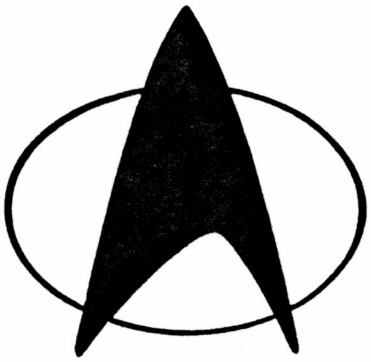
STAR TREK
THE NEXT GENERATION

Writers' Technical Manual
Fourth Season Edition

A Paramount Communications Company

CONTENTS



STAR TREK: THE NEXT GENERATION WRITERS' TECHNICAL MANUAL

OR: "YES, BUT WHICH BUTTON DO I PUSH TO FIRE THE PHASERS?"

by
Rick Sternbach
and
Mike Okuda

FOURTH SEASON EDITION

ABOUT THIS DOCUMENT

The *Star Trek* Writers' Technical Manual was developed to provide a handy reference for the detailed technical background that our writers sometimes need, and is offered as a supplement to the Writers'/Directors' Guide. It is NOT required reading — relatively few of our scripts use more than a tiny amount of this material. Still, some story points do hinge on this stuff, and *Star Trek* has always prided itself on scientific accuracy and internal consistency -- hence this document.

This document is divided into four major sections:

I. A Technical Primer. This section touches briefly on most of the ship's major systems, with explanations on how things work and definitions of many key scientific terms. Most listings include a capsule "In Brief" description of the system, as well as more detailed background information.

II. Technical Memoranda. A collection of technical memos discussing some of the more esoteric scientific background. Much of this material was jointly developed by our producers, writers, and art department at the beginning of the show, and is for those looking for a deeper technical understanding of our hardware.

III. Emergency Procedures. When bad things happen to good starships.

IV. A Celestial Bestiary. A collection of weird, often dangerous, and scientifically semi-plausible phenomena which is offered here as a springboard for the writers' imagination.

A friendly reminder: Just because this stuff exists, it doesn't mean you *have* to use it in your script. To quote Gene Roddenberry, "Believability is the test. What do real people do and say? When a policeman picks up his .38, does he explain how it works? Do you know how the trigger levers work the firing pin and so on? All you need or really care to know is that when he uses it, you see it work, and you accept it. So why should the captain explain a phaser when he picks it up?" *Star Trek* is about people, not about technology.

This document was written and designed by Rick Sternbach and Mike Okuda. The *Star Trek* Writers' Technical Manual is
 Additional art by Andrew Probert.

SECTION I - A TECHNICAL PRIMER

USS Enterprise Overview

The new USS Enterprise is the fifth starship to bear the name. It is a Galaxy Class vessel, the largest and most powerful in the Starfleet. It is Starfleet's flagship and continues the tradition established by Captain James Kirk on the original Enterprise.

The Enterprise is about 2102 feet long and weighs over five million metric tons. The basic hull structure is fabricated from tritanium/duranium alloys.

The Galaxy-Class Enterprise boasts a complement of about 1012 people, including crew members and their families. The ship is capable of independent operation for about three years without refueling. The Enterprise was built at Starfleet's Utopia Planitia Yards, high in orbit above the planet Mars and is not designed to land on a planet.

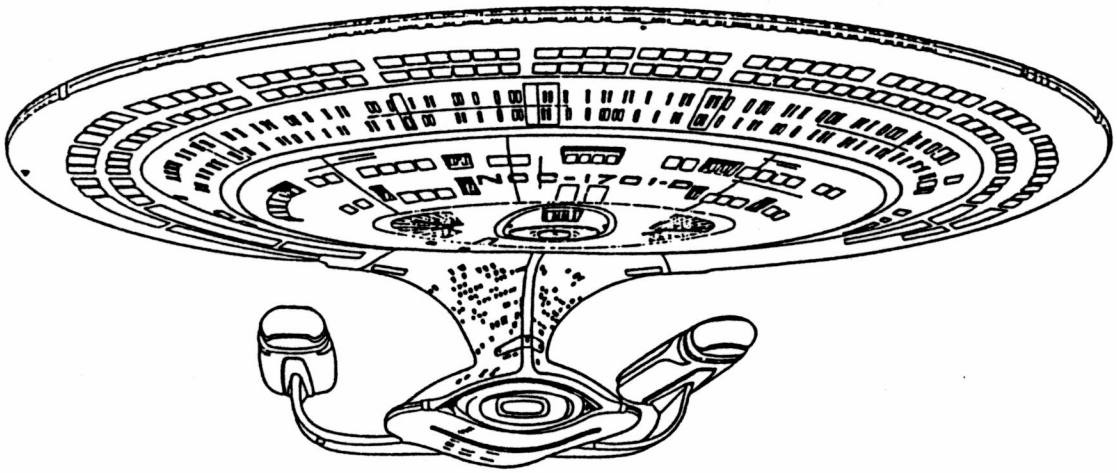
The mission of the Enterprise is primarily research and diplomacy, and it is superbly equipped for both. For those occasions when a show of military force is unavoidable, the ship is also equipped with an impressive array of defensive and offensive weapons.

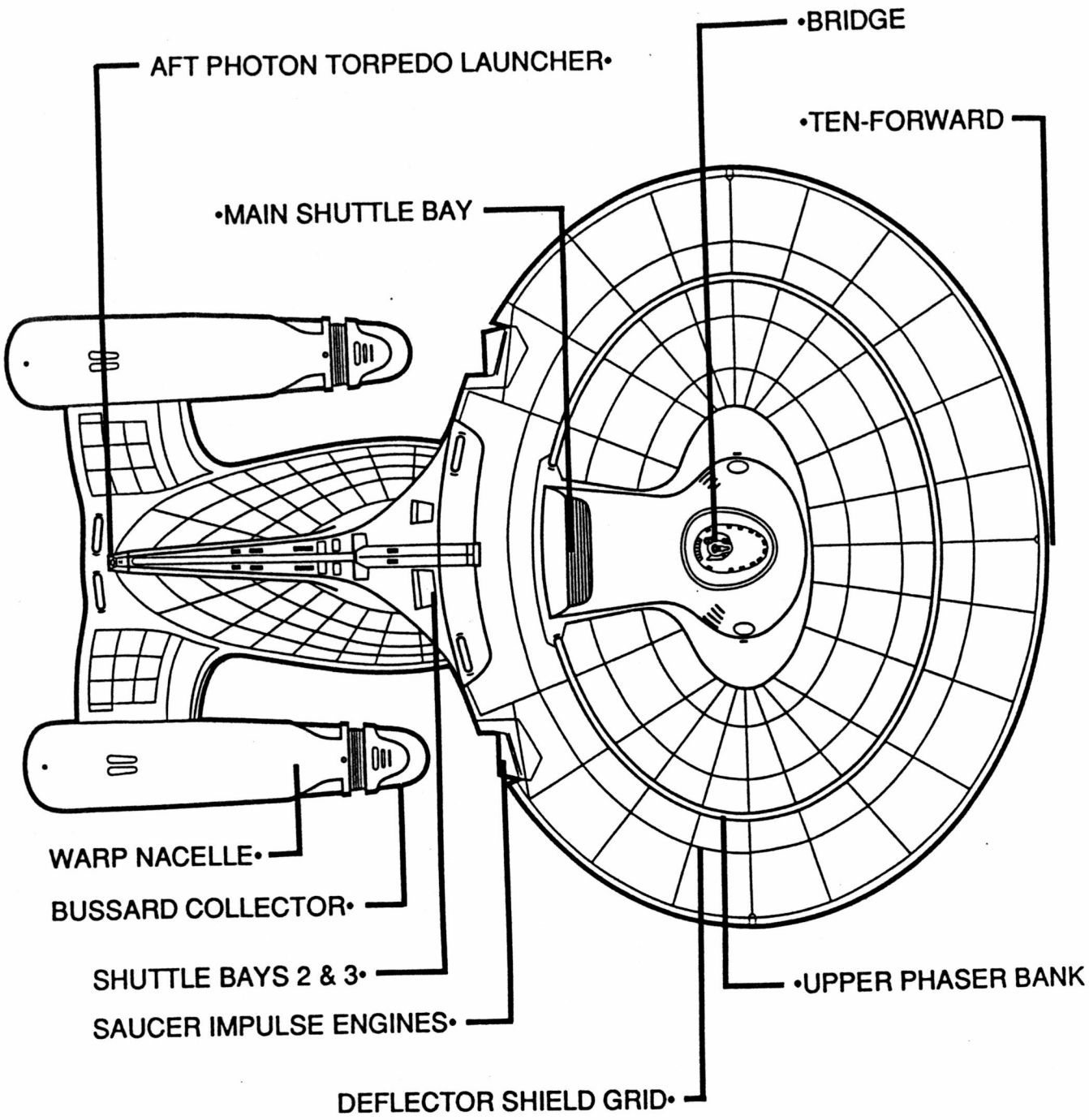
There are perhaps as few as six Galaxy Class starships in the Starfleet. (One, the USS Yamato, was destroyed in the episode "Contagion". We assume that there also exists a USS Galaxy, after which the class is named.)

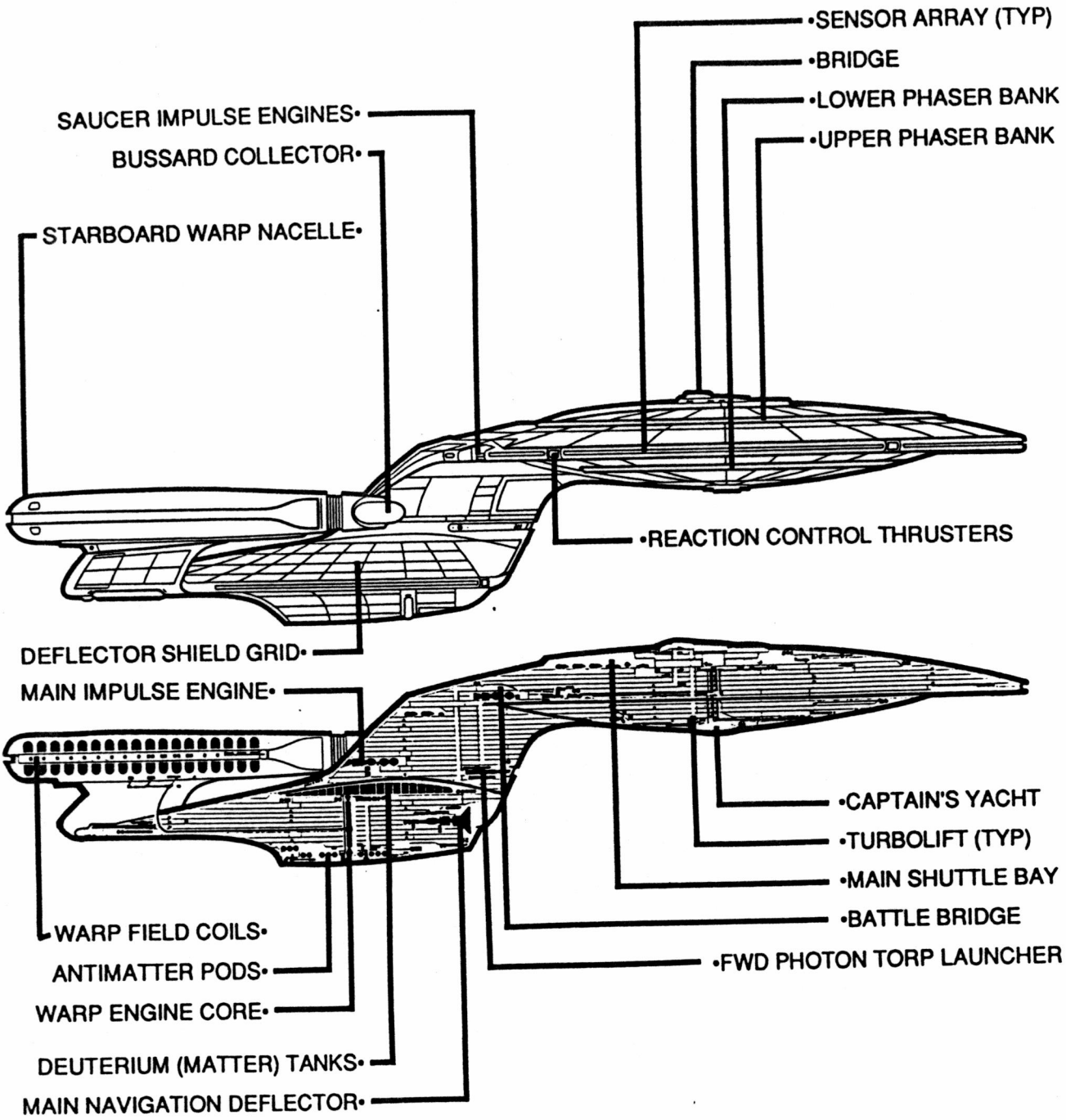
Locations of Key Enterprise Sets

Bridge, Battle - Deck 8
Bridge, Main- Deck 1
Brig - Deck 38
Cargo Bays - Deck 4
Cargo Bays - Deck 38+39
Crusher, Beverly's Quarters - Deck 7
Docking Port (Dorsal) - Deck 25
Engineering, Main - Deck 36
Geordi's Quarters - Deck 4
Gymnasium - Deck 11
Holodecks 1-4 - Deck 11
Observation Lounge - Deck 1
Picard's Quarters - Deck 8
Ready Room - Deck 1
Riker's Quarters - Deck 8
Shuttlebay, Main - Deck 4
Shuttlebay 2-3 - Deck 13
Sickbay - Deck 12
Ten-Forward - Deck 10
Transporter Rooms 1-4 - Deck 6
Transporter Rooms 5-6 - Deck 14
Troi's Quarters - Deck 8
Wesley's Quarters - Deck 5
Worf's Quarters - Deck 5

