c,i,j,k)&(d,e,n,o)-35%

Program	Initial Cost	Unit Cost	Unit Weight	Max Payload	Initial Safety Factor	R&D Cost per Die	Max R&D	Max Safety	Special Starting Safety
i-Three Person Space Station	75	20	3000	N/A	5%	8	80%	98%	c-10%, h-20%, j,k-25%
j-Three Person Habitation Module	90	30	2000	N/A	10%	4	85%	98%	a-15%, b-20%, c,h,i-25%, k-40%
k-Five Person Habitation Module	120	40	4000	N/A	10%	4	90%	98%	a-15%, b-20%, c,h,i,j-30%
l-Five Person Reentry Capsule	48	12	1200	N/A	10%	5	90%	98%	a-15%, b-20%, c,h,i,j-30%, k-40%
m-Six Person Shuttle	120	60	2500	N/A	5%	10	95%	98%	f-20%
n-Two Person Mars Lander	50	10	2000	N/A	10%	5	90%	98%	d,e-20%, h,n-40%
o-Three Person Mars Lander	60	10	3000	N/A	10%	4	90%	98%	d,e-20%, m-30%, h-40%
p-Habitation Extender	30	3	200	N/A	N/A	N/A	N/A	N/A	N/A
Photo Recon	N/A	N/A	N/A	N/A	65%	N/A	N/A	100%	N/A
2 <sup>nd</sup> Launch Facility	30	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3 <sup>rd</sup> Launch Facility	30	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4 <sup>th</sup> Launch Facility	30	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5 <sup>th</sup> Launch Facility	30	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6 <sup>th</sup> Launch Facility	30	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Astronaut & Training	18	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Human Hibernation	100	10	50	N/A	5%	10	90%	98%	N/A
Space Construction	20	N/A	N/A	N/A	55%	N/A	N/A	100%	N/A

## Programs and Hardware

2) Interplanetary Satellite. In addition to the missions listed in the basic rules, interplanetary satellites are also used for the outer planet missions.

5) Mars Probe. The unit weight of a Mars probe is 1500, so it requires at least a two stage rocket (max payload 1500) to launch one in a mission (note that a one stage rocket with liquid- or solid-fule strap-ons could lift the Mars probe, but a one stage rocket may not be used on Mars missions). The only mission the Mars probe can be used on is the Mars Probe Landing.

H) Solid Rocket Boosters. Solid rocket boosters can be used in conjunction with rocket programs A, B, C, G, and I to increase lift capacity by 2000 weight units. They are more powerful, but also more tempermental, than liquid fuel strap-ons.

I) NERVA Rocket. NERVA rockets are powerful, restartable rocket motors based around a nuclear reactor core. They may be used both as a launch rocket as well as as a Kicker on any

manned mission. Any NERVA failure roll is made on a special failure table. NERVA rockets can shorten the duration of manned interplanetary missions, but the safety factor of the NERVA rocket must be rolled against during every Interplanetary In-Route Activities step. NERVA rockets may be launched on orbital missions for testing purposes.

J) Ion Engine. An ion engine is a special low-thrust, high-efficiency engine that can run continuously during a mission. They can be used during any Mars or outer planet mission. When used, it reduces the transit time as indicated on the mission steps chart, but the safety factor must be rolled against during every Interplanetary In-Route Activities step. Ion engines may be used on orbital missions for testing purposes.

K) Solar Sail. A solar sail is a large, light mirror structure that allows a craft to be propelled by sunlight. It provides a low thrust with no energy expenditure – only steering is necessary. It can be used on any manned interplanetary mission to reduce

the mission duration, but the safety factor must be rolled against during every Interplanetary In-Route Activities step. Due to its dependence on sunlight, solar sails are not appropriate for outer planet missions. Solar sails may be used on orbital missions for testing purposes.

i) Three Person Space Station. This is a small, permanent structure that provides a place of rendezvous and long-duration training for astronauts. It initially provides 12 months of life support for three people. Additional life support can be added through the use of Habitation Extenders. A three person space station can be launched in two, 1500 weight unit assemblies, and then assembled in space using the Space Construction program. It can also be launched as a unit. Additional stations can be launched and docked together to form larger stations. Capsules or shuttles can be docked to space stations to serve as life boats.

j) Three Person Habitation Module. This is similar to a space station, except for the fact that it is intended as a temporary habitat for astronauts on their way to and from Mars. It provides 12 months of life support for three people, but that may be extended by using Habitation Extenders. Habitation modules may be launched on orbital missions for testing purposes.

k) Five Person Habitation Module. This is a larger version of the three person habitation module. The main differences between the two, are the fact that the five person habitation module provides 12 months of life support for five people, and that it comes equipped with a “storm shelter” – which is a small chamber within the water tanks so the crew can be shielded from solar flares. Life support capacity may be extended by the use of Habitation Extenders. Five person habitation modules may be launched in two pieces, each weighing 2000 weight units and assembled using space construction. Habitation modules may be launched on orbital missions for testing purposes.

l) Five Person Reentry Capsule. This is simply a capsule able to hold 5 people intended for re-entry onto Earth. It can be used for any mission using a Five Person Habitation Module or a Space Station to allow astronauts to come back to Earth.

l) Six Person Shuttle. This is a larger version of the three person mini-shuttle. Like a mini-shuttle, it need not be discarded after use, but can be refit for 4MB. Life support for a six person shuttle is 15 days for 6 people.

m) Two Person Mars Lander. A two person Mars lander can be used in conjunction with a three or five person habitation module to take two astronauts from Mars orbit to the surface and back again. The only missions that a two person Mars

lander can be used on are the various manned Mars landings. The lander must be docked with in the activity phases immediately before and immediately after the landing attempt to transfer the lander’s crew to and from the habitation module (the lander takes its crew from the habitation module, it does not carry two additional astronauts from Earth). Life support for a two person Mars lander is one month for 2 people. This can be extended through the use of habitation extenders.

n) Three Person Mars Lander. A three person Mars lander can be used in conjunction with a five person habitation module to take three astronauts from Mars orbit to the surface and back again. The only missions that a three person Mars lander can be used on are the various manned Mars landings. The lander must be docked with in the activity phases immediately before and immediately after the landing attempt to transfer the lander’s crew to and from the habitation module (the lander takes its crew from the habitation module, it does not carry three additional astronauts from Earth). Life support for a three person Mars lander is one month for 3 people. This can be extended through the use of habitation extenders.

o) Habitation Extender. A habitation extender is simply a package containing food, water, and air for one person for six months. It can be used in conjunction with space stations, habitation modules, and Mars landers to extend the life support capacity of each. They cannot be used by any other equipment. If launched separately from the equipment it is extending, space construction is required to install it.

Human Hibernation. This represents a program to reduce the metabolism of an astronaut so that virtually no life support is needed to maintain him/her through a prolonged mission. The unit cost represents a hibernation unit, which can be installed in a habitation module or space station. When in use, an astronaut in hibernation does not use up life support, but the hibernation must be rolled against at each Interplanetary In-Route Activities or Orbital Activities step for each astronaut in hibernation. Astronauts in hibernation cannot use their experience to save against failures, but all astronauts on a mission need not be in hibernation. Astronauts do not hibernate during the Mars portion of a mission, only during the travel to and from Mars.

Space Construction. This represents the skill necessary to assemble large structures in space. It includes assembly of parts of a space station or habitation module launched in pieces, as well as the construction of a larger space station from individual pieces and the installation of habitation extenders. Each attempt to put the pieces together adds 5% to the skill, success adds an additional 10%, for a total of 15%.

## Mission List

Orbital Satellite  
Manned Sub-Orbital  
Manned Orbital  
Manned Orbital and Spacewalk  
Manned Orbital and Docking  
Manned Orbital, Docking, and Spacewalk  
Lunar Satellite Flyby  
Lunar Probe Landing  
Mars Satellite Flyby  
Venus Satellite Flyby

Manned Lunar Pass  
Manned Lunar Orbital  
Manned Lunar Landing  
Medium Duration Manned Orbital  
Long Duration Manned Orbital  
Mars Probe Landing  
Outer Planet Flyby  
Multiple Outer Planet Flyby  
Manned Mars Landing (Direct)  
Manned Mars Landing (via Venus)  
Manned Mars Landing (NERVA)  
Manned Mars Landing (Ion Drive)  
Manned Mars Landing (Solar Sail)

# Required Missions

- Orbital Satellite
- Manned Sub-Orbital
- Manned Orbital
- Lunar Satellite Flyby
- Lunar Probe Landing
- Mars Satellite Flyby
- Manned Lunar Pass

- Manned Lunar Orbital
- Manned Lunar Landing
- Medium Duration Manned Orbital
- Long Duration Manned Orbital
- Mars Probe Landing
- Manned Mars Landing (any)

# Mission Explanations

Mission Type	Mission Steps - Programs
Mars Probe Landing	Liftoff – <i>Rocket or Booster</i> Earth Orbital Burn – <i>Mars Probe</i> Earth Mission Burn – <i>Mars Probe</i> The following steps are checked the next turn Mars Orbital Burn – <i>Mars Probe</i> Mars De-Orbital Burn – <i>Mars Probe</i> Photo Reconnaissance – <i>Photo Reconnaissance</i> Mars Landing – <i>Mars Probe</i>

# Space Station Missions

These are long-duration orbital missions used to test astronaut endurance in microgravity conditions. The space station itself can be launched along with or separately from the astronauts. Hibernation can be tested by launching a hibernation module either with the space station or on a subsequent turn (when it must be installed via Space Construction – each module requires a separate roll). For each astronaut hibernating, a roll versus hibernation must be made after each Earth Orbital Activities step in the space station. Note that players can launch a capsule to serve as a life boat for the space station. It can be docked to the station as long as the station is manned at the time.

Mission Type	Mission Steps - Programs
Space Station Launch	Liftoff – <i>Rocket or Booster</i> Earth Orbital Burn – <i>Kicker</i> Earth Orbital Activities – <i>Space Station</i> Liftoff – <i>Rocket or Booster</i>
Space Station Assembly	Earth Orbital Burn – <i>Kicker or Capsule</i> Earth Orbital Activities – <i>Capsule</i> Rendezvous – <i>Docking Assembly – Space Construction</i> Earth De-Orbital Burn – <i>Capsule</i> Re-Entry – <i>Capsule</i> Recovery – <i>Capsule</i> Liftoff – <i>Rocket or Booster</i>
Medium Duration Stay	Earth Orbital Burn – <i>Kicker or Capsule</i> Earth Orbital Activities – <i>Capsule</i> Docking – <i>Docking</i> The following step is rolled against three times (each representing one month). Earth Orbital Activities – <i>Space Station</i> Earth De-Orbital Burn – <i>Capsule</i>

Mission Type	Mission Steps - Programs
Long Duration Stay	Re-Entry – <i>Capsule</i> Recovery – <i>Capsule</i> Liftoff – <i>Rocket or Booster</i> Earth Orbital Burn – <i>Kicker or Capsule</i> Earth Orbital Activities – <i>Capsule</i> Docking – <i>Docking</i> The following step is rolled against three times (each representing one month). Earth Orbital Activities – <i>Space Station</i> The following rolls take place during the subsequent turn The following step is rolled against three times (each representing one month). Earth Orbital Activities – <i>Space Station</i> Earth De-Orbital Burn – <i>Capsule</i> Re-Entry – <i>Capsule</i> Recovery – <i>Capsule</i> Liftoff – <i>Rocket or Booster</i>
Station Reserviceing	Earth Orbital Burn – <i>Kicker or Capsule</i> Earth Orbital Activities – <i>Capsule</i> Docking – <i>Docking</i> Earth Orbital Activities – <i>Space Station</i> Reservicing – <i>Space Construction</i> Earth De-Orbital Burn - <i>Capsule</i> Re-Entry – <i>Capsule</i> Recovery - <i>Capsule</i> Liftoff – <i>Rocket or Booster</i>
Medium Duration Manned Orbital (non-space station)	Earth Orbital Burn – <i>Kicker or Habitation Module</i> The following step is rolled against three times (each representing one month). Earth Orbital Activities – <i>Habitation Module</i> Earth De-Orbital Burn – <i>Capsule</i> Re-Entry – <i>Capsule</i> Recovery – <i>Capsule</i> Liftoff – <i>Rocket or Booster</i>
Long Duration Manned Orbital (non-space station)	Earth Orbital Burn – <i>Kicker or Habitation Module</i> The following step is rolled against three times (each representing one month). Earth Orbital Activities – <i>Habitation Module</i> The following rolls take place during the subsequent turn The following step is rolled against three times (each representing one month). Earth Orbital Activities – <i>Habitation</i>

<b>Mission Type</b>	<b>Mission Steps - Programs</b>
	<i>Module</i>
	Earth De-Orbital Burn – <i>Capsule</i>
	Re-Entry – <i>Capsule</i>
	Recovery – <i>Capsule</i>

## Outer Planet Missions

These are robotic probes to the outer planets. Due to the distances involved, they take a long time to complete. They can be launched either with or without the help of an ion drive – an ion drive considerably increases the flexibility of when to launch.

<b>Mission Type</b>	<b>Mission Steps - Programs</b>
Jupiter Flyby	Liftoff – <i>Rocket or Booster</i>
	Earth Orbital Burn – <i>Interplanetary Satellite</i>
	Earth Mission Burn – <i>Interplanetary Satellite</i>
	The following roll takes place on the next turn
	In-Route Activities – <i>Interplanetary Satellite</i>
	The following roll takes place on the next turn
	Jupiter Orbital Burn – <i>Interplanetary Satellite</i>
	Jupiter Orbital Activities – <i>Interplanetary Satellite</i>
Jupiter Flyby with Ion Drive	Liftoff – <i>Rocket or Booster</i>
	Earth Orbital Burn – <i>Interplanetary Satellite</i>
	Earth Mission Burn – <i>Interplanetary Satellite</i>
	The following roll takes place on the next turn
	Ion Drive – <i>Ion Drive</i>
	Jupiter Orbital Burn – <i>Interplanetary Satellite</i>
	Jupiter Orbital Activities – <i>Interplanetary Satellite</i>
Saturn Flyby	Liftoff – <i>Rocket or Booster</i>
	Earth Orbital Burn – <i>Interplanetary Satellite</i>
	Earth Mission Burn – <i>Interplanetary Satellite</i>
	The following roll is made once per turn for the next 4 turns
	In-Route Activities – <i>Interplanetary Satellite</i>
	The following rolls are made on the 5 <sup>th</sup> turn after launch
	Saturn Orbital Burn – <i>Interplanetary Satellite</i>
	Saturn Orbital Activities – <i>Interplanetary Satellite</i>
Saturn Flyby with Ion Drive	Liftoff – <i>Rocket or Booster</i>
	Earth Orbital Burn – <i>Interplanetary Satellite</i>
	Earth Mission Burn – <i>Interplanetary Satellite</i>
	The following roll is made once per turn for the next two turns
	Ion Drive – <i>Ion Drive</i>
	The following rolls are made on the third turn after launch

<b>Mission Type</b>	<b>Mission Steps - Programs</b>
	Earth De-Orbital Burn – <i>Capsule</i>
	Re-Entry – <i>Capsule</i>
	Recovery – <i>Capsule</i>

## Outer Planet Missions

These are robotic probes to the outer planets. Due to the distances involved, they take a long time to complete. They can be launched either with or without the help of an ion drive – an ion drive considerably increases the flexibility of when to launch.

<b>Mission Type</b>	<b>Mission Steps - Programs</b>
Jupiter Flyby	Liftoff – <i>Rocket or Booster</i>
	Earth Orbital Burn – <i>Interplanetary Satellite</i>
	Earth Mission Burn – <i>Interplanetary Satellite</i>
	The following roll takes place on the next turn
	In-Route Activities – <i>Interplanetary Satellite</i>
	The following roll takes place on the next turn
	Jupiter Orbital Burn – <i>Interplanetary Satellite</i>
	Jupiter Orbital Activities – <i>Interplanetary Satellite</i>
Jupiter Flyby with Ion Drive	Liftoff – <i>Rocket or Booster</i>
	Earth Orbital Burn – <i>Interplanetary Satellite</i>
	Earth Mission Burn – <i>Interplanetary Satellite</i>
	The following roll takes place on the next turn
	Ion Drive – <i>Ion Drive</i>
	Jupiter Orbital Burn – <i>Interplanetary Satellite</i>
	Jupiter Orbital Activities – <i>Interplanetary Satellite</i>
Saturn Flyby	Liftoff – <i>Rocket or Booster</i>
	Earth Orbital Burn – <i>Interplanetary Satellite</i>
	Earth Mission Burn – <i>Interplanetary Satellite</i>
	The following roll is made once per turn for the next 4 turns
	In-Route Activities – <i>Interplanetary Satellite</i>
	The following rolls are made on the 5 <sup>th</sup> turn after launch
	Saturn Orbital Burn – <i>Interplanetary Satellite</i>
	Saturn Orbital Activities – <i>Interplanetary Satellite</i>
Saturn Flyby with Ion Drive	Liftoff – <i>Rocket or Booster</i>
	Earth Orbital Burn – <i>Interplanetary Satellite</i>
	Earth Mission Burn – <i>Interplanetary Satellite</i>
	The following roll is made once per turn for the next two turns
	Ion Drive – <i>Ion Drive</i>
	The following rolls are made on the third turn after launch



<b>Mission Type</b>	<b>Mission Steps - Programs</b>	<b>Mission Type</b>	<b>Mission Steps - Programs</b>
	Saturn Orbital Burn – <i>Interplanetary Satellite</i>		Earth Mission Burn – <i>Interplanetary Satellite</i>
Uranus Flyby	Saturn Orbital Activities – <i>Interplanetary Satellite</i> Liftoff – <i>Rocket or Booster</i>		The following roll is takes place on the next turn In-Route Activities – <i>Interplanetary Satellite</i>
	Earth Orbital Burn – <i>Interplanetary Satellite</i>		The following rolls take place on the next turn Jupiter Orbital Burn – <i>Interplanetary Satellite</i>
	Earth Mission Burn – <i>Interplanetary Satellite</i>		Jupiter Orbital Activities – <i>Interplanetary Satellite</i>
	The following roll is made once per turn for the next 8 turns In-Route Activities – <i>Interplanetary Satellite</i>		The following roll takes place on the next turn In-Route Activities – <i>Interplanetary Satellite</i>
	The following rolls are made on the 9 <sup>th</sup> turn after launch Uranus Orbital Burn – <i>Interplanetary Satellite</i>		The following rolls take place on the next turn Saturn Orbital Burn – <i>Interplanetary Satellite</i>
	Uranus Orbital Activities – <i>Interplanetary Satellite</i>		Saturn Orbital Activities – <i>Interplanetary Satellite</i>
Uranus Flyby with Ion Drive	Liftoff – <i>Rocket or Booster</i>	Jupiter and Saturn Flyby with Ion Drive	Liftoff – <i>Rocket or Booster</i>
	Earth Orbital Burn – <i>Interplanetary Satellite</i>		Earth Orbital Burn – <i>Interplanetary Satellite</i>
	Earth Mission Burn – <i>Interplanetary Satellite</i>		Earth Mission Burn – <i>Interplanetary Satellite</i>
	The following roll is made once per turn for the next 5 turns Ion Drive – <i>Ion Drive</i>		The following rolls is take place on the next turn Ion Drive – <i>Ion Drive</i>
	The following rolls are made on the sixth turn after launch Uranus Orbital Burn – <i>Interplanetary Satellite</i>		Jupiter Orbital Burn – <i>Interplanetary Satellite</i>
	Uranus Orbital Activities – <i>Interplanetary Satellite</i>		Jupiter Orbital Activities – <i>Interplanetary Satellite</i>
Neptune Flyby	Liftoff – <i>Rocket or Booster</i>		The following rolls take place on the next turn Ion Drive – <i>Ion Drive</i>
	Earth Orbital Burn – <i>Interplanetary Satellite</i>		Saturn Orbital Burn – <i>Interplanetary Satellite</i>
	Earth Mission Burn – <i>Interplanetary Satellite</i>		Saturn Orbital Activities – <i>Interplanetary Satellite</i>
	The following roll is made once per turn for the next 14 turns In-Route Activities – <i>Interplanetary Satellite</i>	Grand Tour	Liftoff – <i>Rocket or Booster</i>
	The following rolls are made on the 15 <sup>th</sup> turn after launch Neptune Orbital Burn – <i>Interplanetary Satellite</i>		Earth Orbital Burn – <i>Interplanetary Satellite</i>
	Neptune Orbital Activities – <i>Interplanetary Satellite</i>		Earth Mission Burn – <i>Interplanetary Satellite</i>
Neptune Flyby with Ion Drive	Liftoff – <i>Rocket or Booster</i>		The following roll is takes place on the next turn In-Route Activities – <i>Interplanetary Satellite</i>
	Earth Orbital Burn – <i>Interplanetary Satellite</i>		The following rolls take place on the next turn Jupiter Orbital Burn – <i>Interplanetary Satellite</i>
	Earth Mission Burn – <i>Interplanetary Satellite</i>		Jupiter Orbital Activities – <i>Interplanetary Satellite</i>
	The following roll is made once per turn for the next 8 turns Ion Drive – <i>Ion Drive</i>		The following roll takes place on the next turn In-Route Activities – <i>Interplanetary Satellite</i>
	The following rolls are made on the ninth turn after launch Neptune Orbital Burn – <i>Interplanetary Satellite</i>		The following rolls take place on the next turn Saturn Orbital Burn – <i>Interplanetary Satellite</i>
	Neptune Orbital Activities – <i>Interplanetary Satellite</i>		Saturn Orbital Activities – <i>Interplanetary Satellite</i>
Jupiter and Saturn Flyby	Liftoff – <i>Rocket or Booster</i>		The following roll takes place on each of the next two turns In-Route Activities – <i>Interplanetary</i>
	Earth Orbital Burn – <i>Interplanetary Satellite</i>		