Starship Enterprise -- NCC-1701D




•BRIDGE
AFT PHOTON TORPEDO LAUNCHER•
•TEN-FORWARD
•MAIN SHUTTLE BAY
WARP NACELLE•
BUSSARD COLLECTOR•
SHUTTLE BAYS 2 & 3•
SAUCER IMPULSE ENGINES•
•UPPER PHASER BANK
DEFLECTOR SHIELD GRID•

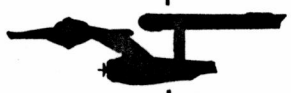
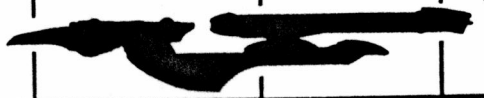

•SENSOR ARRAY (TYP)
•BRIDGE
•LOWER PHASER BANK
•UPPER PHASER BANK
SAUCER IMPULSE ENGINES•
BUSSARD COLLECTOR•
STARBOARD WARP NACELLE•
•REACTION CONTROL THRUSTERS
DEFLECTOR SHIELD GRID•
MAIN IMPULSE ENGINE•
•CAPTAIN'S YACHT
•TURBOLIFT (TYP)
•MAIN SHUTTLE BAY
•BATTLE BRIDGE
•FWD PHOTON TORP LAUNCHER
WARP FIELD COILS•
ANTIMATTER PODS•
WARP ENGINE CORE•
DEUTERIUM (MATTER) TANKS•
MAIN NAVIGATION DEFLECTOR•

USS Enterprise Deck Breakdown

Deck Number	Primary Hull (Saucer Section)	Deck Number	Secondary Hull (Engineering/Battle Section)
1	Main Bridge, Observation Lounge	-	-
2	Junior Officers' Quarters	-	-
3	Junior Officers' Quarters	-	-
4	Main Shuttle Bay, Cargo Bays	-	-
5	Science labs and Residential Apartmen	-	-
6	Transporter rooms 1-4, Science labs	-	-
7	Residential Apartments	-	-
8	Residential Apartments	8	Battle Bridge
9	Residential Apartments, life support	9	Docking latches
10	Ten-Forward, computer core, lifeboats	10	Emergency batteries, phaser bank support
11	Holodecks, Apartments	11	Life support equipment
12	Sickbay, Gymnasium	12	Science Labs
13	Residential Apartments, life support	13	Shuttle Bays 2 and 3
14	Residential Apartments	14	Shuttle bay support, Transporters 5 & 6
15	Maintenance	15	Science Labs
16	Captain's Yacht	16	Maintenance
-	-	17	Living quarters
-	-	18	Living quarters
-	-	19	Living quarters
-	-	20	Living quarters
-	-	21	Power distribution
-	-	22	Engineering support
-	-	23	Main impulse engines
-	-	24	Life support
-	-	25	Photon torpedo launcher , Docking port
-	-	26	Engineering support
-	-	27	Deuterium (hydrogen) pumps and fill ports
-	-	28	Deuterium (hydrogen) fuel storage
-	-	29	Deuterium (hydrogen) fuel storage
-	-	30	Deuterium injection reactors
-	-	31	Science labs
-	-	32	Living quarters
-	-	33	Living quarters
-	-	34	Environmental support
-	-	35	Aft photon torpedo launcher
-	-	36	Main Engineering, Geordi's office
-	-	37	Environmental support, waste management
-	-	38	Cargo bays, brig
-	-	39	Cargo bays
-	-	40	Antimatter injection reactors
-	-	41	Antimatter fuel storage pods
-	-	42	Antimatter fuel storage pods, fill ports

Note: This is a listing of selected features only... the Enterprise is a BIG starship with a LOT of other stuff.

A brief history of the Starships Enterprise

	Name	Starfleet Registry	Description	Commanded by	Class-type	Crew size	length meters (feet)	Year launched (AD)
1	USS ENTERPRISE 	NCC-1701	Ship from the first STAR TREK television series	Captain James Kirk (et al)	Constitution	430	289 (947)	2245
1	USS ENTERPRISE (refit) 	NCC-1701	Same ship as above, refitted for the first Star Trek movie. Seen in Star Trek movies I, II, and III. Destroyed in Star Trek III while trying to save Spock.	Captain James Kirk (et al)	Constitution	500	305 (1000)	2245
2	USS ENTERPRISE 	NCC-1701-A	Second starship to bear the name. Refit of starship USS Yorktown. Seen in Star Trek IV and V.	Captain James Kirk	Constitution	500	305 (1000)	2286
3	USS ENTERPRISE 	NCC-1701-B	Third starship to bear the name As yet unseen.	-unknown-	Excelsior	-unk-	467 (1531)	-unk-
4	USS ENTERPRISE 	NCC-1701-C	Fourth starship to bear the name. Seen in "Yesterday's Enterprise" Lost in battle, ca. 2344 AD.	Captain Rachel Garrett	Ambassador	700	526 (1725)	-unk-
5	USS ENTERPRISE 	NCC-1701-D	Fifth starship to bear the name. As seen in Star Trek: TNG	Captain Jean-Luc Picard	Galaxy	1012	641 (2102)	2363

Note: For purposes of comparison, the first season of ST*TNG was set in the year 2364.

Warp Drive

In brief: To traverse the literally astronomical distances between the stars, the Enterprise employs WARP ENGINES. This system actually warps space, enabling the ship to travel faster than light. The primary fuel source of the Enterprise is ANTIMATTER.

Warp speed: Warp Factor One is the speed of light. Higher warp factors are computed according to a geometric formula. Normal cruising speed of the Enterprise is Warp Six, about 392 times the speed of light. Maximum rated speed is Warp 9.6 (1,909 times light speed), and the ship can exceed Warp 9.9 for only a few minutes. Under NO circumstances can the Enterprise or any other ship attain or exceed Warp 10. See the table on the next page for approximate travel times at various warp factors.

Power: The heart of the warp drive system is a matter/antimatter reactor in which deuterium plasma (hydrogen) is brought together with antimatter. This reactor is part of our Engineering set.

Antimatter: This refers to matter whose electrical charge and spin is opposite to that of "normal" matter. (For example, a proton — normally positively charged — would have a negative electric charge.) When matter and antimatter are brought together, they annihilate each other, releasing a tremendous amount of energy (as per Einstein's "$E=mc^2$"). Antimatter fuel is extremely volitile for this reason, and can only be stored in special magnetic containment pods which prevent the fuel from touching the rest of the ship.

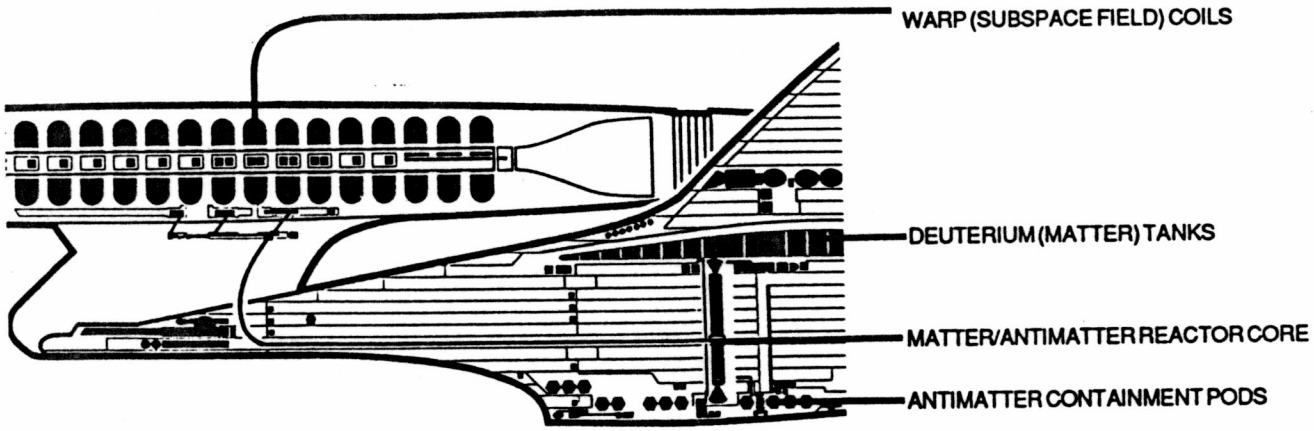
Dilithium Crystals: The matter/antimatter reactor includes a component called a Dilithium Chamber, which is used to "tune" the harmonics of the antimatter reaction. The dilithium chamber is a small drawer at the center of the antimatter reactor. This "tuning" enables the warp coils in the engines to generate the subspace field which makes warp speed possible. 24th Century technology allows dilithium to be regenerated, so there is rarely a problem with these once-priceless crystals.

Warp Ten. This is the absolute speed limit of the universe. As Warp Factors approach 10, speed increases dramatically (sort of like the Richter Scale) and so does the required power. Warp 9.9 is over 50% faster than Warp 9.6, and Warp 9.99 is nearly triple Warp 9.9. (Subspace radio signals propagate at about Warp 9.9999, about 100 times faster than Warp 9.6). Warp Ten is effectively infinite, and an object at that "speed" would occupy all points in the universe simultaneously.

Subspace: When travelling at warp speed, the Enterprise is actually suspended in a "bubble" of "subspace", which allows the ship to travel faster than light.

Refueling: The Enterprise normally carries sufficient antimatter and deuterium for about three years of operation. Refuelling is usually accomplished at a starbase by means of a special-purpose tanker. Entire antimatter containment pods can also be loaded through the external cargo bay doors. (Transporter loading is possible, but considered too dangerous because of the highly unstable nature of antimatter and the large mass involved.)

Warp drive



STAR TREK * TNG -- STARSHIP ENTERPRISE WARP SPEED CHART

SPEED	Miles per hour	Number of times speed of Light	APPROXIMATE TIME TO TRAVEL: Earth to moon	Across solar system	Between two nearby stars	Across one sector	Across Federation	Across entire Galaxy	To nearby Galaxy	NOTES
			250,000 miles	7,440,000,000 miles	5 light years	20 light years	10,000 light years	100,000 light years	2,000,000 light years	
Standard orbit	6,000	less than 0.00001 SUBLIGHT	42 hours	142 years	558,335 years	2 Million years	1.12 Billion years	11.17 Billion years	223.33 Billion years	synchronous orbit around Class M planet
Full impulse (1/4 lightspeed)	167 Million	0.25 SUBLIGHT	5.38 seconds	44 hours	20 years	80 years	40,000 years	400,000 years	8,000,000 years	normal maximum impulse speed
Warp factor 1	670 Million	1	1.34 seconds	11 hours	5 years	20 years	10,000 years	100,000 years	2,000,000 years	Warp One = SPEED OF LIGHT
Warp factor 2	7 Billion	10	0.13 seconds	1 hours	6 months	3 years	992 years	9,921 years	198,425 years	
Warp factor 3	26 Billion	39	0.03 seconds	17 minutes	2 months	1 years	257 years	2,568 years	51,360 years	
Warp factor 4	68 Billion	102	0.01323737 seconds	7 minutes	18 days	2 months	98 years	984 years	19,686 years	
Warp factor 5	143 Billion	214	0.00629170 seconds	3 minutes	9 days	1 months	47 years	468 years	9,357 years	
Warp factor 6	263 Billion	392	0.00342634 seconds	2 minutes	5 days	19 days	25 years	255 years	5,096 years	normal cruising speed
Warp factor 7	439 Billion	656	0.00204963 seconds	1 minutes	3 days	11 days	15 years	152 years	3,048 years	
Warp factor 8	686 Billion	1,024	0.00131331 seconds	39 seconds	2 days	7 days	10 years	98 years	1,953 years	
Warp factor 9	1.02 Trillion	1,516	0.00088687 seconds	26 seconds	1 days	5 days	7 years	66 years	1,319 years	
Warp factor 9.2	1.10 Trillion	1,649	0.00081573 seconds	24 seconds	27 hours	4 days	6 years	61 years	1,213 years	normal maximum speed
Warp factor 9.6	1.28 Trillion	1,909	0.00070450 seconds	21 seconds	23 hours	4 days	5 years	52 years	1,048 years	maximum rated speed can be maintained for 12 hours
Warp factor 9.9	2.04 Trillion	3,053	0.00044050 seconds	13 seconds	14 hours	2 days	3 years	33 years	655 years	auto-shutdown of engines after 10 minutes
Warp factor 9.99	5.30 Trillion	7,912	0.00016997 seconds	5 seconds	6 hours	22 hours	1 years	13 years	253 years	nearly infinite power required
Warp factor 9.9999	134 Trillion	199,516	0.00000674 seconds	0.20 seconds	13 minutes	53 minutes	18 days	6 months	10 years	maximum speed of subspace radio (using booster relays)
Warp factor 10	<infinite>	<infinite>	0	0	0	0	0	0	0	Warp 10 CANNOT be reached.
This speed is meaningless -- a starship travelling at Warp 10 would occupy all points in the universe simultaneously.										