<b>Mission Type</b>	<b>Mission Steps - Programs</b>
	<i>Satellite</i>
	The following rolls take place on the next turn
	Uranus Orbital Burn – <i>Interplanetary Satellite</i>
	Uranus Orbital Activities – <i>Interplanetary Satellite</i>
	The following roll takes place on each of the next four turns
	In-Route Activities – <i>Interplanetary Satellite</i>
	The following roll takes place on the next turn
	Neptune Orbital Burn – <i>Interplanetary Satellite</i>
	Neptune Orbital Activities – <i>Interplanetary Satellite</i>
Grand Tour with Ion Drive	Liftoff – <i>Rocket or Booster</i>
	Earth Orbital Burn – <i>Interplanetary Satellite</i>
	Earth Mission Burn – <i>Interplanetary Satellite</i>
	The following rolls take place on the next turn
	Ion Drive – <i>Ion Drive</i>
	Jupiter Orbital Burn – <i>Interplanetary Satellite</i>
	Jupiter Orbital Activities – <i>Interplanetary Satellite</i>
	The following rolls take place on the next turn
	Ion Drive – <i>Ion Drive</i>
	Saturn Orbital Burn – <i>Interplanetary Satellite</i>
	Saturn Orbital Activities – <i>Interplanetary Satellite</i>
	The following roll takes place on the next turn
	Ion Drive – <i>Ion Drive</i>
	The following rolls take place on the next turn
	Ion Drive – <i>Ion Drive</i>
	Uranus Orbital Burn – <i>Interplanetary Satellite</i>
	Uranus Orbital Activities – <i>Interplanetary Satellite</i>
	The following roll takes place on each of the next two turns
	Ion Drive – <i>Ion Drive</i>
	The following roll takes place on the next turn
	Ion Drive – <i>Ion Drive</i>
	Neptune Orbital Burn – <i>Interplanetary Satellite</i>
	Neptune Orbital Activities – <i>Interplanetary Satellite</i>

## Manned Mars Missions

There are many options for manned Mars missions. The first involves the size of the habitation module. The second involves the route and/or propulsion. The third involves whether or not hibernation is used. The fourth involved whether the mission is launched directly from Earth, or lifted to a space station, assembled, and launched from there. Each of these options influences the safety checks that are made at various steps, as well as the possibilities that can occur in the event of a failure. For most cases, the possibilities are taken

into account with the rolls below. In the case of human habitation, remember that at every Interplanetary In-Route Activities step, *each* habitation module must make its own check, and astronauts in hibernation cannot use their experience to mitigate problems.

<b>Mission Type</b>	<b>Mission Steps - Programs</b>
Manned Mars	Liftoff – <i>Rocket or Booster</i>
Landing (Direct, Earth Launched)	Earth Orbital Burn – <i>Kicker or Habitation Module</i>
	Earth Mission Burn – <i>Kicker or Habitation Module</i>
	The following rolls take place on the next turn
	The following step is rolled against nine times (each representing one month).
	Interplanetary In-Route Activities – <i>Habitation Module</i>
	Docking – <i>Docking</i>
	Mars Orbital Burn – <i>Kicker or Habitation Module</i>
	Mars De-Orbital Burn – <i>Mars Lander</i>
	Photo Reconnaissance – <i>Photo Reconnaissance</i>
	Mars Landing – <i>Mars Lander</i>
	The following three steps are rolled against three times (each representing one month).
	Mars Walk – <i>EVA</i>
	Mars Orbital Activities – <i>Habitation Module</i>
	Mars Surface Activities – <i>Mars Lander</i>
	The following rolls take place on the next turn
	The following three steps are rolled against ten times (each representing one month).
	Mars Walk – <i>EVA</i>
	Mars Orbital Activities – <i>Habitation Module</i>
	Mars Surface Activities – <i>Mars Lander</i>
	Mars Launch – <i>Mars Lander</i>
	Docking – <i>Docking</i>
	Mars Mission Burn – <i>Kicker or Habitation Module</i>
	The following step is rolled against twice (each representing one month).
	Interplanetary In-Route Activities – <i>Habitation Module</i>
	The following rolls take place on the next turn
	The following step is rolled against seven times (each representing one month).
	Interplanetary In-Route Activities – <i>Habitation Module</i>
	Earth Orbital Burn – <i>Kicker or Habitation Module</i>
	Earth Orbital Activities – <i>Habitation Module</i>
	Earth De-Orbital Burn – <i>Capsule</i>
	Re-entry – <i>Capsule</i>
	Recovery – <i>Capsule</i>
Manned Mars	Earth Orbital Burn – <i>Kicker or Habitation Module</i>
Landing (Direct, Space Station	

**Mission Type****Mission Steps - Programs**

Launched)

Earth Mission Burn – *Kicker or Habitation Module*

The following rolls take place on the next turn  
The following step is rolled against nine times (each representing one month).

Interplanetary In-Route Activities – *Habitation Module*  
Docking – *Docking*

Mars Orbital Burn – *Kicker or Habitation Module*Mars De-Orbital Burn – *Mars Lander*Photo Reconnaissance – *Photo Reconnaissance*Mars Landing – *Mars Lander*

The following three steps are rolled against three times (each representing one month).

Mars Walk – *EVA*Mars Orbital Activities – *Habitation Module*Mars Surface Activities – *Mars Lander*

The following rolls take place on the next turn

The following three steps are rolled against ten times (each representing one month).

Mars Surface Activities – *Mars Lander*  
Mars Walk – *EVA*Mars Orbital Activities – *Habitation Module*Mars Surface Activities – *Mars Lander*Mars Launch – *Mars Lander*Docking – *Docking*Mars Mission Burn – *Kicker or Habitation Module*

The following step is rolled against twice (each representing one month).

Interplanetary In-Route Activities – *Habitation Module*

The following rolls take place on the next turn

The following step is rolled against seven times (each representing one month).

Interplanetary In-Route Activities – *Habitation Module*Earth Orbital Burn – *Kicker or Habitation Module*Earth Orbital Activities – *Habitation Module*Docking – *Docking*Liftoff – *Rocket or Booster*

Manned Mars

Landing (via Venus,

Earth Launched)

Earth Orbital Burn – *Kicker or Habitation Module*Earth Mission Burn – *Kicker or Habitation Module*

The following rolls take place on the next turn  
The following step is rolled against six times (each representing one month).

Interplanetary In-Route Activities – *Habitation Module*Venus Mission Burn – *Kicker or***Mission Type****Mission Steps - Programs**Earth Mission Burn – *Kicker or Habitation Module*

The following rolls take place on the next turn  
The following step is rolled against nine times (each representing one month).

Interplanetary In-Route Activities – *Habitation Module*  
Docking – *Docking*

Mars Orbital Burn – *Kicker or Habitation Module*Mars De-Orbital Burn – *Mars Lander*Photo Reconnaissance – *Photo Reconnaissance*Mars Landing – *Mars Lander*

The following three steps are rolled against three times (each representing one month).

Mars Walk – *EVA*Mars Orbital Activities – *Habitation Module*Mars Surface Activities – *Mars Lander*

The following rolls take place on the next turn

The following three steps are rolled against ten times (each representing one month).

Mars Surface Activities – *Mars Lander*  
Mars Walk – *EVA*Mars Orbital Activities – *Habitation Module*Mars Surface Activities – *Mars Lander*Mars Launch – *Mars Lander*Docking – *Docking*Mars Mission Burn – *Kicker or Habitation Module*

The following step is rolled against twice (each representing one month).

Interplanetary In-Route Activities – *Habitation Module*

The following rolls take place on the next turn

The following step is rolled against seven times (each representing one month).

Interplanetary In-Route Activities – *Habitation Module*Earth Orbital Burn – *Kicker or Habitation Module*Earth Orbital Activities – *Habitation Module*Docking – *Docking*Liftoff – *Rocket or Booster*

Manned Mars

Landing (via Venus,

Earth Launched)

Earth Orbital Burn – *Kicker or Habitation Module*Earth Mission Burn – *Kicker or Habitation Module*

The following rolls take place on the next turn  
The following step is rolled against six times (each representing one month).

Interplanetary In-Route Activities – *Habitation Module*

<b>Mission Type</b>	<b>Mission Steps - Programs</b>	<b>Mission Type</b>	<b>Mission Steps - Programs</b>
	<i>Habitation Module</i>		
	The following step is rolled against five times (each representing one month).		The following step is rolled against five times (each representing one month).
	Interplanetary In-Route Activities – <i>Habitation Module</i>		Interplanetary In-Route Activities – <i>Habitation Module</i>
	Docking – <i>Docking</i>		Docking – <i>Docking</i>
	Mars Orbital Burn – <i>Kicker or Habitation Module</i>		Mars Orbital Burn – <i>Kicker or Habitation Module</i>
	Mars De-Orbital Burn – <i>Mars Lander</i>		Mars De-Orbital Burn – <i>Mars Lander</i>
	Photo Reconnaissance – <i>Photo Reconnaissance</i>		Photo Reconnaissance – <i>Photo Reconnaissance</i>
	Mars Landing – <i>Mars Lander</i>		Mars Landing – <i>Mars Lander</i>
	Mars Walk – <i>EVA</i>		Mars Walk – <i>EVA</i>
	Mars Orbital Activities – <i>Habitation Module</i>		Mars Orbital Activities – <i>Habitation Module</i>
	Mars Surface Activities – <i>Mars Lander</i>		Mars Surface Activities – <i>Mars Lander</i>
	Mars Launch – <i>Mars Lander</i>		Mars Launch – <i>Mars Lander</i>
	Docking – <i>Docking</i>		Docking – <i>Docking</i>
	The following rolls take place on the next turn		The following rolls take place on the next turn
	Mars Mission Burn – <i>Kicker or Habitation Module</i>		Mars Mission Burn – <i>Kicker or Habitation Module</i>
	The following step is rolled against eight times (each representing one month).		The following step is rolled against eight times (each representing one month).
	Interplanetary In-Route Activities – <i>Habitation Module</i>		Interplanetary In-Route Activities – <i>Habitation Module</i>
	Earth Orbital Burn – <i>Kicker or Habitation Module</i>		Earth Orbital Burn – <i>Kicker or Habitation Module</i>
	Earth Orbital Activities – <i>Habitation Module</i>		Earth Orbital Activities – <i>Habitation Module</i>
	Earth De-Orbital Burn – <i>Capsule</i>		Earth De-Orbital Burn – <i>Capsule</i>
	Re-entry – <i>Capsule</i>		Re-entry – <i>Capsule</i>
	Recovery - <i>Capsule</i>		Recovery - <i>Capsule</i>
Manned Mars Landing (via Venus, Space Station Launched)	Earth Orbital Burn – <i>Kicker or Habitation Module</i>	Manned Mars Landing (via Venus, Space Station Launched)	Earth Orbital Burn – <i>Kicker or Habitation Module</i>
	Earth Mission Burn – <i>Kicker or Habitation Module</i>		Earth Mission Burn – <i>Kicker or Habitation Module</i>
	The following rolls take place on the next turn		The following rolls take place on the next turn
	The following step is rolled against six times (each representing one month).		The following step is rolled against six times (each representing one month).
	Interplanetary In-Route Activities – <i>Habitation Module</i>		Interplanetary In-Route Activities – <i>Habitation Module</i>
	Venus Mission Burn – <i>Kicker or Habitation Module</i>		Venus Mission Burn – <i>Kicker or Habitation Module</i>
	The following step is rolled against five times (each representing one month).		The following step is rolled against five times (each representing one month).
	Interplanetary In-Route Activities – <i>Habitation Module</i>		Interplanetary In-Route Activities – <i>Habitation Module</i>
	Docking – <i>Docking</i>		Docking – <i>Docking</i>
	Mars Orbital Burn – <i>Kicker or Habitation Module</i>		Mars Orbital Burn – <i>Kicker or Habitation Module</i>
	Mars De-Orbital Burn – <i>Mars Lander</i>		Mars De-Orbital Burn – <i>Mars Lander</i>
	Photo Reconnaissance – <i>Photo Reconnaissance</i>		Photo Reconnaissance – <i>Photo Reconnaissance</i>
	Mars Landing – <i>Mars Lander</i>		Mars Landing – <i>Mars Lander</i>
	Mars Walk – <i>EVA</i>		Mars Walk – <i>EVA</i>
	Mars Orbital Activities – <i>Habitation Module</i>		Mars Orbital Activities – <i>Habitation Module</i>
	Mars Surface Activities – <i>Mars Lander</i>		Mars Surface Activities – <i>Mars Lander</i>

<b>Mission Type</b>	<b>Mission Steps - Programs</b>	<b>Mission Type</b>	<b>Mission Steps - Programs</b>
	Mars Launch – <i>Mars Lander</i>		<i>Module</i>
	Docking – <i>Docking</i>		Earth De-Orbital Burn – <i>Capsule</i>
	The following rolls take place on the next turn		Re-entry – <i>Capsule</i>
	Mars Mission Burn – <i>Kicker or Habitation Module</i>		Recovery - <i>Capsule</i>
	The following step is rolled against eight times (each representing one month).	Manned Mars	Earth Orbital Burn – <i>Kicker or Habitation Module</i>
	Interplanetary In-Route Activities – <i>Habitation Module</i>	Landing (Solar Sail, Space Station Launched)	
	Earth Orbital Burn – <i>Kicker or Habitation Module</i>		Earth Mission Burn – <i>Kicker or Habitation Module</i>
	Earth Orbital Activities – <i>Habitation Module</i>		Solar Sail Deployment – <i>Solar Sail</i>
	Docking - <i>Docking</i>		The following rolls take place on the next turn
Manned Mars	Liftoff – <i>Rocket or Booster</i>		The following two steps are rolled against eight times (each representing one month).
Landing (Solar Sail, Earth Launched)			Interplanetary In-Route Activities – <i>Habitation Module</i>
	Earth Orbital Burn – <i>Kicker or Habitation Module</i>		Solar Sail – <i>Solar Sail</i>
	Earth Mission Burn – <i>Kicker or Habitation Module</i>		Solar Sail – <i>Solar Sail</i>
	Solar Sail Deployment – <i>Solar Sail</i>		Docking – <i>Docking</i>
	The following rolls take place on the next turn		Mars Orbital Burn – <i>Kicker or Habitation Module</i>
	The following two steps are rolled against eight times (each representing one month).		Mars De-Orbital Burn – <i>Mars Lander</i>
	Interplanetary In-Route Activities – <i>Habitation Module</i>		Photo Reconnaissance – <i>Photo Reconnaissance</i>
	Solar Sail – <i>Solar Sail</i>		Mars Landing – <i>Mars Lander</i>
	Docking – <i>Docking</i>		The following three steps are rolled against four times (each representing one month).
	Mars Orbital Burn – <i>Kicker or Habitation Module</i>		Mars Walk – <i>EVA</i>
	Mars De-Orbital Burn – <i>Mars Lander</i>		Mars Orbital Activities – <i>Habitation Module</i>
	Photo Reconnaissance – <i>Photo Reconnaissance</i>		Mars Surface Activities – <i>Mars Lander</i>
	Mars Landing – <i>Mars Lander</i>		The following rolls take place on the next turn.
	The following three steps are rolled against four times (each representing one month).		The following three steps are rolled against twice (each representing one month).
	Mars Walk – <i>EVA</i>		Mars Walk – <i>EVA</i>
	Mars Orbital Activities – <i>Habitation Module</i>		Mars Orbital Activities – <i>Habitation Module</i>
	Mars Surface Activities – <i>Mars Lander</i>		Mars Launch – <i>Mars Lander</i>
	The following rolls take place on the next turn.		Docking – <i>Docking</i>
	The following three steps are rolled against twice (each representing one month).		Mars Mission Burn – <i>Kicker or Habitation Module</i>
	Mars Walk – <i>EVA</i>		
	Mars Orbital Activities – <i>Habitation Module</i>		The following two steps are rolled against eight times (each representing one month).
	Mars Surface Activities – <i>Mars Lander</i>		Interplanetary In-Route Activities – <i>Habitation Module</i>
	Mars Launch – <i>Mars Lander</i>		Solar Sail – <i>Solar Sail</i>
	Docking – <i>Docking</i>		Earth Orbital Burn – <i>Kicker or Habitation Module</i>
	Mars Mission Burn – <i>Kicker or Habitation Module</i>		Earth Orbital Activities – <i>Habitation Module</i>
	The following two steps are rolled against eight times (each representing one month).		Earth De-Orbital Burn – <i>Capsule</i>
	Interplanetary In-Route Activities – <i>Habitation Module</i>		Docking – <i>Docking</i>
	Solar Sail – <i>Solar Sail</i>		Liftoff – <i>NERVA</i>
	Earth Orbital Burn – <i>Kicker or Habitation Module</i>	Manned Mars	Earth Orbital Burn – <i>NERVA</i>
	Earth Orbital Activities – <i>Habitation Module</i>	Landing (NERVA)	Earth Mission Burn – <i>NERVA</i>
	Earth De-Orbital Burn – <i>Capsule</i>		The following rolls take place on the next turn
	Docking – <i>Docking</i>		The following two steps are rolled against six times (each representing one month).
	Liftoff – <i>NERVA</i>		Interplanetary In-Route Activities –

<u>Mission Type</u>	<u>Mission Steps - Programs</u>	<u>Mission Type</u>	<u>Mission Steps - Programs</u>
	<i>Habitation Module</i>		
	Course Adjustment Burn – <i>NERVA</i>		Course Adjustment Burn – <i>NERVA</i>
	Docking – <i>Docking</i>		Docking – <i>Docking</i>
	Mars Orbital Burn – <i>NERVA</i>		Mars Orbital Burn – <i>NERVA</i>
	Mars De-Orbital Burn – <i>Mars Lander</i>		Mars De-Orbital Burn – <i>Mars Lander</i>
	Photo Reconnaissance – <i>Photo Reconnaissance</i>		Photo Reconnaissance – <i>Photo Reconnaissance</i>
	Mars Landing – <i>Mars Lander</i>		Mars Landing – <i>Mars Lander</i>
	The following three steps are rolled against six times (each representing one month).		The following three steps are rolled against six times (each representing one month).
	Mars Walk – <i>EVA</i>		Mars Walk – <i>EVA</i>
	Mars Orbital Activities – <i>Habitation Module</i>		Mars Orbital Activities – <i>Habitation Module</i>
	Mars Surface Activities – <i>Mars Lander</i>		Mars Surface Activities – <i>Mars Lander</i>
	Mars Launch – <i>Mars Lander</i>		Mars Launch – <i>Mars Lander</i>
	Docking – <i>Docking</i>		Docking – <i>Docking</i>
	Mars Mission Burn – <i>NERVA</i>		Mars Mission Burn – <i>NERVA</i>
	The following rolls take place on the next turn.		The following rolls take place on the next turn.
	The following two steps are rolled against six times (each representing one month).		The following two steps are rolled against six times (each representing one month).
	Interplanetary In-Route Activities – <i>Habitation Module</i>		Interplanetary In-Route Activities – <i>Habitation Module</i>
	Course Adjustment Burn – <i>NERVA</i>		Course Adjustment Burn – <i>NERVA</i>
	Earth Orbital Burn – <i>NERVA</i>		Earth Orbital Burn – <i>NERVA</i>
	Earth Orbital Activities – <i>Habitation Module</i>		Earth Orbital Activities – <i>Habitation Module</i>
	Earth De-Orbital Burn – <i>Capsule</i>		Earth De-Orbital Burn – <i>Capsule</i>
	Re-entry – <i>Capsule</i>		Re-entry – <i>Capsule</i>
	Recovery - <i>Capsule</i>		Recovery - <i>Capsule</i>
Manned Mars Landing (Ion Drive, Earth Launched)	Liftoff – <i>Rocket or Booster</i>	Manned Mars Landing (Ion Drive, Earth Launched)	Liftoff – <i>Rocket or Booster</i>
	Earth Orbital Burn – <i>Habitation Module</i>		Earth Orbital Burn – <i>Habitation Module</i>
	Earth Mission Burn – <i>Habitation Module</i>		Earth Mission Burn – <i>Habitation Module</i>
	The following rolls take place on the next turn		The following rolls take place on the next turn
	The following two steps are rolled against four times (each representing one month).		The following two steps are rolled against four times (each representing one month).
	Interplanetary In-Route Activities – <i>Habitation Module</i>		Interplanetary In-Route Activities – <i>Habitation Module</i>
	Course Adjustment Burn – <i>Ion Drive</i>		Course Adjustment Burn – <i>Ion Drive</i>
	Docking – <i>Docking</i>		Docking – <i>Docking</i>
	Mars Orbital Burn – <i>Habitation Module</i>		Mars Orbital Burn – <i>Habitation Module</i>
	Mars De-Orbital Burn – <i>Mars Lander</i>		Mars De-Orbital Burn – <i>Mars Lander</i>
	Photo Reconnaissance – <i>Photo Reconnaissance</i>		Photo Reconnaissance – <i>Photo Reconnaissance</i>
	Mars Landing – <i>Mars Lander</i>		Mars Landing – <i>Mars Lander</i>
	The following three steps are rolled against four times (each representing one month).		The following three steps are rolled against four times (each representing one month).
	Mars Walk – <i>EVA</i>		Mars Walk – <i>EVA</i>
	Mars Orbital Activities – <i>Habitation Module</i>		Mars Orbital Activities – <i>Habitation Module</i>
	Mars Surface Activities – <i>Mars Lander</i>		Mars Surface Activities – <i>Mars Lander</i>
	Mars Launch – <i>Mars Lander</i>		Mars Launch – <i>Mars Lander</i>
	Docking – <i>Docking</i>		Docking – <i>Docking</i>
	Mars Mission Burn – <i>Habitation Module</i>		Mars Mission Burn – <i>Habitation Module</i>
	The following two steps are rolled against four times (each representing one month).		The following two steps are rolled against four times (each representing one month).
	Interplanetary In-Route Activities –		Interplanetary In-Route Activities –