(Use these estimates for comparison only -- your actual mileage may vary) - Rev 9/21/89

Other means of refueling: The front of the warp engine nacelles incorporates a set of powerful electromagnetic coils called a BUSSARD COLLECTOR. When the ship is travelling at high speed, these coils generate an electromagnetic field which collects stray atoms of interstellar hydrogen for use as fuel. The warp drive system also incorporates a device called a QUANTUM STATE REVERSAL UNIT, also called a "spin reverser" or an antimatter generator. This device uses transporter-based technology to actually dematerialize a quantity of hydrogen and rematerialize it with reversed charge and spin, thereby converting it to antimatter! The limitation here is that the spin reverser is extremely energy inefficient — it takes a whole lot of energy from the fusion generators to create a relatively small amount of antimatter.

Other uses of warp power: When necessary, we can pull power directly from the warp core for applications which require massive amounts of energy. In the past, such situations have included applying warp power directly to the main deflector and using the warp fields for non-propulsive tasks. Such power usage is generally measured in WARP EQUIVALENT POWER comparisons, as in "we're feeding the main deflector with Warp equivalent power nine."

Impulse Power

In brief: The Enterprise uses its IMPULSE POWER propulsion system for slower-than-light travel. The distances between the stars are so vast that impulse power is generally used only while in orbit or within a solar system.

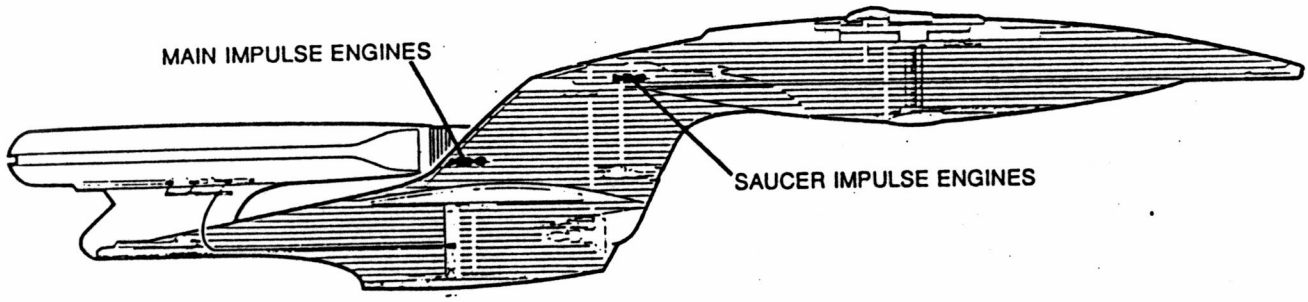
Power: The impulse drive is powered by a series of FUSION REACTORS which are located in the dorsal, just below the saucer. A set of high-powered magnetic accelerator coils drives the reactor exhaust through a set of subspace field coils, which propel the ship at up to .999 of lightspeed. A second set of impulse engines is located on the rim of the saucer, for use when the ship is separated.

Fuel: The impulse fusion reactors are fueled by frozen hydrogen, (actually, a sort of a very cold ice slush) also called by its isotope name, DEUTERIUM.

Speed: Normal maximum impulse speed is about one-fourth the speed of light. Greater sublight speeds are possible, but above this, it is considered more efficient to go to Warp drive. Note that although one-quarter lightspeed is extremely slow in interstellar terms, it is nearly 10,000 times faster than our present-day space shuttle. See the accompanying speed chart for approximate travel times.

Speed terminology: When at sublight, it is rarely necessary to specify an actual speed. It is usually sufficient to specify "slowing to orbital velocity", "holding at station-keeping" (when you want to match the speed of another craft), or "accelerating to full impulse". On those occasions when it is necessary to specify an actual speed, these are usually expressed in fractions of the speed of light. Full impulse is "point-two-five light" or "quarter lightspeed". (Orbital velocity is less than .00001 lightspeed.) Very slow speeds are expressed in terms of meters-per-second (as in "final docking approach... one-point-two meters per second.")

Impulse Engines



Main Bridge

In brief: A tiny bubble at the top of the saucer-shaped primary hull of the Enterprise. This is the command center from which all the starship's activities are coordinated. See diagram on following page.

Command area: At the center of the Main Bridge. Provides seating and information displays for the Captain and two other officers.

Conn and Ops: These two forward stations are responsible for routine ship flight and operations.

Tactical: Responsible for weaponry, defense, and internal security.

Aft stations: A variety of special-purpose consoles including Science, Mission Operations, Environment, and Engineering.

Battle Bridge: In a battle situation, when the ship is split into two parts, command of the (lower) battle section is transferred to the Battle Bridge. In such an event, the main bridge crew (along with the captain) enter the EMERGENCY TURBOLIFT which transports them directly to the Battle Bridge, located on Deck 8. A replacment crew takes over responsibility for the Main Bridge, controlling the primary hull

Notes on operating the Enterprise's control panels: (*The following material was distributed to the cast at the start of Star Trek's first season.)*

The most important thing to remember in using the control panels on the new Starship Enterprise is that they're very easy to use. Like certain brands of automatic cameras, they're so advanced, they're simple.

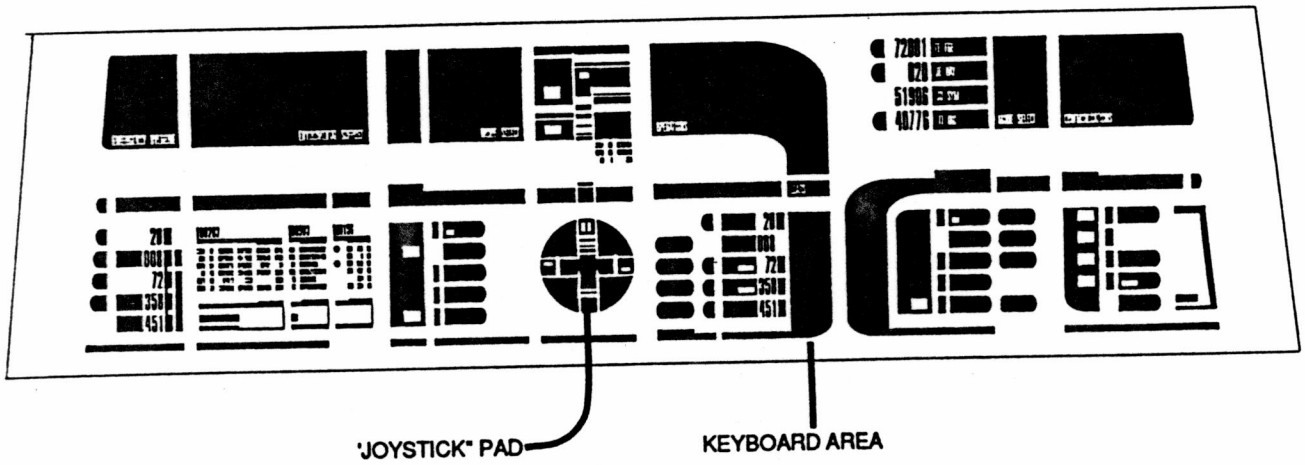
Most Enterprise control panels have a keyboard area which is usually closest to the operator. These are the buttons which control most routine functions, and about three-fourths of your control panel "business" should be in this area. This will represent most routine things that you want your panel to do. Less routine tasks may require you to touch some controls outside of the keyboard area.

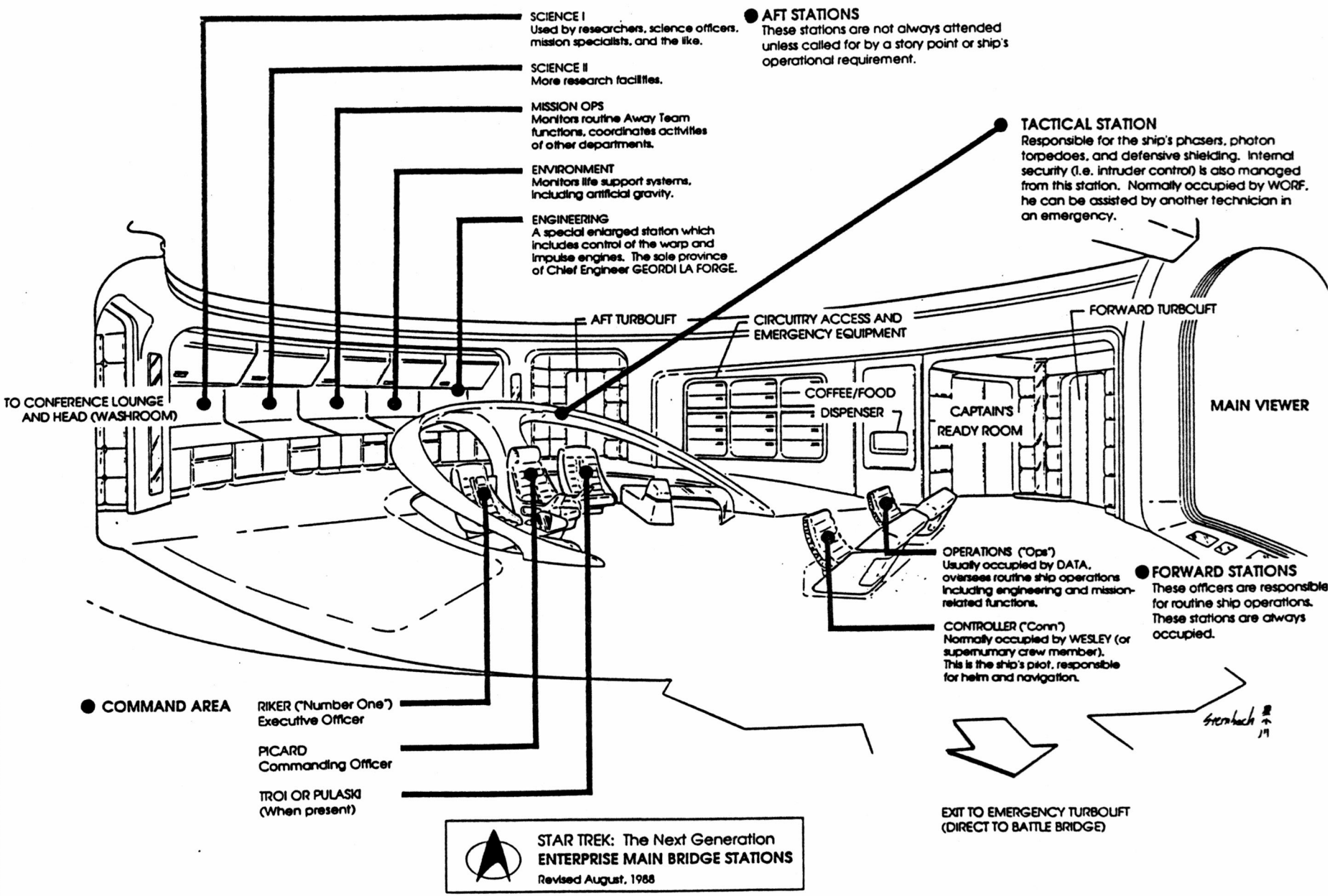
One specialized item you may wish to use on occasion is the *joystick pad* provided on some panels for manual steering, targeting, and such. Most aiming and steering will be done automatically, but you may want to use the joystick pads for occasional things the computer isn't programmed to handle.

Our computers can anticipate most of your needs and are constantly reprogramming themselves to handle them with a minimum effort on your part. Most routine operations will require only a few keystrokes, or perhaps only a voice command. **You do not have to be a concert pianist to fly the ship.** The only time you will need to demonstrate fast and furious keyboard work is when you're doing something very unusual, or when some kind of system failure requires you to take manual control.

Always remember that your characters are skilled professionals with many years of starship experience. Even when things get rough, you should have no difficulty in operating your controls with ease — and maybe even a bit of flair.