<b>Mission Type</b>	<b>Mission Steps - Programs</b>
	<i>Habitation Module</i>
	Course Adjustment Burn – <i>Ion Drive</i>
	Earth Orbital Burn – <i>Habitation Module</i>
	Earth Orbital Activities – <i>Habitation Module</i>
	Earth De-Orbital Burn – <i>Capsule</i>
	Re-entry – <i>Capsule</i>
	Recovery - <i>Capsule</i>
Manned Mars Landing (Ion Drive, Space Station Launched)	Earth Orbital Burn – <i>Habitation Module</i>
	Earth Mission Burn – <i>Habitation Module</i>
	The following rolls take place on the next turn
	The following two steps are rolled against four times (each representing one month).
	Interplanetary In-Route Activities – <i>Habitation Module</i>
	Course Adjustment Burn – <i>Ion Drive</i>
	Docking – <i>Docking</i>
	Mars Orbital Burn – <i>Habitation Module</i>
	Mars De-Orbital Burn – <i>Mars Lander</i>
	Photo Reconnaissance – <i>Photo Reconnaissance</i>
	Mars Landing – <i>Mars Lander</i>
	The following three steps are rolled against four times (each representing one month).
	Mars Walk – <i>EVA</i>
	Mars Orbital Activities – <i>Habitation Module</i>
	Mars Surface Activities – <i>Mars Lander</i>
	Mars Launch – <i>Mars Lander</i>
	Docking – <i>Docking</i>
	Mars Mission Burn – <i>Habitation Module</i>
	The following two steps are rolled against four times (each representing one month).
	Interplanetary In-Route Activities – <i>Habitation Module</i>
	Course Adjustment Burn – <i>Ion Drive</i>
	Earth Orbital Burn – <i>Habitation Module</i>
	Earth Orbital Activities – <i>Habitation Module</i>
	Docking – <i>Docking</i>

## Miscellaneous Missions

Most of these missions involve launching, constructing, and retrieving components of other missions. For example, any manned Mars mission launched from a space station, needs these missions to launch the crew to the space station, potentially construct the mission equipment, and later to send the crew back to Earth.

For purposes of these missions, a “Component” is any equipment or piece thereof (such as a five person habitation module launched in two sections) needed for a mission.

<b>Mission Type</b>	<b>Mission Steps - Programs</b>
Launch Mission Component	Liftoff – <i>Rocket or Booster</i>

<b>Mission Type</b>	<b>Mission Steps - Programs</b>
	Course Adjustment Burn – <i>Ion Drive</i>
	Earth Orbital Burn – <i>Habitation Module</i>
	Earth Orbital Activities – <i>Habitation Module</i>
	Earth De-Orbital Burn – <i>Capsule</i>
	Re-entry – <i>Capsule</i>
	Recovery - <i>Capsule</i>
Manned Mars Landing (Ion Drive, Space Station Launched)	Earth Orbital Burn – <i>Habitation Module</i>
	Earth Mission Burn – <i>Habitation Module</i>
	The following rolls take place on the next turn
	The following two steps are rolled against four times (each representing one month).
	Interplanetary In-Route Activities – <i>Habitation Module</i>
	Course Adjustment Burn – <i>Ion Drive</i>
	Docking – <i>Docking</i>
	Mars Orbital Burn – <i>Habitation Module</i>
	Mars De-Orbital Burn – <i>Mars Lander</i>
	Photo Reconnaissance – <i>Photo Reconnaissance</i>
	Mars Landing – <i>Mars Lander</i>
	The following three steps are rolled against four times (each representing one month).
	Mars Walk – <i>EVA</i>
	Mars Orbital Activities – <i>Habitation Module</i>
	Mars Surface Activities – <i>Mars Lander</i>
	Mars Launch – <i>Mars Lander</i>
	Docking – <i>Docking</i>
	Mars Mission Burn – <i>Habitation Module</i>
	The following two steps are rolled against four times (each representing one month).
	Interplanetary In-Route Activities – <i>Habitation Module</i>
	Course Adjustment Burn – <i>Ion Drive</i>
	Earth Orbital Burn – <i>Habitation Module</i>
	Earth Orbital Activities – <i>Habitation Module</i>
	Docking – <i>Docking</i>

## Miscellaneous Missions

Most of these missions involve launching, constructing, and retrieving components of other missions. For example, any manned Mars mission launched from a space station, needs these missions to launch the crew to the space station, potentially construct the mission equipment, and later to send the crew back to Earth.

For purposes of these missions, a “Component” is any equipment or piece thereof (such as a five person habitation module launched in two sections) needed for a mission.

<b>Mission Type</b>	<b>Mission Steps - Programs</b>
Launch Mission Component	Liftoff – <i>Rocket or Booster</i>

<u>Mission Type</u>	<u>Mission Steps - Programs</u>	<u>Mission Type</u>	<u>Mission Steps - Programs</u>
Launch Space Station Crew	Earth Orbital Burn – <i>Kicker</i>	Manned Orbital with Solar Sail	Earth De-Orbital Burn – <i>Capsule</i>
	Earth Orbital Activities (space station rendezvous) – <i>Component</i>		Re-entry – <i>Capsule</i>
Construct Components	Liftoff – <i>Rocket or Booster</i>	Manned Orbital with Ion Drive	Recovery – <i>Capsule</i>
	Earth Orbital Burn – <i>Capsule or Kicker</i>		Liftoff – <i>Rocket or Booster</i>
Return Space Station Crew	Earth Orbital Activities – <i>Capsule</i>	Earth Orbital Burn – <i>Capsule or Kicker</i>	Earth Orbital Activities – <i>Capsule</i>
	Docking – <i>Docking</i>		Solar Sail Deployment – <i>Solar Sail</i>
Manned Orbital (NERVA)	Space Construction – <i>Space Construction (roll once for every component minus 1)</i>	Earth Orbital Burn – <i>Capsule or Kicker</i>	Earth Orbital Activities – <i>Capsule</i>
	Space Station Separation – <i>Capsule</i>		Maneuvering tests – <i>Solar Sail</i>
	Earth De-Orbital Burn – <i>Capsule</i>	Earth Orbital Burn – <i>Capsule or Kicker</i>	Earth De-orbital Burn – <i>Capsule</i>
	Re-Entry – <i>Capsule</i>		Re-entry – <i>Capsule</i>
	Recovery - <i>Capsule</i>	Earth Orbital Burn – <i>Capsule or Kicker</i>	Recovery – <i>Capsule</i>
	Liftoff – <i>NERVA</i>		Liftoff – <i>Rocket or Booster</i>
	Earth Orbital Burn – <i>NERVA</i>	Earth Orbital Burn – <i>Capsule or Kicker</i>	Earth Orbital Burn – <i>Capsule or Kicker</i>
	Earth Orbital Activities – <i>Capsule</i>		Earth Orbital Activities – <i>Capsule</i>
	Maneuvering tests – <i>NERVA</i>	Earth Orbital Burn – <i>Capsule or Kicker</i>	Maneuvering test – <i>Ion Drive</i>
			Earth De-orbital Burn – <i>Capsule</i>
		Earth Orbital Burn – <i>Capsule or Kicker</i>	Re-entry – <i>Capsule</i>
			Recovery – <i>Capsule</i>

## Simple Failure Chart

In addition to the failures found in the standard game, here are the failures that apply to the extended game.

<u>Chart</u>	<u>Event</u>	<u>Save</u>	<u>Catastrophe</u>	<u>Failure Effect</u>
B	Liftoff! (NERVA)	No	50%	<i>Radiation leak:</i> Crew suffers minor radiation poisoning. They are unavailable for missions next year.
R	Earth Orbital Burn (NERVA)	No	60%	<i>Mission Scrubbed:</i> Go directly to Re-entry step. Mission is a failure
S	Earth Mission Burn (NERVA)	Yes	60%	<i>Mission Scrubbed:</i> Go directly to Earth De-orbital Burn step. Mission is a failure.
G	Mars Orbital Activities	Yes	10%	<i>Communications Failure:</i> No further crew saving rolls are allowed. Mission still a success.
T	Interplanetary Activities	Yes	15%	<i>Communications Failure:</i> No further crew saving rolls are allowed. Mission still a success.
U	Mars Surface Activities	Yes	20%	<i>Communications Failure:</i> Mars surface stay cut short. Proceed directly to the Mars Launch step. Continue in Mars orbit until regularly scheduled departure time. Mission still a success.
V	Mars Walk	Yes	20%	<i>Astronaut injury:</i> Astronaut is injured and incapacitated for remainder of mission. Proceed directly to the Mars Launch step. Continue in Mars orbit until regularly scheduled departure time. Mission is a failure.
W	Mars Orbital Burn	Yes	50%	<i>Landing scrubbed:</i> Landing portion of mission scrubbed. Omit Mars De-orbital Burn and all related activities. Remain in Mars orbit until regularly scheduled departure time. Mission failure.
X	Mars Orbital Burn (NERVA)	Yes	60%	<i>Landing scrubbed:</i> Landing portion of mission scrubbed. Omit Mars De-orbital Burn and all related activities. Remain in Mars orbit until regularly scheduled departure time. Mission failure.
Y	Mars De-orbital Burn	Yes	50%	<i>Landing aborted:</i> Re-dock with habitation module. Remain in Mars orbit until regularly scheduled departure time. Mission failure.
Z	Mars Landing	Yes	35%	<i>Landing aborted:</i> Re-dock with habitation module. Remain in Mars orbit until regularly scheduled departure time. Mission failure.
AA	Mars Launch	Yes	30%	<i>Engine failure:</i> Crew stranded on Mars. Check craft endurance for rescue. Mission failure. If crew not