"Ops" control panel




SCIENCE I
Used by researchers, science officers, mission specialists, and the like.
SCIENCE II
More research facilities.
MISSION OPS
Monitors routine Away Team functions, coordinates activities of other departments.
ENVIRONMENT
Monitors life support systems, including artificial gravity.
ENGINEERING
A special enlarged station which includes control of the warp and impulse engines. The sole province of Chief Engineer GEORDI LA FORGE.
AFT STATIONS
These stations are not always attended unless called for by a story point or ship's operational requirement.
TACTICAL STATION
Responsible for the ship's phasers, photon torpedoes, and defensive shielding. Internal security (i.e. intruder control) is also managed from this station. Normally occupied by WORF, he can be assisted by another technician in an emergency.
AFT TURBOLIFT
CIRCUITRY ACCESS AND EMERGENCY EQUIPMENT
FORWARD TURBOLIFT
TO CONFERENCE LOUNGE AND HEAD (WASHROOM)
COFFEE/FOOD DISPENSER
CAPTAIN'S READY ROOM
MAIN VIEWER
OPERATIONS ("Ops")
Usually occupied by DATA, oversees routine ship operations including engineering and mission-related functions.
CONTROLLER ("Conn")
Normally occupied by WESLEY (or supernumary crew member). This is the ship's pilot, responsible for helm and navigation.
FORWARD STATIONS
These officers are responsible for routine ship operations. These stations are always occupied.
COMMAND AREA
RIKER ("Number One")
Executive Officer
PICARD
Commanding Officer
TROI OR PULASKI
(When present)
EXIT TO EMERGENCY TURBOLIFT
(DIRECT TO BATTLE BRIDGE)
STAR TREK: The Next Generation
ENTERPRISE MAIN BRIDGE STATIONS
Revised August, 1988

Transporter

In brief: The transporter is a remarkable device capable of converting matter into energy and reconverting it back to matter at another location. The transporter allows our crew members to go quickly from the ship to a planet's surface and back again. It is also capable of reproducing many objects such as foods, tools, and the like.

Limitations in brief: The transporter is limited in range to about 40,000 kilometers, or the distance of the ship to a planet while in standard orbit. The transporter cannot be used when the ship's shields are operating or when the ship is at warp drive (unless the destination is at the same warp factor). Objects stored in computer memory have only a limited "resolution" so that one CANNOT store and reproduce a living being.

Replication technology: The ability to convert matter into energy and back again implies the ability to recreate objects. This is done in the ship's food service units which instantly recreate any dish in the computer's memory. The key limitation here is that the computer memory stores patterns at "molecular resolution". This is adequate for food and tools, but inadequate for living, conscious beings. The transporter (when used to beam people) operates at "quantum-level resolution", recreating all of the electron states and sub-atomic configurations necessary to accurately reproduce a person's thought patterns and DNA. Storing "quantum-level" patterns would require billions of times more memory than the Enterprise computers can hold.

Other transporters: There are four personnel transporters in the Enterprise's command (saucer) section on Deck 6, and two more in the engineering section on Deck 14. There are also a total of eight cargo transporters in both sections. Additionally, there are six emergency evacuation transporters capable of one-way beaming off the ship only.

Transporter biofilter: The transporters have a built-in safety mechanism which scans an incoming person's beam and automatically filters out many kinds of known hazardous bacteria and viruses. It is not effective against organisms for which the biofilter has not been programmed.

Direct beaming: Most use of the transporter involves beaming people or objects either to or from the Transporter Chamber. On occasion, it may be necessary to order "direct beaming" as in "beam her directly to Sickbay". This procedure essentially involves beaming the person twice — first, to the Transporter, then to the destination. As such, it presumably consumes almost twice the power. Because of this, our crew tends to avoid direct beaming unless time or safety considerations outweigh the extra energy cost.

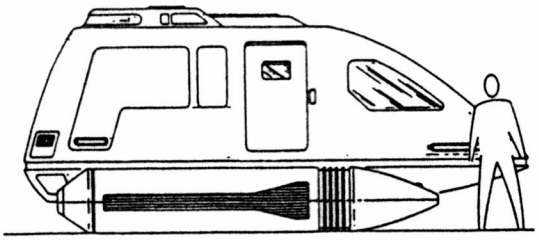
Environmental systems: Artifical Gravity

Synthetic gravity: The Enterprise uses a network of force field generators to create an artificial gravity field virtually identical to Earth's. These generators employ a series of superconducting graviton field matrices located under each deck. Because of the superconducting components, these hockey puck-sized gizmos can remain in operation for several hours, even when power is cut off.

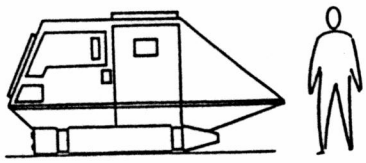
Inertial damping field: A second set of forcefield generators is used to create a field which absorbs the inertial stress created when the ship accelerates to high impulse speed or warp drive. (Otherwise, the high gee-forces would instantly crush our crew beyond recognition.) The inertial damping field generators also create a "structural integrity field" which helps reinforce the structure of the ship. Thanks to an incredibly ingenious energy-conservation system, the IDF and SIF also serve to absorb and recycle the excessive inertia generated by each other and by the tractor beams.

Tractor Beams

In brief: Starfleet's equivalent of the grappling hook and towing line. A focused beam of polarized gravitons which acts as a linear forcefield to pull objects toward the ship. See "Tractor Beam Operation" under Technical Memoranda.



Personnel Shuttlecraft



Shuttlepod

Shuttlecraft and Shuttlebays

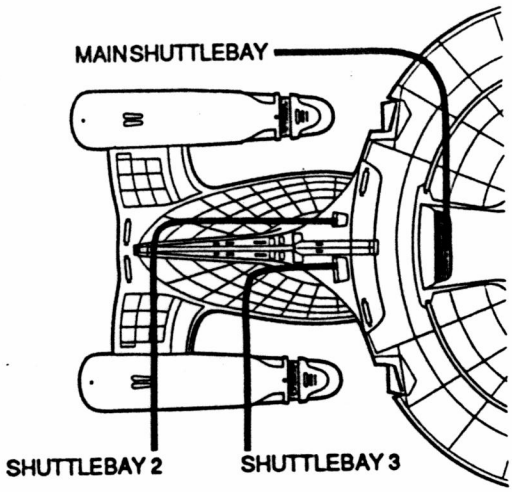
In brief: The Enterprise carries a number of small auxiliary spacecraft for short-range use when a transporter is inappropriate. Most of our shuttlecraft are named after famous explorers and scientists.

Personnel shuttle: These are used for transport of about six people on trips within a solar system. Maximum speed of these craft is warp factor one. An "executive shuttle" can be used for VIP transport.

Cargo shuttle: A variation on the personnel shuttle, but with the passenger accomodations removed.

Shuttlepod: A small two-person craft, about the size of a Hyundai. The shuttlepod is used for very short-range transport and for extravehicular activity (like inspecting the ship's exterior). Shuttlepods are also the basis of a number of (yet to be designed) auxiliary service craft like a starbase's antimatter tankers for which a shuttlepod serves as a driver's cab. Shuttlepods are incapable of warp speed.

Shuttle bays: The Enterprise has one large MAIN SHUTTLE BAY located at the top rear of the saucer section. This facility is located on Deck 4 and is adjacent to the ship's cargo bays. Two smaller secondary shuttle bays (SHUTTLE BAYS 2 and 3) are located on Deck 13 at the rear of the ship's "neck". Because of stage space limitations, most of our episodes use Shuttlebays 2 or 3 rather than the much larger Main Shuttlebay.



Shuttlecraft landing bays

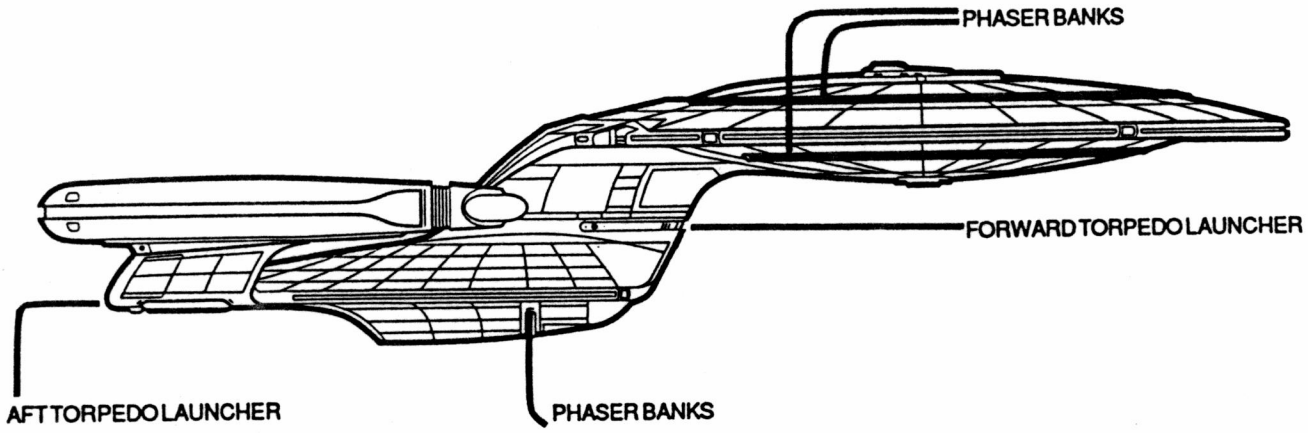
Shuttlecraft names: We have established the following names for Enterprise shuttles. We assume there are quite a number of other shuttles carried aboard the Enterprise.

Shuttlecraft #1: Sakharov
Shuttlepod #5: El-Baz
Shuttlepod #7: Onizuka
Shuttlepod #12: Pike (destroyed)

Weapons and Defense

The mission of the Enterprise is exploration, science, and diplomacy. It is not a warship, nor is Starfleet a military organization in the 20th Century sense. Nevertheless, the galaxy is a big place, full of unknown -- and occasionally hostile -- life forms. For those times when the Enterprise must protect itself and the interests of the Federation, the ship is fully equipped with both defensive and offensive weaponry. When provoked, the Enterprise is a formidable adversary.

Additionally, Picard's staff is fully trained in cultural sociology, strategy and crisis analysis, and they have at their disposal a powerful array of information-gathering sensors and computers. They know that their skills in these areas are often more important in the succesful resolution of a crisis than are advanced weaponry.



Phaser banks and Photon Torpedo Launchers

Weapons - Ship's Phasers

In brief: A particle/beam projector which is the ship's primary offensive weapon. The Enterprise has a number of massive phaser banks that wrap around both of the ship's main sections. At maximum power, the main phaser banks can totally disrupt the surface of a planet. Phaser beams travel at the speed of light, and thus are relatively ineffective at warp speed. Phaser is short for "phased array emitter". Maximum effective phaser range is about 300,000 kilometers.

Phaser frequencies: It is occasionally useful to adjust the "base emitter frequency" or "secondary modulation" of a phaser beam. This can sometimes be used to more effectively disrupt a deflector shield, although most sophisticated deflectors use "random modulation" to prevent such tactics.

Weapons - Photon Torpedoes

In brief: An energy weapon in which a small quantity of matter and antimatter are bound together in a magnetic bottle and launched at warp speed at a target. Photon torpedoes are the weapons of choice when the ship is at warp drive, because their speed is not limited by the speed of light.

Torpedo launchers: There are two torpedo launchers on the Enterprise, one at the front and one at the rear of the Engineering hull. Photon torpedoes are "smart" weapons and are capable of tracking a moving target. Torpedoes are usually launched in clusters, each independently targeted.

Deflector Shields

In brief: A series of energy forcefields which protect the Enterprise against both natural dangers and enemy attack. The defensive shields are very powerful and are more than adequate to protect the ship against most hostile forces. A NAVIGATIONAL DEFLECTOR sweeps far ahead of the Enterprise and pushes aside meteoroids and space dust which might otherwise be a hazard to the ship at high impulse or warp speed. The transporter cannot be used when the shields are in place. The ship's computer can automatically activate the shields in a crisis situation before our human crew can react

Deflector shield power: Usually expressed in terms of percentage of shielding remaining, as in "shields down to thirty-seven percent... we cannot survive another attack."

Battle Configuration (Saucer Sep)

In brief: In combat situations, the Enterprise is capable of separating into two spacecraft. This allows the saucer (which houses the majority of the crew and their families) to wait in relative safety while the remainder of the ship (the "battle section") becomes a formidable deterrent force. When separated, command of the battle section is transferred to the battle bridge.

Battle section: This is the lower half of the ship, incorporating the Engineering hull and Warp Engines. The Battle Section is capable of warp speeds and is equipped with two photon torpedo launchers and a full spread of phaser banks and deflector shield generator. The top of the Battle Section (Deck 8) is the location of the Battle Bridge, which serves as a command center.