Chart	Event	Save	Catastrophe	Failure Effect
				rescued, mission is catastrophic failure.
BB	Mars Mission Burn	Yes	50%	<i>Major failure:</i> Rockets suffer major failure. When mission reaches Earth Orbital Burn step treat as automatic failure and go directly to chart P. Barring additional disasters, mission is still a success.
CC	Mars Mission Burn (NERVA)	Yes	60%	<i>Major failure:</i> Rockets suffer major failure. When mission reaches Earth De-orbital Burn step treat as automatic failure and go directly to chart P. In addition, at each Interplanetary In-Route Activities step, there is a 5% chance for each crewmember to receive enough radiation to cause incapacity. Any incapacitated crew member has a 10% chance of dying on a subsequent Interplanetary In-Route Activities step if not in hibernation, a 5% chance if in Hibernation. Barring additional disasters, mission is still a success. If any crew members die, mission is a catastrophic failure.
DD	Venus Mission Burn	Yes	50%	<i>Major failure:</i> Rockets suffer major failure. When mission reaches Mars Orbital Burn step treat as automatic failure and go directly to chart V. Barring additional disasters, mission is still a success.
EE	Course Adjustment Burn (Ion Drive)	Yes	30%	<i>Engine failure:</i> Craft takes double expected time to reach destination. Double the number of remaining months remaining in the Mars-bound and Earth-bound phases of the mission. Mission is still a success.
FF	Course Adjustment Burn (NERVA)	Yes	45%	<i>Engine failure:</i> Craft takes double expected time to reach destination. Double the number of remaining months remaining in the Mars-bound and Earth-bound phases of the mission. In addition, at each Interplanetary In-Route Activities step, there is a 5% chance for each crewmember to receive enough radiation to cause incapacity. Any incapacitated crew member has a 10% chance of dying on a subsequent Interplanetary In-Route Activities step if not in hibernation, a 5% chance if in Hibernation. Mission is still a success. If any crew members die, mission is a catastrophic failure.
GG	Solar Sail Deployment	Yes	5%	<i>Improper deployment:</i> For the remainder of the mission, the solar sail safety factor is cut in half. Mission is still a success.
HH	Solar Sail	Yes	5%	<i>Degraded performance:</i> Add one additional month to the Mars-bound and Earth-bound phases of the mission. Mission is still a success.
II	Space Construction	Yes	5%	<i>Construction fails:</i> Items being assembled fail to come together. Attempt may be made again on a future turn. Mission failure.
JJ	Hibernation	Yes	15%	<i>Hibernation failure:</i> Astronaut comes out of hibernation early. Mission still a success unless there is insufficient endurance to maintain awake astronauts, in which case, mission is a catastrophic failure if no rescue is achieved.

## Advanced Failure Charts

### B-LAUNCH (NERVA) (NERVA engines)

01-15 Major booster problem, launch is cancelled. Mission failure.

16-50 Last second countdown abort. Roll 1d10.

1-3 Problem resolved, countdown resumes same day. Recheck booster safety.

4-7 Launch delayed, try again last in launch schedule. Booster suffers temporary -8% safety factor for the re-try.

8-0 Major problem in the boosters. Mission failure. Subtract 20% from the booster's safety factor.

51-60 Propellant flow problems, rocket still on pad, astronaut(s) must be evacuated. Roll 1d10.

1-7 Astronaut(s) evacuate safely. Roll 1d10.

- 1-8 Rocket is shut down safely. Mission is a failure.
- 9-0 Reactor overheats and ruptures, spreading radioactive material over the launch facility and killing ground crew. Mission is a failure. No more launches from this facility until 20MB's are paid for decontamination and repair. Subtract 20% from the NERVA' safety factor.
- 8-0 Reactor overheats and ruptures, killing astronaut(s) and ground crew, and spreading radioactive material over the launch site. Mission is a catastrophic failure. No more launches from this facility until 20MB's are paid for decontamination and repair.
- 61-70 Minor radiation leak on pad. Astronaut(s) evacuate safely. Launch is cancelled. Mission is a failure.
- 71-75 Major radiation leak on pad. Roll 1d10.
- 1-7 *If capsule is used.* Capsule ejection system successful. Mission failure. For each astronaut, roll 1d10.
- 1-5 Astronaut is OK.
- 6-9 Astronaut sustains serious injury and retires from the program.
- 0 Astronaut takes a major radiation dose and subsequently dies. Mission is a catastrophic failure.
- If launch was a shuttle or minishuttle.* The craft is destroyed. Mission failure. For each astronaut, roll 1d10.
- 1-6 Astronaut is OK.
- 7-9 Astronaut sustains serious injury and retires from the program.
- 0 Astronaut takes a major radiation dose and subsequently dies. Mission is a catastrophic failure.
- 76-80 Radiation leak in flight. Roll percentile dice.
- 01-50 Minor leak, shielding protects crew, but mission is scrubbed. Proceed to Recovery step. Mission failure.
- 51-85 Major leak, each astronaut has a 25% chance of suffering fatal radiation exposure. Mission is scrubbed. Proceed to Recovery step. Mission failure. If any astronaut dies, mission is a catastrophic failure.
- 86-00 Major containment breach. All astronauts are killed. Catastrophic failure.
- 81-90 Major containment breach on pad. Roll 1d10.
- 1-8 Meltdown! Launch facility, components, and astronaut(s) are destroyed! Catastrophic failure. Launch facility must be completely rebuilt for the full 30MB cost.
- 9-0 Emergency system ejects capsule (shuttles and minishuttles may only suffer the fate of 1-8 above). Roll 1d10.
- 1-4 Parachutes are damaged by the heat of the meltdown. Each astronaut has a 20% chance of survival. If he survives, he has a 70% chance of serious injury and removal from the space program. Any deaths mean failure was catastrophic.
- 5-8 Successful ejection! Each astronaut has a 10% chance of fatal radiation poisoning. If he survives, he has a 20% chance of severe injuries and removal from the space program. Any deaths mean failure was catastrophic.
- 9-0 Capsule lands too close to booster. All astronauts receive a fatal dose of radiation and are killed. Failure is catastrophic.
- 91-00 Major reactor containment breach during ascent. Astronauts killed. Radiation contamination is widespread, causing public outcry that permanently cancels the NERVA program.

R – EARTH ORBITAL INSERTION BURN (NERVA)

(NERVA engines)

- 01-10 Radiation leak. Ground control scrubs mission. Proceed directly to Re-entry step. If returning from a lunar or Mars mission, proceed instead to the Earth De-Orbital Burn step. Mission failure. In addition, roll 1d10
- 1-4 Minor leak, shielding holds.
- 5-7 Minor leak, some crew exposure. Each crewman has a 25% chance of suffering radiation sickness severe enough to prevent him from going on any missions in the next turn.
- 8-9 Moderate leak. Each crew member has a 60% chance of severe radiation sickness, and retirement from the space program.
- 0 Major leak. Each crew member suffers severe radiation sickness and has a 50% chance of dying. Any surviving crew members retire from the space program. If any crew member dies, mission is a catastrophic failure.
- 11-15 Radiation leak and malfunction. Mission failure. Roll 1d10 on the table above, and roll on failure table E. Implement both results.
- 16-00 Roll on failure table E.

S – EARTH, LUNAR MISSION BURN (NERVA)

(NERVA engines)

- 01-10 Radiation leak. Ground control scrubs mission. Any further rolls using the NERVA have a –10% safety penalty. Mission failure. In addition, roll 1d10
- 1-4 Minor leak, shielding holds.
- 5-7 Minor leak, some crew exposure. Each crewman has a 25% chance of suffering radiation sickness severe enough to prevent him from going on any missions in the next turn.
- 8-9 Moderate leak. Each crew member has a 60% chance of severe radiation sickness, and retirement from the space program.
- 0 Major leak. Each crew member suffers severe radiation sickness and has a 50% chance of dying. Any surviving crew members retire from the space program. If any crew member dies, mission is a catastrophic failure.
- 11-90 Ignition failure, roll 1d10. In addition, there is a 10% chance of having to roll 1d10 on the table above as well.
- 1-3 Glitch is minor, thrust good. Mission still a success.

4-6 Repairs are made and a substitute thrust can make the burn, but the mission is scrubbed. Mission failure.

7-0 Repairs cannot be made, the vessel is stranded in an earth-lunar or earth-Mars orbit. Go to the in-route activities step and stop there. Mission failure. If the crew cannot be rescued, the mission is a catastrophic failure.

91-00 Total containment breach, all aboard are killed. Catastrophic failure.

### T – INTERPLANETARY INROUTE ACTIVITIES

(Habitation Module)

01-10 Solar flare! Roll 1d10.

1-3 Flare pointed away from spacecraft. No effect.

4-6 Minor flare, regular shielding effective. No effect.

7-9 Moderate flare, crew must get to the solar storm shelter. Each crew member has a 5% chance of receiving a moderate radiation exposure, sufficient to incapacitate that crew member for the remainder of the mission. If there is no solar storm shelter, each crewmember has a 70% chance of receiving an incapacitating radiation dose, and a 15% chance of receiving a fatal radiation dose. If any crew member is so incapacitated, the mission must be cut to its shortest possible timeframe, and the mission is a failure. Any incapacitated crewmember has a 5% chance of dying each month until he is returned to earth. If any crewmember dies, the mission is a catastrophic failure. If all crewmembers are incapacitated, then the capsule is stranded, and if rescue is not successful, the mission is a catastrophic failure.

0 Major flare. All crewmembers must get to the solar storm shelter. All crewmembers have a 20% chance of receiving an incapacitating radiation dose, and a 5% chance of receiving a fatal radiation dose. If there is not solar storm shelter, each crew member has a 90% chance of receiving an incapacitating radiation dose and a 40% chance of receiving a fatal dose. Otherwise, treat as result 7-9 above. If any crewmembers are incapacitated, mission failure. If any crewmembers are killed, mission is a catastrophic failure.

11-90 Consult failure table G.