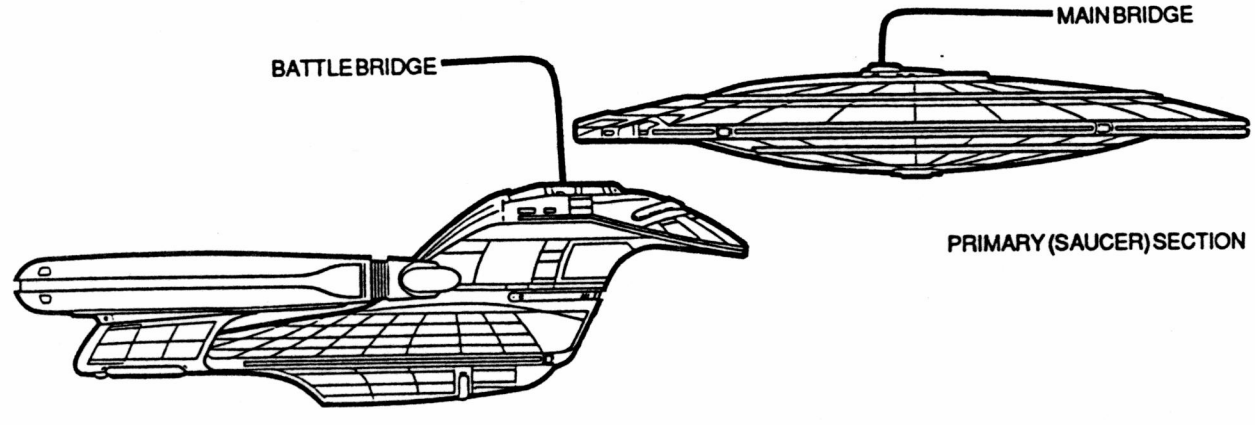
Saucer section (aka primary hull): When seperated from the battle section (which contains the warp drive), the Saucer section is incapable of warp speed. The saucer section does have its own set of impulse engines for slower-than-light travel, and it has a complete set of deflector shields and phaser banks. When seperation occurs at warp speed, the residual warp fields can take several minutes to fully collapse, so the primary hull can "coast" for some distance before it goes sublight. Control of the saucer section is managed from the main bridge.

Tactical Analysis

One of the more formidable weapons in the Enterprise's arsenal is its extensive tactical analysis ability. These capabilities and skills are often more important in the succesful resolution of a crisis than are advanced weaponry and shields. The ship's captain and staff are fully trained in cultural sociology, crisis analysis, and strategy. They are able to anticipate and deal with most potential conflicts, long before they reach the need for force.

Sensors and computers play an crucial part in the ship's defensive and offensive capabilities. The intelligence-gathering capability of these sophisticated systems are a powerful tool in evaluating potential adversaries and helping our people to estimate their probable responses.

Enterprise Saucer Sep to Battle Configuration



Holodecks

In brief: The HOLOGRAPHIC ENVIRONMENT SIMULATOR is wonderfully useful for crew training, recreation, and exercise. It can recreate, with virtually 100% fidelity, almost any environment in the computer's memory. The ship's computer holds a large selection of simulated environments which can be recreated at a moment's notice.

How it works: The Holodeck uses two main subsystems, the holographic imagery subsystem and the matter conversion subsystem. The holographic imagery system creates images of incredibly realistic background environements. The computer-driven holographic projectors also control a series of shaped-field forcebeam projectors which are capable of giving physical substance to these images. The second major subsystem is the matter conversion system. Using transporter-based technology, this system creates physical "props" and "set dressing" from raw material. Under normal conditions, a participant in a holodeck simulation should be unable to tell the difference between the two types of props.

The Holodeck and animated characters: The holodeck often generates astoundingly life-like simulations of humans and other life-forms. Such animated characters are composed of solid matter created by transporter-based replicators and manipulated by highly articulated computerized tractor beams. This results in incredibly realistic "puppets" which look and behave almost exactly like living beings. (Note that transporter-based matter replication is incapable of duplicating an actual living being.)

The Holodeck and the reality of objects: Objects created on the holodeck which are pure holographic images cannot be removed from the holodeck, even if they have apparent physical reality because of focused forcebeam imagery. Objects created by transporter matter conversion do indeed have physical reality and can indeed be removed from the holodeck, even though they may no longer be under computer control.

Location: Holodecks 1-4 (most frequently used on the show) are located on Deck 11.

Personal holodecks: In addition to the large holodecks normally seen on the show, the Enterprise has a number of smaller "PERSONAL HOLODECKS". These rooms are the holodeck equivalent of a treadmill. In one of these rooms, one can jog for miles in Yosemite National Park, climb Mount Seleya on Vulcan, or even go Scuba diving.

(Note: In the episode "Elementary, Dear Data", the character of Moriarty was "alive" in the sense that the holodeck control computer created a program for the character that was so sophisticated that the computer program — not the "puppet" — became "alive".)

Computer System

In brief: One of the Enterprise's most important components is its massive library computer system which is used in virtually every element of ship and mission operations. Nearly every control panel on the ship is, in effect, a computer terminal and can respond to voice commands as well as keypad input. The Enterprise computer — like all its systems — are designed for the ease and convenience of the crew. Unlike its clumsy 20th century ancestors, the ship's computer is easy to use.

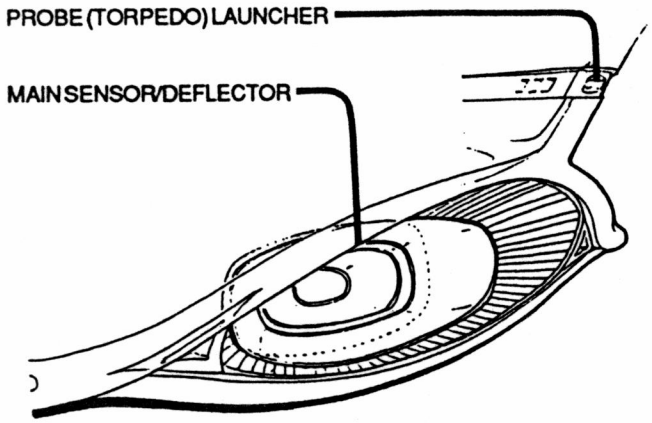
Iso-linear optical chips: The information storage medium of the Enterprise's computer system is the iso-linear chip. This small rectangle of iso-chromatic linear memory crystal incorporates a large amount of information storage and a considerable amount of computer processing power. These chips are throughout the ship's optical processing network, often found mounted in "chip panel" racks. Iso-linear chips are also used for portable information transport, much as we use books or videocassettes today.

Operating system: The main library computers of the Enterprise employ optical (rather than electronic) processing. There are two massive computer cores near the center of the primary (saucer) hull, and one in the secondary (engineering) section, each incorporating a series of miniature subspace field generators, allowing information to be processed faster than lightspeed. (This is a key limitation to 20th Century computers.) Information is carried by a complex network of optical fiber conduits. The proper name of the main computer is the Library Computer Access and Retrieval System, sometimes called "L-CARS".

Sensors

In brief: "Sensors" are an impressive collection of sophisticated scientific instruments which provide much useful information to our crew. In order to avoid cluttering dialog with a battery of confusing technical names, we lump these instruments under the generic term "sensors". The Enterprise is one of the most advanced scientific research craft in existence and has the most advanced and sophisticated sensors ever built.

More: The Enterprise has a number of sensor arrays located around the hull of the ship. Additionally, there is a main sensor at the front of the engineering hull which continually sweeps far ahead of the ship to detect possible upcoming hazards.



Tricorders: These nifty handheld devices contain a miniature sensor array, giving our crew the ability to detect a wide variety of phenomena.

Probes

In brief: The Enterprise carries a variety of small unmanned instrumented space probes which can be used to return valuable sensor information to the ship. Probes are generally used to find out things about areas which are out of sensor range (inside of a thick dust cloud, for example) or into which one does not wish to take the Enterprise.

Probes are fired from the Photon Torpedo launchers. A variety of probe types are available. Class-One probes are short-range devices which carry the widest range of instrumentation. Class-Three probes are intended for entry into a planet's atmosphere. Class-Eight probes are capable of warp travel and are based on a photon torpedo spaceframe.

Subspace Radio

In brief: A faster-than-light means of communications, necessary because the size of the Federation and of the vast operating range of starships. (Without subspace radio, a starship could warp to a distant planet and back in much less time than it would take to send a conventional radio message).

The speed of subspace radio: Subspace radio propagates at a maximum speed of about Warp 9.9999 (about 100 times faster than maximum warp, 9.6). The key limitation is that this speed falls off dramatically over time as the warp fields decay. This is not a problem within the Federation, as there is a complex network of relays and boosters which keep subspace messages going at near-maximum speed (which allows a message to cross the entire Federation — 10,000 light years — about two weeks). Outside of the Federation, this network does not exist and messages travel much more slowly. It is therefore fairly common for the Enterprise to be several weeks out of touch with the nearest Starbase.

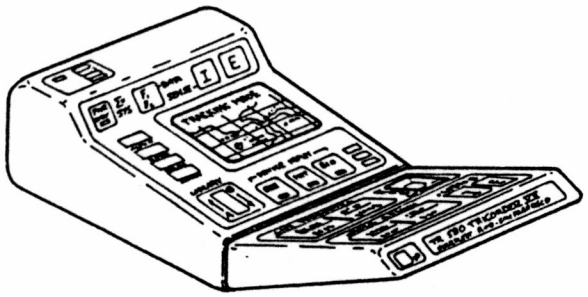
Turbolifts

Turbo-elevators are capable of travelling both vertically and horizontally. Turbolifts connect to nearly every deck and section of the Enterprise. Control of the turbolifts is vocal ("Deck 12, Sickbay, please".) A network of Jeffries Tubes and ladder wells can also be used for travel between decks when the turbolifts are inoperative.

Lifeboats

Several hundred lifeboat pods are available for use in extreme emergency. These pods would be ejected from small hatches in rows along the ship's exterior. The pods would probably drift, awaiting rescue. (We'll probably never see these in full use, but in a crisis, we might hear an order for all personnel to report to lifeboats.) In a lesser emergency, the captain might give an order for the crew to evacuate to the primary hull and to separate from the engineering hull (assuming that it was the engineering section that was in trouble.)

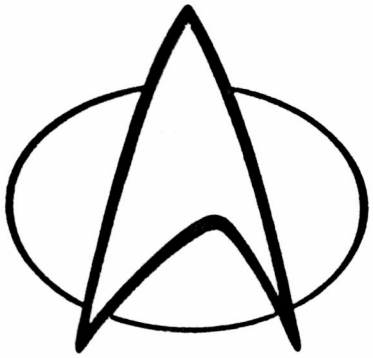
Tricorders



In brief: The Swiss army pocketknife of 24th Century science. A combination sensor, computer and recorder, the tricorder is used to analyze and detect virtually anything needed on our Away missions and on board ship. Special purpose tricorders are also available, like the medical tricorder used by Dr. Crusher. See Tricorder operating instructions under "Technical Memoranda". Tricorders are equipped with small remote peripheral sensors (the size of an eraser) which can be used for very fine work.

Standard tricorders are incapable of sensing neutrinos or subspace phenomena, although special purpose tricorders or peripherals could provide this ability if needed.

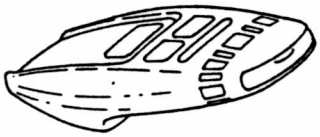
Communicators

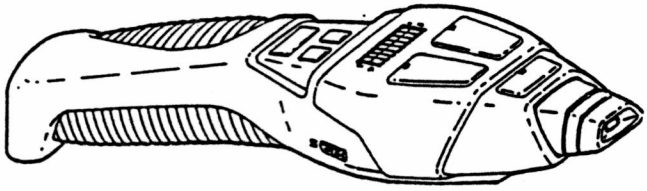


In brief: The Starfleet insignia on our uniforms also serve as a communicator. Communicators are activated by touch, as well as by voice. Maximum usable distance is slightly more than transporter range, about 60,000 kilometers. Communicators also serve as a homing beacon with which the transporter can determine the exact coordinates of a person to be beamed back to the ship.

Companels are located throughout the ship, and these are sometimes used instead of one's personal communicator. Communicators are equipped with a "dermal sensor" which automatically verifies the identify of the person by his or her touch.

Personal Phasers





In brief: Personal phasers are the normal sidearms used by the Enterprise crew. Phasers have a variety of settings ranging from "stun" (which is renders a person briefly unconscious) to "cut" (which acts as a cutting torch) to "disrupt" (which actually vaporizes the target.)

Phaser types: The smallest, Type I, is about the size of a keychain, carried when our people want to be inconspicuously armed. Although a potent weapon, the Type I phaser is only good for a few shots. The next size up is Type II, carried when trouble is suspected. Larger phasers including the Type III phaser rifle, can be made available, but are not used for normal Away Missions. (By comparison, the ship's main phaser banks are Type X.)

Food Service Technology

In brief: Most food service aboard the Enterprise is provided by handy transporter terminals, usually called FOOD SLOTS, which can instantly materialize virtually any dish in the computer's memory at a moment's notice.

More: As with all transporter-based replication technology, food service transporter terminals recreate matter at the "molecular resolution level", which means it is sufficient to duplicate nutritional properties and taste, but is inadequate to recreate a living being. Despite all this advanced technology, there are still those crew members whose hobbies include "old fashioned" food preparation — cooking.

Spaceflight and the Galaxy

Standard orbit: When the Enterprise orbits a planet, it generally assumes what is called STANDARD ORBIT. For a Class M (Earth-like) planet, this is often a synchronous orbit at about 35,000 kilometers altitude.

Warp drive: The distances between the stars are so vast that the ship is normally under warp drive except when in orbit or when it is within a solar system. By comparison, impulse speed represents a virtual standstill.

Courses and directions: Most times when the Captain specifies a course for the ship or a direction in space, it should be in the form: "Unidentified spacecraft at Bearing 104, Mark 12", where both numbers are measurements in degrees (which means that both numbers should be less than 360). Other forms used when setting courses include specifying Sectors, or just the name of the destination planet.

For the truly curious: The term "bearing" (as in Bearing 270, Mark 47) refers to two angles measured relative to the ENTERPRISE. (Bearing 000, Mark 0 is straight ahead.) The term "heading" (as in Heading 270, Mark 47) refers to angles measured relative to the GALAXY itself. Imagine you're driving a car and think of "bearing 090" as turning right (relative to the car), but "heading 090" would be turn west (relative to the Earth). If this is confusing, don't worry, we usually just use "bearings".

Sectors: The primary unit of measure in known space is the SECTOR. Each sector is about 20 light-years across and typically contains perhaps a half-dozen solar systems. A starship travelling at Warp Six takes about 19 days to cross a sector. At maximum warp (9.6) it takes about 4 days.

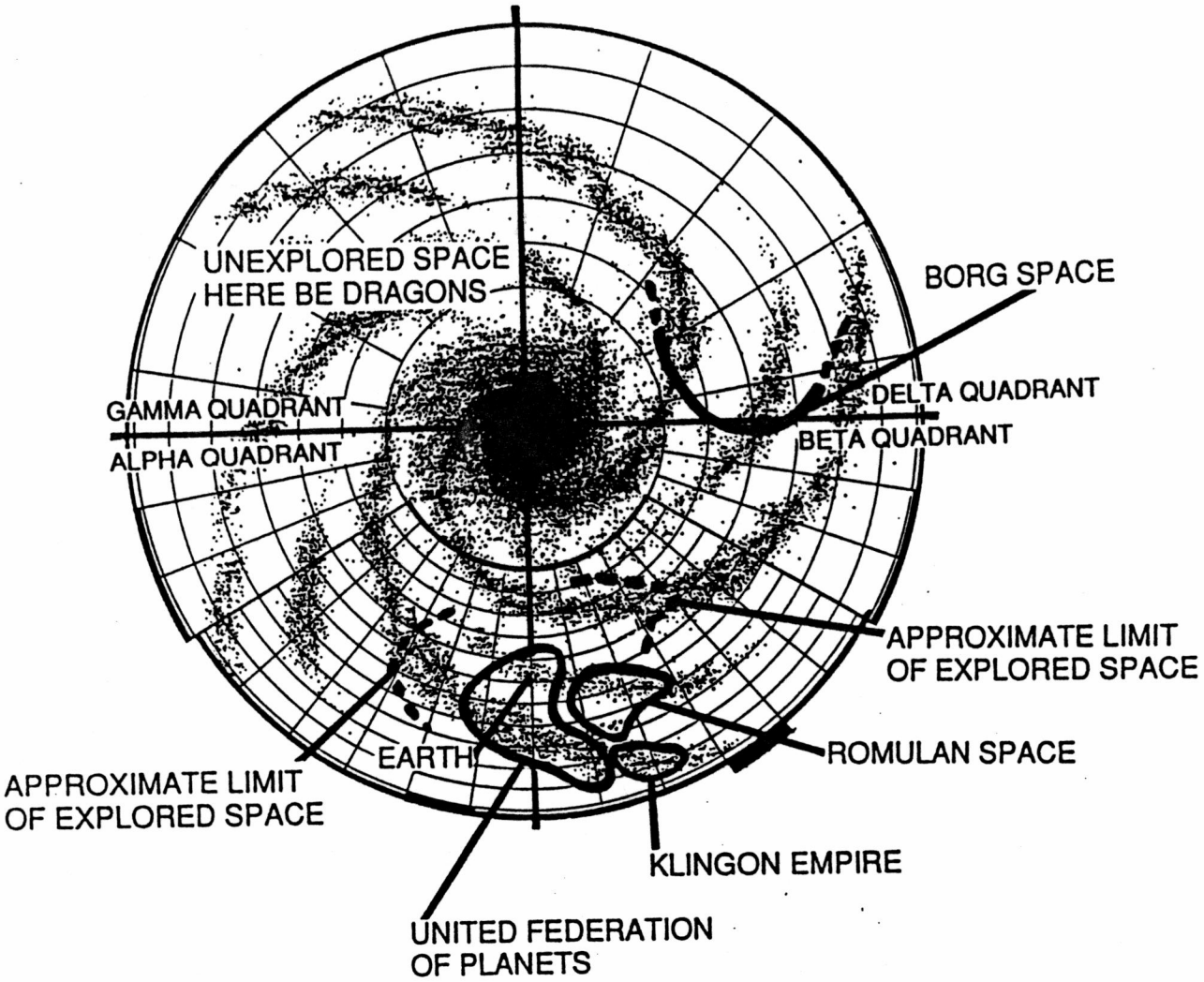
Sector numbers and names: Sectors are properly known by a three-to-six digit number (i.e. Sector 18834), but many sectors have common names for their major star systems or planets. For example, the Earth is located in Sector 001, also known as the Sol Sector, and Starbase 515 was located in the Scylla Sector.

Quadrants: The galaxy is divided into four QUADRANTS. Each quadrant is incredibly huge (about eight billion cubic light-years, hundreds of thousands of sectors). The four quadrants are labeled with Greek letters, Alpha, Beta, Delta, and Gamma. The Federation is located at the boundary between Alpha and Beta quadrants. Even within these two "home" quadrants are vast volumes of unexplored space. It is very unusual for a Federation starship to venture to the other side of the galaxy into the Delta or Gamma quadrants. (We have no doubt that Starfleet will eventually get around to exploring those areas, but there is still so much to explore nearer home.) Quadrants are so big that we rarely refer to them in day-to-day operations, much as you would rarely talk about continents while driving interstate.

Galactic coordinates: When specifying travel destinations for the Enterprise, it is occasionally appropriate to give GALACTIC COORDINATES. These are generally given in a set of three numbers, such as "Set course for galactic coordinates 394345 by 885354 by 032234." (Note that the galaxy is such a huge place that these numbers are fairly imprecise, sort of like specifying a ZIP code but not the street address.) In most cases it will be easier and more understandable to simply specify the destination sector ("Set course for the Orion Sector") or even just the direction of flight ("Set course 312, mark 5").

Starbases: Starfleet Command maintains a network of a little over five hundred support and operations facilities throughout Federation space. These are called STARBASES, some of which are on the surfaces of planets, while others are space stations. A starbase is generally the next-higher authority in the Starfleet chain-of-command over a Starship Captain. The Enterprise often operates past the frontier of Federation space, and it is not uncommon for it to be weeks out of touch with any starbase, even by subspace radio.

Note: For estimated travel times at various warp factors, see the Warp Speed chart on Page 9.



The Milky Way Galaxy

The Federation

The United Federation of Planets comprises perhaps 150 different cultures and colony planets, representing a wide diversity of life forms. It is the primary political organization within this (small) part of the galaxy, but outside of its domain may exist other such organizations of which we have not yet heard. Even within the Federation are large pockets of unexplored space in which there may well be planets and alien races to be discovered.

Starfleet

The Federation Starfleet is an extraordinary organization dedicated to exploration, diplomacy, research, and defense. Although its mission includes military elements vital to the Federation's survival, Starfleet does not primarily consider itself a military organization in the 20th Century sense of the term. Think of a cross between the US Coast Guard, NASA, and Jacques Cousteau's Calypso.

Based on the events early in our fourth season, we assume that Starfleet is experiencing a shortage of starships and that it is embarking on a program of new ship construction.

Ship Nomenclature: "Starship" is the generic term used by Starfleet for most of its interstellar spacecraft. We assume that there are a number of different types of starships designed for a number of different missions. (The Galaxy Class starships are the largest and most powerful in the Starfleet.)

Class Nomenclature: Starfleet observes the old

ST*TNG Starship list

Name (USS)	Episode	Class/type	Model type	Registry	Status	Captain	Notes
Ajax	Where None						Kosinski worked on this ship's engines
Ambassador	-	Ambassador	Enterprise-C				Class ship for Enterprise-C
Aries	Icarus Factor	scout			still around		Riker was to have commanded this ship
Berlin	Angel One						Stationed near Romulan Neutral Zone
Bradbury	Menage a Troi						Was going to transport Wesley to Starfleet Academy
Charleston	Neutral Zone						Ferried revived 20th century survivors back to Earth
Constantinople	Schizoid	transport					Suffered hull breach -- Enterprise helped them
Constellation	The Battle	Constellation	Stargazer				Class ship for Stargazer
Drake	Arsenal...	freighter			destroyed	P. Rice	Paul Rice's ship, presumably destroyed at Minos
Enterprise	series	Galaxy	Enterprise	NCC-1701D	boldly going	Picard	Starfleet's flagship, 5th ship to bear the name
Enterprise-C	Yesterday's	Ambassador	Enterprise-C	NCC-1701C	destroyed	R. Garrett	Predecessor to our ship, 4th ship to bear the name
Fearless	Where None	Excelsior	Excelsior		still around		Kozinski's last assignment before "Where None"
Galaxy	-	Galaxy	Enterprise				Class ship for Enterprise
Gettysberg	Too Short...						Admiral Jameson's last command
Hathaway	Peak Perf	Constellation	Stargazer	NCC-2593	derelict		used in military exercise
Hood	Farpoint	Excelsior	Excelsior	NCC-42296			
Horatio	Conspiracy		Ambassador	NCC-10532	destroyed	W. Keel	destroyed at Dytallix B
Lalo	We'll...Paris	freighter					
Lantree	Unnatural S.	Class 6 supply	Reliant	NCC-1837	destroyed	I. Telaka	Crew killed by genetic super-children
Melbourne	11001001						based at Starbase 74
Oden	Angel One				destroyed		Ramsey's old ship
Potemkin	Peak Perf						Riker once served aboard this ship.
Renegade	Conspiracy	frigate				T. Scott	
Repulse	The Child	Excelsior	Excelsior	NCC-2544	still around	Taggert	Pulaski's old assignment
Stargazer	The Battle	Constellation	Stargazer	NCC-2893	derelict	Picard	Picard's old ship
Thomas Paine	Conspiracy	frigate				Rixx	
Trieste	11001001						based at Starbase 74
Tripoli	Datalore						Ship that discovered and activated Data 20 years ago
Tsiolkovski	Naked Now	Grissom	Grissom	NCC-59311	destroyed		Victim of the Psi 2000 virus
Victory	Elementary	Constellation	Stargazer		still around	Zimbata	
Wellington	11001001						based at Starbase 74
Yamato	Contagion	Galaxy	Enterprise	NCC-71807	destroyed	D. Varley	

As of ST*TNG's third season

Naval tradition of naming each class of starships after the first ship built of its type. For example, the Enterprise is a Galaxy Class starship, presumably named after the USS Galaxy, which would have been the first starship of that type built. The USS Stargazer, (Picard's former ship) was a Constellation Class starship, while the original Enterprise (commanded by Captain Kirk), was a Constitution Class vessel.

Starfleet Registry Numbers: Each Starship is identified by a Starfleet Registry Number, such as the Enterprise's NCC-1701-D. Most current (ST*TNG) Starfleet vessels have five-digit registry numbers, such as the USS Yamato, which was NCC-71807, or the USS Hood, NCC-42296. Most Starfleet operational vessels have the characteristic "NCC" prefix, although some experimental ships have an "NX" designation. Additionally, we assume that various non-Starfleet vessels under Federation jurisdiction will have other prefixes (such as NAR-18834). (Note that the Enterprise is a special case in that Starfleet chooses to honor the original Enterprise by continuing to keep its number in service, simply adding a new letter suffix to each new ship bearing the name. The Enterprise is probably the only Starfleet vessel with a letter suffix in its registry number.)

Alien Spacecraft

We have established a number of standard starship types for some of the alien cultures that we encounter on a recurring basis. Naturally, we prefer to use existing ships for budgetary reasons, but we assume that each space-faring culture has a good range of vehicle types.