### U – MARS SURFACE ACTIVITIES

(Mars Lander)

01-15 Instrumentation failure, roll percentiles

01-25 Minor problem, backup systems take over, no effect.

26-50 Simple problem if any astronauts have previous mission experience, repairs are made, no effect. If the crew has no experience, go to 51-75 below.

51-75 Complex problem, repair instructions must be relayed from ground control. Must have working communications with ground control, roll 1d10.

1-6 Problem resolved with ground control's guidance, no effect.

7-0 Repair attempts fail, despite ground control's assistance, go to 76-00 below.

76-00 Problem cannot be repaired on Mars, roll 1d10.

1-4 Ground control elects to have the astronaut(s) in orbit control the lander remotely. This has no effect on the mission, provided good communication is maintained.

5-0 Mission is scrubbed. Proceed immediately to Mars Launch step. Mission failure.

NOTE: In the event of faulty communications between the lander and the orbiting craft (and thence to Earth), ground control will be unable to assist in the repair process, and the orbiting craft will be unable to assume remote control of the lander. If the problem cannot be repaired by the crew, then the craft will have to automatically roll a failure on chart AA on Mars Launch.

16-30 Internal power loss, automatic loss of communications with the orbiting craft, roll percentiles.

01-25 Minor problem, backup systems take over, communications are re-established, no effect on mission.

26-60 Simple problem, repairs made by the crew, roll 1d10.

1-4 Ground control doesn't like the results and scrubs the mission. Proceed immediately to Mars Launch step. Mission failure.

5-0 Ground control elects to continue the mission, there is no effect, unless a second internal power loss occurs later on in the same mission. Should this happen, go to 61-95 below.

61-95 Permanent power outage, stranded. Crew has  $\frac{3}{4}$  of current life support available. Mission failure. If no rescue is made, then the mission is a catastrophic failure.

96-00 Permanent power outage (same as above) and a second problem develops in the blackout. Re-roll percentiles on this table, re-rolling any additional internal power loss result.

31-50 Communications failure, roll percentiles.

01-25 Minor problem, backup system takes over.

26-60 Simple problem, repaired by crew unless no astronauts have experience (then go to 61-00 below).

61-00 Permanent communications loss with orbiting craft. Mission is scrubbed, proceed immediately to Mars Launch step. Mission failure.

51-65 Bad weather, roll percentiles.

01-25 Minor dust storm, no effect on mission.

26-50 Moderate dust storm, cancel next Mars Walk, but otherwise continue with mission.

51-75 Major series of dust storms, cancel all further Mars Walks.

76-00 Severe global dust storm. Mars stay cut short, proceed immediately to Mars Launch step. Mission failure.

66-75 Fuel or propellant problem, roll percentiles.

01-25 Minor problem, fuel gauge error, no effect.

26-50 A glitch in one of the fuel cells, roll 1d10.

1-6 One of the cells is draining too fast, but corrects itself.

7-0 One of the fuel cells shuts down completely. Mission is scrubbed. Proceed immediately to Mars Launch step. Mission failure.

Note: There is a total of three fuel cells and a minimum of two must be working. Otherwise, the ship is without power and is stranded.

51-75 Complex problem, roll 1d10

1-5 Reactant valve jams. Mission scrubbed. Proceed immediately to Mars Launch step. Mission is a failure.

6-0 Tanks are venting too fast. Mission is scrubbed. Proceed immediately to Mars Launch step. Mission is a failure.

76-00 Safety gauge shuts down, roll 1d10.

1-3 Fuel tank overheats causing overventing. Mission is scrubbed. Proceed immediately to Mars Launch step. Mission is a failure.

4-0 Cryogenic stir causes electrical arc, tank explodes, roll 1d10.

1-4 Craft badly damaged and stranded. 50% of available life support survives. Mission is a failure. Without rescue, mission is a catastrophic failure.

5-0 Explosion causes flash fire, crew is killed instantly. Catastrophic failure.

76-85 Engines, roll percentiles.

01-25 Minor problem, engine gauges are slightly off.

26-50 Simple problem, a computer glitch, but results in a -10% penalty during the Mars Launch step. Mission continues.

51-75 Complex problem, engine function is compromised. Safety factor is cut in half during the Mars Launch step. Mission continues.

76-00 Total engine failure. Crew stranded. Mission failure. Without rescue, mission is a catastrophic failure.

86-96 Atmosphere, roll percentiles.

01-25 Minor problem, filtering system slightly clogged.

26-50 Simple problem, CO2 content is too high, roll 1d10.

1-5 Repairs are successful, no effect on mission.

6-0 Repairs are unsuccessful, ground control scrubs mission. Proceed immediately to Mars Launch step. Mission failure.

51-75 Complex problem, atmosphere venting too fast. Proceed immediately to Mars Launch step. Mission failure.

76-00 Cabin pressure is lost. Proceed immediately to Mars Launch step. Mission failure. Each astronaut has a 20% chance of death due to decompression. If any deaths result, mission is a catastrophic failure.

97-00 Food and waste, roll percentiles.

01-25 Water recycling is slightly polluted, roll 1d10. If roll is greater than 8, then the crew is sick and mission is scrubbed and a failure. Proceed immediately to Mars Launch step if mission scrubbed.

26-50 Water recycling is broken, mission scrubbed and a failure. Proceed immediately to Mars Launch step.

51-75 Craft's coolant system shuts down, roll 1d10.

1-3 Repairs are good, mission continues.

4-0 Cabin begins to overheat, mission is scrubbed. Proceed immediately to Mars Launch step. Mission failure.

76-00 Containment backflow, quite messy, mission is scrubbed. Proceed immediately to Mars Launch step. Mission failure.

### V – MARS WALK

(EVA Suit)

01-85 Roll on failure table H.

86-00 Astronaut suffers personal injury. Roll 1d10

1-5 Injury is minor, surface activity cut short. Mission still a success.

6-8 Moderate injury, astronaut requires assistance. If no assistance rendered, astronaut dies. Astronaut cannot conduct surface activity for 1d6 months. If an astronaut dies, mission is a catastrophic failure, otherwise mission is still a success.

9 Serious injury, astronaut requires assistance. If no assistance rendered, astronaut dies. Crew must immediately launch to orbit and remain there until the normal orbital window for return. Mission failure. If an astronaut dies, mission is a catastrophic failure.

0 Fatal injury, astronaut dies. Ground control scrubs further surface activity, crew must launch to orbit and remain there until the normal orbital window for return. Mission is catastrophic failure.

### W – MARS ORBITAL BURN

(Habitation Module or Kicker)

01-85 Ignition failure, roll 1d10.

1-3 Glitch is minor, thrust is good, mission successful.

4-6 Repairs are completed, but system suffers a -10% on all future safety checks this mission. Mission successful.

7-0 Repairs cannot be made, the vessel is stranded. Go back to prior in-route activities step. Mission failure. If crew is not rescued, mission is a catastrophic failure.

86-00 Major fire breaks out, all aboard are killed. Catastrophic failure.

### X – MARS ORBITAL BURN (NERVA)

(NERVA engine)

01-10 Radiation leak. Ground control scrubs mission. Crew must take next available window for return. Mission failure. The NERVA suffers a -10% safety penalty for the remainder of this mission. In addition, roll 1d10.

1-4 Minor leak, shielding holds.

5-7 Minor leak, some crew exposure. Each crewman has a 25% chance of suffering radiation sickness severe enough to prevent him from going on any missions in the next turn.

8-9 Moderate leak. Each crew member has a 60% chance of severe radiation sickness, and retirement from the space program.

0 Major leak. Each crew member suffers severe radiation sickness and has a 50% chance of dying.

Any surviving crew members retire from the space program. If any crew member dies, mission is a catastrophic failure.

Whichever of the results above are rolled, reroll the effect for each month remaining in the mission. Thus, if 5-7 were rolled, each astronaut would again have a 25% chance of receiving another radiation dose. A second dose at the 5-7 level results in incapacity and retirement, a third dose is fatal. Two dose at the 8-9 level are fatal. In the event of 0, all crew members will be dead well before they can get home.

- 11-15 Radiation leak and malfunction. Mission failure. Roll 1d10 on the table above, and roll on failure table V. Implement both results.
- 16-00 Roll on failure table V.

### Y – MARS DE-ORBITAL BURN

(Mars Landers)

- 01-60 Premature burnout, engine cut-off, roll 1d10.
  - 1-6 Additional burn attempts are unsuccessful to de-orbit. Mission scrubbed. Mission failure.
  - 7-9 Engine performs below minimum thrust requirement. When landing attempt is made, roll on failure chart Y.
  - 0 Engine shuts down and causes radical orbital decay. When landing attempt is made roll on failure chart Y.
- 61-00 Burn is good, proceed with mission.

### Z – MARS LANDING

(Mars Landers)

- 01-25 Retro fire failure, roll 1d10.
  - 1-8 Landing is aborted. Main engines thrust craft into orbit. Mission scrubbed. Mission failure.
  - 9-0 Engines stay shutdown and vehicle has a hard landing. Roll 1d10.
    - 1-3 Hard landing, damage is minimal. Mission success.
    - 4-6 Hard landing, descent stage and living quarters damaged. Half of the craft's life support capacity is lost. If there is insufficient remaining capacity for the full planned stay on the surface, mission is a failure.
    - 7-8 Hard landing, widespread damage. Each crew member has a 50% chance of injury and incapacitation. If all crew members are incapacitated, mission is a catastrophic failure. Otherwise, crew must make an immediate liftoff attempt with a –20% to the safety factor of the Lander. Mission failure.
    - 9-0 Vehicle crashes and is destroyed. Catastrophic failure.
- 26-50 Parachute problem, roll 1d10.
  - 1-4 Minor problems, parachute deploys properly. Mission success.
  - 5-9 Parachute streamer, capsule hits hard. Roll 1d10 on the 9-0 result above.
  - 0 Total parachute failure. Roll 1d10 on the 9-0 result above, but add 2 to the die roll. Any result over 0 is treated as 0.
- 51-75 Vehicle approaches landing target area, roll 1d10.

1-5 Hard landing, but craft is OK, systems are operating.

6-8 Severe landing and craft is damaged. When launch is attempted, roll on failure chart Z.

9-0 Vehicle crashes and all aboard are killed. Catastrophic failure.

76-00 Maneuvering failure, roll 1d10.

1-3 Craft lands within target area, all systems are go!

4-7 Craft lands in rough terrain, roll 1d10.

1-4 Crew finds an open landing area, all systems are go!

5-0 Craft lands in rough terrain causing damage to it. Go to failure chart Z when launching.

8-0 Vehicle crash lands on the edge of a crater. All aboard are killed. Catastrophic failure.