Klingons

Klingon ships are roughly comparable to those of the Federation Starfleet. Thanks to a previous alliance with the Romulans, most Klingon ships are equipped with a cloaking device which renders them nearly invisible to most sensors. Because of the tremendous power drain involved, weapons systems cannot be used while the cloaking device is engaged.

Klingon Bird-of-Prey: We have most frequently seen the Klingon Bird-of-Prey (first seen in the feature film *Star Trek III*). This is a small vessel with a crew of about twelve. Propulsion is matter/antimatter warp drive, main weapons are called disruptors.

Klingon K't'inga Class Battlecruiser: First seen in the feature film *Star Trek I*. This is about the size of the original Enterprise. Propulsion is matter/antimatter warp drive, armed with disruptors and torpedoes.

Klingon K'Vort Class Battlecruiser: This is a larger version of the Bird-of-Prey. Propulsion is matter/antimatter warp drive, armed with disruptors and torpedoes. Power and range are comparable to a Galaxy Class starship.

The emblem of the Klingon Empire

Romulans

The Romulans have only recently emerged from an extended period of isolationism, and thus very little is known about their technology. We do know that they have developed some formidable new ships in the interim, and that they are equipped with a more sophisticated cloaking device which renders their ships nearly invisible to even our most advanced sensors. Because of the tremendous power drain involved, weapons systems cannot be used while the cloaking device is engaged. Romulan ships-of-the-line are generically called Warbirds.

Romulan D'Deridex Class Warbird: This is a huge vessel, which is probably more than a match for the Enterprise in terms of firepower. Maximum sustainable warp speed is about 9.1, slightly slower than that of the Enterprise. Power source is believed to be a system which harnesses the x-ray emissions from a captive quantum singularity. Armed with disruptor banks and torpedoes.

The standard of the Romulan Star Empire

Romulan Scout Ship: Seen in "The Defector". A small, minimally armed, warp capable vehicle. Substantially slower than the Warbird.

Ferengi

Ferengi ships are called Maurauders, powered by matter/antimatter reactors very similar to (and probably copied from) older-style Federation starships. Some Ferengi Maurauders are equipped with a very powerful energy/wave weapon (seen in "The Last Outpost"), while others are armed with some kind of photon torpedoes.

The Borg

Very little is known about the huge cube-shaped ships of the Borg. We do know that their technology is highly decentralized with each key system having numerous backups located throughout the ship. This gives their ships an ability to continue operating even after having absorbed a tremendous amount of damage. Starfleet believes the Borg use some kind of sophisticated power source which somehow taps the difference in energy-state potential between different layers of subspace. This gives them an almost unlimited power source which allows their ships to travel vast distances at very high warp factors. It also gives their ships the ability to quickly regenerate damaged parts during battle situations. The Borg home world is believed to be located on the other side of the galaxy, somewhere deep in the Delta quadrant.

The symbol of the Borg

SECTION II: TECHNICAL MEMORANDA

Enterprise Spacecraft Structure

According to a rough calculation of area for each deck of the USS Enterprise NCC-1701D, I've gotten the following estimates (assuming 8' ceilings):

Saucer:
Raw Deck Space: 11,500,000 square feet
Usable Deck Space: 7,500,000 square feet (66%)
People accessable volume: 60,720,000 cubic feet

Engineering:
Raw Deck Space: 1,250,000 square feet
Usable Deck Space: 850,000 square feet (66%)
People accessable volume: 6,600,000 cubic feet

The established figure for personnel on board is approximately 1012. This might be considered as the mission general crew level for routine exploratory missions. After all, the actual running of the vehicle and maintenance of its systems will not require a great many people. A large percentage of that 1000 are family members not directly connected with spacecraft operations and scientific investigators.

For small-scale science or diplomatic missions, the ship can accomodate a larger crew. In fact, the Galaxy class vehicle can comfortably accept up to 1000 people. Even at this level, each person would have living quarters volume of 9300 cubic feet, or 1200 square feet of deck space. This is quite a luxurious area. Even if we assume that each person got only one half of that for living quarters, it still works out to about 24' x 24' per person. A single technician would have a fine cabin, and a family would have just about the same space as in a house.

If the Enterprise were called up for evacuation duty, it might be able to take on an additional 15,000 persons over the 6500 before straining its services and habitat space. The transporter would, of course, be another matter altogether...

Starship Impulse and Warp Technology
or Understanding How the Enterprise Does What She Does Without Having to be a Nuclear Physicist

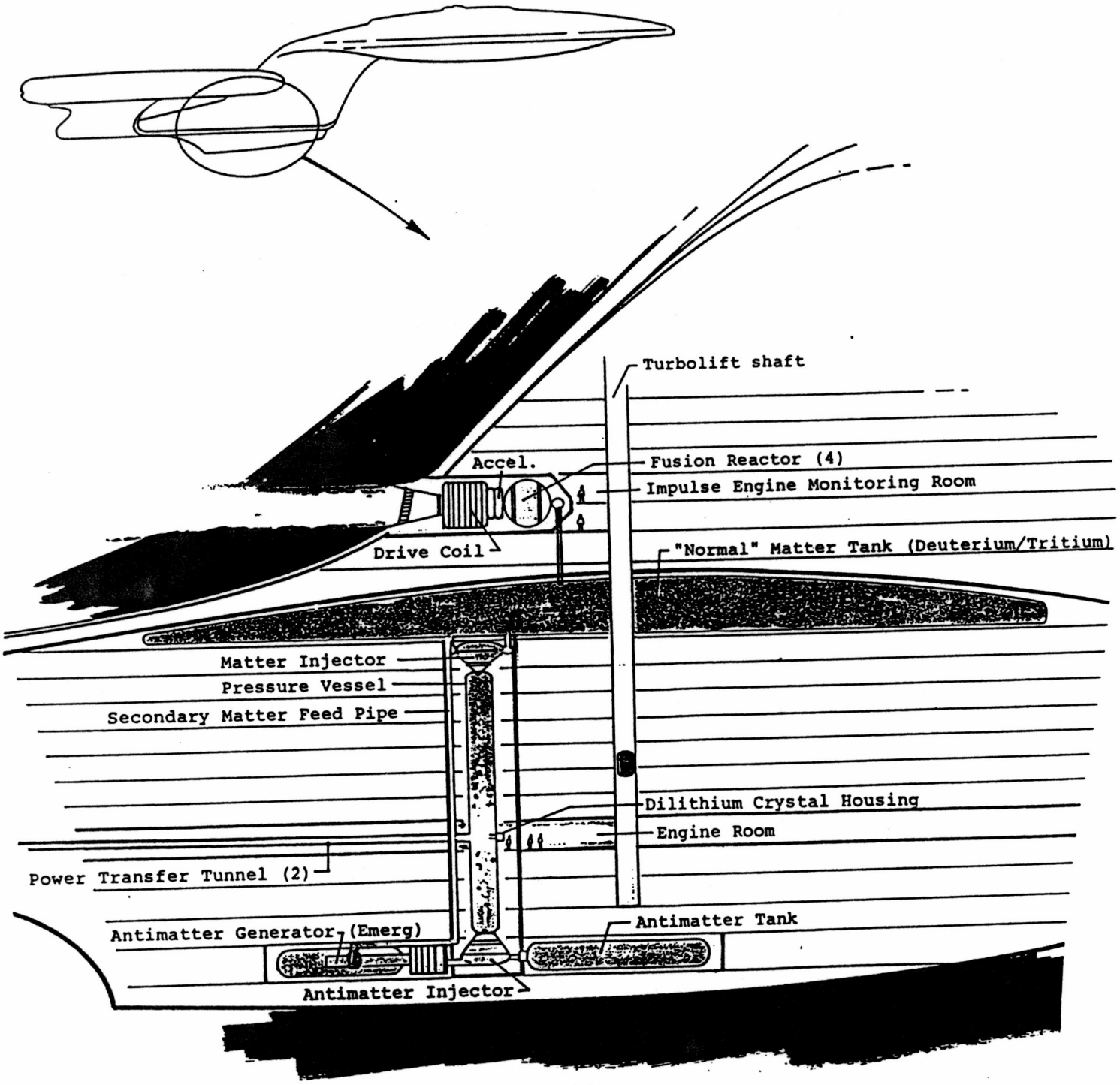
This memo is for the benefit of anyone who must understand the primary propulsion systems of the Starship Enterprise, NCC-1701D. Although it contains some technical yak-yak rooted in reality as well as fiction, it is not necessary for one to have a graduate degree in physics in order to grasp the basics of the ship's motive power.

Technology Level: We can assume that Starfleet and/or Federation science has reached a plateau regarding major propulsion schemes for interstellar vessels. The sail, the steam engine, internal combustion engine, the jet turbine, and the rocket engine all continue in use today, due either to practicality of application (the right engine for the right vehicle) or economics (someone owns a sailboat because he/she cannot afford a power boat). In the case of the rocket engine, even the most advanced design in operation or under testing can be traced back to the days of Robert Goddard, Herman Oberth, and Konstantin Tsiolokovsky. The basic principle has not changed one bit.

So it may be with Starfleet R&D. Once warp physics was discovered, and the prototype engines were built and tested ("proof-of-concept"), the principles have remained pretty much the same. Refinements in design and gains in engine efficiency may be the big goals for the world of *Star Trek: The Next Generation.* Especially if we assume that Starfleet doesn't have all the credits in the galaxy to pump into R&D and operational vessels. In the history of space exploration, there has always been an advanced technology peeking over the horizon, but you have to freeze the design somewhere and get to building. In terms of time, one can allocate 10-15 years per major space project, so that in 100 years, even with "high technology", we aren't looking at that many great leaps.

Impulse Power: We'll begin with the impulse engines, since they are the initial low-power devices traditionally employed to drive a starship. Impulse engines work in part like conventional rocket motors, in that they produce an exhaust stream and forward thrust. The fusion reaction involved in the Enterprise goes beyond simple solid or liquid rocket fuel, relying on high-energy thermonuclear explosions (perhaps 30-60 per second) which are convined within a spherical chamber. Please note that "thermonuclear" refers only to the type of reaction and has nothing to do with weapons applications.

The exhaust plasma is directed through a vectored thrust vent, but only after it passes through two


Turbolift shaft
Accel.
Fusion Reactor (4)
Impulse Engine Monitoring Room
Drive Coil
"Normal" Matter Tank (Deuterium/Tritium)
Matter Injector
Pressure Vessel
Secondary Matter Feed Pipe
Dilithium Crystal Housing
Engine Room
Power Transfer Tunnel (2)
Antimatter Generator (Emerg)
Antimatter Tank
Antimatter Injector

devices: A magnetic accelerator and a set of compact space-time (subspace) driver coils (the accelerator is modelled on a real device, the coils are magic at this point).

The superhot plasma is sped up within the accelerator, and the power is taken from there to run the driver coils. These coils perform the continuum "distortion" necessary to bring the ship up to .999 of the speed of light. They are, essentially, low-power versions of the coils used in the warp engines.

Since the combined mass of the two Enterprise components is close to 5,000,000 metric tons, pure exhaust thrust would not do the entire job, even if the plasma were shot out at nearly lightspeed (trust me; I won't bore you with Newton and Einstein to get the proof, but reaction physics below lightspeed works the same on the Space Shuttle as it does on the Enterprise).

The fuel supply for the fusion reactors is a set of large conformal tanks of liquid deuterium and tritium (-425F), both isotopes of hydrogen.

Warp Power: The warp engines operate on another principle altogether. The power needed to crack lightspeed is much greater, requiring 100+ times more energetic reactions. This is accomplished through the use of antimatter, specifically antiprotons. Matter and antimatter differ in atomic charge and spin direction, and will experience violent annihilation when brought together. The energy released by this process is used to power the warp field generators located in the outboard nacelles.

When a starship like the Enterprise is prepared for a long-duration mission, the matter and antimatter storage tanks are purged and refilled (the antimatter is stored in the form of antihydrogen liquid). Magnetic injectors, which operate like precision spray nozzles, are located at either end of the warp engine core. These injectors are primed, and the reaction begins when minute amounts of matter and antimatter plasma collide in the center of the core (also known as the engine pressure vessel). At this point the ratio of M:A is about 25:1, and the engine is at "idle".

Normally the pressure in the engine is slowly brought up to about 10,000 PSI, roughly 715 times atmospheric pressure. More matter and antimatter react until their by-products fill the vessel. The ratio is adjusted until it reaches 10:1. A ratio of 1:1 is reached during Warp Factor 8; higher Warp Factors require greater greater amounts of reactants, but no further change in ratio.

Antiprotons will annihilate with anything, so residual gasses will eventually be used up. Engine control computers automatically keep the mixture balanced and introduce matter and antimatter through the injectors as needed to sustain the reaction.