### AA – MARS LAUNCH

(Mars Lander)

- 01-25 Minor programming error is corrected and launch is good.
- 26-50 Main engine shutdown, roll 1d10.
  - 1-3 Repairs made, launch is good.
  - 4-0 Craft is stranded, mission failure. Without rescue, mission is catastrophic failure.
- 51-70 Launch is underpowered, go to MARS LANDING CHART. Note: if roll is 01-25, additional power has been throttled in and launch is good. Otherwise, craft is stranded on Mars. Mission failure. Without rescue, mission is a catastrophic failure.
- 71-80 Main engine shutdown. Mission failure. Without rescue, mission is a catastrophic failure.
- 81-00 Explosion! Vehicle is destroyed and crew is killed. Mission is a catastrophic failure.

### BB – MARS MISSION BURN

(Habitation module or kicker)

- 01-85 Ignition failure, roll 1d10.
  - 1-3 Glitch is minor, thrust is good. Mission still a success.
  - 4-6 Repairs are made and a substitute thrust can make the burn, but the mission is extended by 1 to 6 months. Mission is still a success if enough excess life support exists to sustain the astronauts through the extended mission.
  - 7-0 Repairs cannot be made, craft is stranded in Mars orbit. Mission failure. If the crew cannot be rescued, mission is catastrophic failure.
- 86-00 Major fire breaks out, all aboard are killed. Catastrophic failure.

### CC – MARS MISSION BURN (NERVA)

(NERVA engines)

- 01-10 Radiation leak. Ground control scrubs mission. Any further rolls using the NERVA have a –10% safety penalty. Mission failure. In addition, roll 1d10
  - 1-4 Minor leak, shielding holds.
  - 5-7 Minor leak, some crew exposure. Each crewman has a 25% chance of suffering radiation sickness severe enough to prevent him from going on any missions in the next turn.

- 8-9 Moderate leak. Each crew member has a 60% chance of severe radiation sickness, and retirement from the space program.
- 0 Major leak. Each crew member suffers severe radiation sickness and has a 50% chance of dying. Any surviving crew members retire from the space program. If any crew member dies, mission is a catastrophic failure.
- 11-90 Ignition failure, roll 1d10. In addition, there is a 10% chance of having to roll 1d10 on the table above as well.
  - 1-3 Glitch is minor, thrust good. Mission still a success.
  - 4-6 Repairs are made and a substitute thrust can make the burn, but the mission is scrubbed. Mission failure.
  - 7-0 Repairs cannot be made, the vessel is stranded in an earth-lunar or earth-Mars orbit. Go to the in-route activities step and stop there. Mission failure. If the crew cannot be rescued, the mission is a catastrophic failure.
- 91-00 Total containment breach, all aboard are killed. Catastrophic failure.

*DD – VENUS MISSION BURN*  
(Habitation module or kicker)

- 01-85 Ignition failure, roll 1d10.
  - 1-3 Glitch is minor, thrust is good. Mission still a success.
  - 4-6 Repairs are made and a substitute thrust can make the burn, but the craft is on a poor heading for Mars rendezvous. When mission reaches Mars, go directly to failure chart V.
  - 7-0 Repairs cannot be made, craft is stranded in an Earth-Venus orbit. Return to the prior In-route Activities step. Mission failure. If the crew cannot be rescued, mission is catastrophic failure.
- 86-00 Major fire breaks out, all aboard are killed. Catastrophic failure.

*EE – COURSE ADJUSTMENT BURN*  
(Ion Drive)

- 01-40 Minor glitch, problem corrected. Mission still a success.
- 41-75 Thrust problem, roll 1d10.
  - 1-5 Problem partially fixed, but all future rolls suffer a – 10% on the Ion Drive safety check.
  - 6-9 Engine cannot produce full thrust. Double remaining mission travel time. Mission is still a success if the crew have sufficient reserve life support capacity.
  - 0 Total engine failure. Craft is stranded. Mission failure. If the crew cannot be rescued, mission is a catastrophic failure.
- 76-90 Electrical problem, roll 1d10.
  - 1-5 Problem partially fixed, but all future rolls suffer a – 10% on the Ion Drive safety check.
  - 6-9 Control systems shorted out. Ion drive destroyed. Craft is stranded. Mission failure. If the crew cannot be rescued, mission is a catastrophic failure.
  - 0 Coils overheat, causing fire that sweeps through the module. All aboard are killed. Catastrophic failure.
- 91-00 Propellant problem, roll 1d10.

- 1-5 Problem partially fixed, but all future rolls suffer a – 10% on the Ion Drive safety check.
- 6-9 Propellant release is erratic. When craft reaches the next Orbital Burn step, automatically roll on the failure chart.
- 0 Explosion! Craft destroyed and all aboard are killed. Catastrophic failure.

*FF – COURSE ADJUSTMENT BURN*  
(NERVA)

- 01-30 Minor glitch, problem corrected. Mission still a success.
- 31-40 Radiation leak. Ground control scrubs mission. Any further rolls using the NERVA have a –10% safety penalty. Mission failure. In addition, roll 1d10
  - 1-4 Minor leak, shielding holds.
  - 5-7 Minor leak, some crew exposure. Each crewman has a 25% chance of suffering radiation sickness severe enough to prevent him from going on any missions in the next turn.
  - 8-9 Moderate leak. Each crew member has a 60% chance of severe radiation sickness, and retirement from the space program.
  - 0 Major leak. Each crew member suffers severe radiation sickness and has a 50% chance of dying. Any surviving crew members retire from the space program. If any crew member dies, mission is a catastrophic failure.
- 41-75 Thrust problem, roll 1d10.
  - 1-5 Problem partially fixed, but all future rolls suffer a – 10% on the Ion Drive safety check.
  - 6-9 Engine cannot produce full thrust. Double remaining mission travel time. Mission is still a success if the crew have sufficient reserve life support capacity.
  - 0 Total engine failure. Craft is stranded. Mission failure. If the crew cannot be rescued, mission is a catastrophic failure.
- 76-90 Electrical problem, roll 1d10.
  - 1-5 Problem partially fixed, but all future rolls suffer a – 10% on the Ion Drive safety check.
  - 6-9 Control systems shorted out. Ion drive destroyed. Craft is stranded. Mission failure. If the crew cannot be rescued, mission is a catastrophic failure.
  - 0 Coils overheat, causing fire that sweeps through the module. All aboard are killed. Catastrophic failure.
- 91-00 Propellant problem, roll 1d10.
  - 1-5 Problem partially fixed, but all future rolls suffer a – 10% on the Ion Drive safety check.
  - 6-9 Propellant release is erratic. When craft reaches the next Orbital Burn step, automatically roll on the failure chart.
  - 0 Explosion! Craft destroyed and all aboard are killed. Catastrophic failure.

*GG – SOLAR SAIL DEPLOYMENT*  
(Solar Sail)

- 01-40 Minor glitch, problem resolved. Continue with mission.
- 41-75 Sail fails to deploy properly, roll 1d10.
  - 1-4 Crew are able to resolve problem.
  - 5-9 Problem requires EVA. Check EVA safety and if successful, roll 1d10.

- 1-4 Crew is able to fully resolve problem.
- 5-8 Problem is only partially resolved. Solar sail is usable but repairs could easily fail. Solar sail suffers -30% on safety factor for remainder of mission.
- 9-0 Problem cannot be resolved. Sail fails to deploy. Ground control scrubs mission. Mission failure.
- 0 Sail too badly damaged to recover. Mission scrubbed. Mission failure.
- 76-90 Sail damaged on deployment, roll 1d10.
  - 1-4 Damage is minor, no effect on performance, continue with mission.
  - 5-8 Moderate damage, some loss of performance. Add one month to the outbound and homebound phases of the mission. Solar sail suffers -10% on safety factor for remainder of mission.
  - 9-0 Severe damage. Sail unusable. Mission scrubbed. Mission failure.
- 91-00 Steering systems damaged on deployment, roll 1d10.
  - 1-3 Backup systems functioning properly, continue with mission.
  - 4-6 Backup systems functioning below optimum performance, solar sail suffers -20% on safety factor for remainder of mission.
  - 7-8 Backup systems functioning below optimum performance, ground control scrubs mission. Mission failure.
  - 9-0 Total steering system failure. Mission scrubbed. Mission failure.

### HH – SOLAR SAIL

(Solar sail)

- 01-40 Minor problem, repairs made, continue with mission.
- 41-70 Damage to sail, roll 1d10
  - 1-4 Minor damage, sail performance unaffected.
  - 5-7 Moderate damage, -10% to all future solar sail rolls.
  - 8-9 Severe damage, -20% to all future solar sail rolls, plus add one month to each remaining travel leg of the journey.
  - 0 Solar sail shredded and unusable. Craft stranded. Mission failure. Without rescue, mission is a catastrophic failure.
- 71-00 Damage to steering shrouds, roll 1d10.
  - 1-4 Minor damage, sail performance unaffected.
  - 5-7 Moderate damage, one shroud snaps. -20% to all future solar sail rolls, plus add one month to each remaining travel legs.
  - 8-9 Severe damage, several shrouds snap, steering ability severely affected. -40% to all future solar sail rolls, automatically roll on the orbital burn failure chart for the destination when reached.
  - 0 Total steering loss. Craft stranded. Mission failure. Without rescue, mission is a catastrophic failure.

### II – SPACE CONSTRUCTION

(Space Construction)

- 01-70 Construction failure. Attempts may be made again with the same components on a future turn.
- 71-90 One of the components damaged. Roll 1d10.

- 1-5 Damage minor, easily repaired. Attempt may be made again with same components on a future turn.
- 6-0 Major damage, one of the components (determined randomly) is no longer usable and must be replaced.
- 91-10 Astronaut injured, roll 1d10.
  - 1-5 Minor injury, mission can continue.
  - 6-9 Serious injury, mission scrubbed. Astronaut must be returned to Earth at earliest opportunity. Mission failure.
  - 0 Astronaut crushed between components. Catastrophic mission failure.

### JJ – HIBERNATION

(Hibernation)

- 01-40 Minor malfunction, backup systems take over, no effect.
- 41-00 Life support system malfunction, roll 1d10.
  - 1-4 Backup systems are able to recover function, no effect.
  - 5-7 Backup systems are unable to recover on their own. If there are any astronauts not in hibernation, system can be restored manually. Otherwise, see 8-9 below.
  - 8-9 Systems unable to recover. Emergency routines take over, waking up astronaut. This hibernation module cannot be used again. If there is insufficient life support to sustain all awake astronauts through mission end, mission is a catastrophic failure if no rescue succeeds.
  - 0 Systems unable to recover and emergency routines malfunction. Astronaut killed. Catastrophic failure.