There is a small onboard antimatter generator in the lower engineering hull. In crisis situations, this device produces small amounts of antimatter from normal matter, using a "quantum state reversal device", a fancy way of saying that we have a magic box which flips the charge and spin of the normal matter. This process, while an effective way to get you out of a jam, is rather matter-intensive; that is, you get one atom of antimatter for every ten atoms of normal matter put in. The energy-cost is also extremely high, and this is not a "cost effective" way to create fuel.

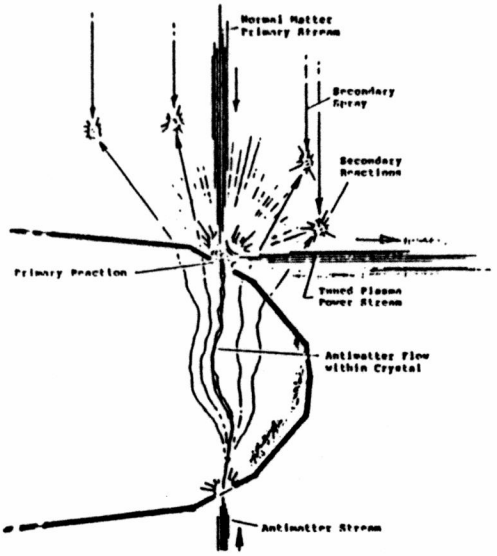
This Enterprise, like its predecessors, is equipped with Bussard ram collector scoops. These gizmos allow it to collect some of the very tenuous interstellar hydrogen atoms it encounters in flight. This presupposes that during warp travel the ship doesn't disappear from this universe into another dimension; if it hit an asteroid at Warp 9.6 it would definitely get creamed.

Dilithium Crystals: The reaction within the core, a continuous thermonuclear process, must be regulated by those rare and mysterious objects we've all come to know, dilithium crystals.

Dilithium, which is probably short for a longer compound name like dilithium diallosilicate heptoferranide, works to focus and "fine tune" the radiated energy of the reaction and channel it into the two power transfer tunnels leacing to the warp nacelles. The exposed crystal assembly extends into the core. It can be imagined that radiation of different frequencies enters the latice structure of the crystal, is bounced and bent about, and exits the crystal in a narrower (perhaps "smoother") range of frequencies down the power transfer tunnels. Order-out-of-chaos. (See following separate notes on dilithium).

The bright light we see coming from the engine is merely photon spill, mostly harmless, but the patterns are a valuable indicator to the engineer on duty as to how smoothly the engine is running, much like an auto mechanic listening to a car engine.

If your dilithium crystals shatter or melt, a cold shutdown may occur, depending on the mixture and power level in the core. We might also imagine a fast (but short-lived) runaway reaction which would heat the core to unacceptable levels, even if the injectors are shut off. If the pressure vessel of the core is breached, the contained plasma would have to be



Dilithium crystal placement in antimatter stream

vented into space explosively; we can hope that force fields around the core protect the crews from the 30,000 degree F gasses.

In a normally operating engine, the plasma carries power to the nacelles, where the warp field generators are energized in much the same manner than in previous Enterprises. Here the nacelles are larger and can provide higher speeds. As in the past, we may assume that warp travel is very power-intensive; if the field generators are knocked off-line for any reason, the ship drops back below lightspeed in a hurry, to whatever its velocity was before going into warp.

Dilithium in warp engine reactions: The accompanying diagram details the role of the dilithium crystal in the operation of the Enterprise's warp engine.

Dilithium, in its fifth-phase crystal form, is the only material yet discovered in nature or manufactured which can withstand exposure to antimatter (specifically antiprotons). Its lattice structure is arranged in such a way that antimatter is held suspended in the empty spaces between the atoms when the crystal is subjected to a high-frequency electromagnetic field in the megawatt range. This occurs with only negligible annihilation taking place (a defective crystal whose structure allows antimatter to touch the normal atoms will degrade at a measurable rate).

Without delving into a lengthly history of dilithium's discovery, suffice it to say that Federation scientists studied the crystals' remarkable properties. The crystal was chosen as the ideal element to control the energies needed to power Warp Drive engines.

The crystal fits into the engine scheme in the following way:

Matter and antimatter are introduced into the warp engine through separate injection reactors, the matter from above and the antimatter from below. The crystal is placed in the path of the two streams, which would naturally collide to produce the well-known explosive reaction. Antiprotons slip through one crystal face like water through a sponge, and travel up to an opposite face. Some antimatter will spray off the main stream, but upwards of 90% will remain tightly bound in one column, having undergone a polarizing effect by the lattice. The random spray will be confined by the core's magnetic coils and will assist in secondary reactions to maintain the engine's temperature and pressure.

The primary reaction takes place at the exit face of the crystal, at a depth of but a few atoms. Matter and antimatter undergo mutual annihilation, and the reaction is guided by the crystal. The radiation by-products are kept within a narrow frequency range; lower-frequency emissions are shifted upwards and higher ones are shifted downwards. The optimum range is tuned continuously for specific warp factors (the core and the warp driver coils are always working together, or at least that's what the owner's manual says).

Energy from the primary reaction is split into two plasma streams at equal angles from the ship's centerline. The streams are then magnetically channelled along the power transfer tubes to the warp engine nacelles.

The crystal is housed within an armored cradle in the

core and held by a jointed gripper mechanism. This gripper is able to move through three axes, since the tuned plasma streams will not form unless the crystal is precisely aligned by computer control. The gripper also acts as a power supply for the high-energy field which enables the crystals to withstand the antimatter stream. Once alignment is made and the gripper is energized, the plasma ripples down the power transfer tubes and up to the warp nacelles. The "throttle" for each engine is a set of valved plasma injectors just below the warp driver coils.

As a crystal is used, it "evaporates" atoms off each face, usually at a constant rate. If the crystal has a defect undetected during testing, the boil-off rate may become asymmetrical and the plasma streams will degrade.

Another change which crystals can undergo is "de-crystalization", or the conversion of the dilithium from a crystalline solid to an amorphous solid, where the atoms in the compounds become less tightly-locked in a specific lattice. Crystals of a century before could be returned to their rigid structure with the re-introduction of gamma-ray photons, but their application was tied to engines of only 75% thermodynamic efficiency. Today's dilithium crystals differ in the addition of one atom (industrially, by nuclear supercollider) and are tied to warp driver coils boasting 89% efficiency, and their reconstitution is possible only through the use of dedicated fusion furnaces. In this process, a crystal is totally vaporized and recrystalized with a gas-to-solid phase technique.

This concludes our lecture, and isn't it even more than you ever wanted to know about the engine?

The Transporter – Once and for all

The Transporter is another one of Starfleet's remarkable devices that requires a little bit more explanation now that it can do more than was originally imagined twenty years ago. While transporter-derived technology can give us tasty foods, life-like scenery, musical instruments, and other bits of solid matter, it does have definite limitations. This article will attempt to clarify the operation of the Transporter in both beam-down and beam-up modes, and touch upon other uses of the device.

In brief, the Transporter is capable of beaming virtually anything — including human beings — from point to point with 100% fidelity. It is also capable of reproducing many objects such as foods, tools, and the like. The key limitation is that stored objects have only a limited "resolution" so that one CANNOT store and reproduce a living being.

The typical personnel or cargo Transporter consists of four major components: the Upper Pad, Lower Pad, Pattern Buffer, and Emitter Array.

The Upper and Lower Pads contain the equipment necessary to "read" an object's molecular and sub-atomic structure. These subsystems include molecular imaging scanners, ionizers, power feeds (primary and emergency), and phase transition coils.

The stream of molecules read by the pads is sent to the Pattern Buffer, a large cylindrical tank surrounded by superconducting electromagnetic coils. It is here that the object to be transported is stored momentarily before actual beaming away from the ship (or even within the ship). It is the Pattern Buffer and its associated subsystems that have been improved the most in the last half-century. While the actual molecules of an object are held in a spinning magnetic suspension (eight minutes tops before degradation), the construction sequence of the object can be read, recorded in computer memory (in some cases), and reproduced. There are limits to the complexity of the object, however, and this is where the potential "miracle" machine still eludes.

The Transporter **cannot** produce working duplicate copies of living tissue or organ systems.

The reason for this is that routine transport involves handling the incredibly vast amount of information required to "disassemble" and "reassemble" a human being or other life form. To transport something, the system must scan, process, and transmit this pattern information. This is analogous to a television, which serves as a conduit to process the vast amount of visual information in a normal television transmission.

Storing that information, however, is another matter. In our analogy, it would be like comparing a television (which is incapable of storing an image) to a videocassette recorder, which can store a relatively low-resolution recording of a television program. In order to store the patterns for a human being, one would have to record not only all the atomic and molecular configurations, but all the quantum and energy states of all the electron shells, and the Brownian motions of every sub-atomic particle of every atom. While we cannot **store** all of this incredibly complex information, we can **use** it as it is being handled in real-time.

This definitely precludes our use of the device to "bring back" a deceased crewmember, or even to clone a missing limb (other traditional cloning methods

could be used). This is not to say that the Transporter cannot reproduce objects and organisms to be beamed; that is precisely that it does do, but the streams of ionized matter that come out will be the same as the stream that went in (when the device is working properly). One cannot, for example, put a wounded person in the Transporter and get back a healthy one, simply based on a person's original "pattern". In transporter usage, the word "pattern" refers to the machine's internal molecular "instructions" for breakdown and reassembly. The amount of computer memory required to store an entire person is far beyond the reach of Federation science. As a person is beamed down, only a minute fragment of the instructions are being computed and used, then lost in each microsecond of the process. One amazing exception to this process was witnessed in the episode "Lonely Among Us", in which a slightly altered Captain Picard returned through the Transporter; this can be assumed to have been a case of the Transporter being affected by the electromagnetic forces of the cloud-entity (ah ha!).

From the Pattern Buffer, the molecular stream and the coded instructions pass through a number of subsystems before reaching the emitter. These include the Subspace, Doppler, and Heisenberg Compensators. Each works to insure that the matter stream is being transmitted or received is in the correct phase, frequencey, and so on.

The actual point of departure from the ship is the emitter array on the hull of the ship. The Enterprise has a number of such emitters, each a gray and cream-colored antenna grid. The matter stream is processed through a device akin to a subspace radio and sent out. Each emitter takes care of targetting the correct reassembly spot, and also works in concert with the standard Starfleet communicator in locating crewmembers to beam up.

During beam-down, the emitter sends two discrete signals. The first is something like a carrier wave known as the ACB, or Annular Confinement Beam. The second is the actual matter stream. The ACB acts as a "tunnel" of energy, preventing the stream from breaking up as it travels down the center. In beam-down, both singals travel downward.

During beam-up, the emitter is configured a little differently. The ACB remains the same, but the matter stream must begin at the surface. In this case, the Transporter sends an "empty" signal to the ground, which intercepts the object to be beamed up, reverses direction, and "pulls" the object up with it. Back in the Transporter Room, the system disregards the empty signal until it senses the upcoming matter stream for reassembly.

Since all the outgoing and incoming signals travel in subspace, they are subject to all the familiar transmission and reception problems.

Improvements in computer memory storage and the reliability of pattern buffer devices have led to some changes in 24th Century life. Solid objects of low complexity can be reproduced, using raw materials to be reformed by the stored patterns. These techniques have worked best with stable, inanimate materials. As mentioned earlier, living tissues and organ systems are extremely complex and have proven difficult to copy. A discussion of the accidental experiment results may be obtained upon request. Plant biology can be copied with certain modifications; these minor changes are structural and undetectable to the eye, and can be used in places like the holodeck. A number of non-living tissues may also be copied, again with small molecular changes, and their nutritional value is unaltered (and in some cases improved.)

Holodecks: Theory and Operation

This memo, originally published in early 1987, was the result of a short discussion among Herman Zimmerman, Andy Probert, Mike Okuda and Rick Sternbach. The material presented below is offered as a possible technical explanation and as such may create interesting story situations.

For many years it has been assumed by science fiction writers and engineers alike that long-duration space flights would require that certain measures by taken to keep the travellers happy and psychologically fit for continued duty.

As far back as Skylab (1973), the United States' first orbital station, crewmembers were listening to cassette tapes of their favorite music, and Mission Control periodically passed up capsule versions of the daily newspapers. Today, on the Space Shuttle (to a limited extent), and soon on the Space Station, documents may be transmitted to onboard printers and video material can be sent up and recorded. A little bit of home away from home.

Flash ahead: Here we are in the 24th Century. Information storage and retrieval systems are sophisticated beyond our imaginations. Well, almost. We can imagine quite a lot.

The powers that be on this show have had the fore-

sight to provide the Enterprise with the ultimate in synthesized recreational systems, the Holodeck. We talked to Starfleet R&D to get a detailed description of the device and possible options/improvements.

The fact sheet says that the basic mechanism behind the Holodeck is the Omnidirectional Holo Diode. This is a miniature gizmo that projects a variety of special electromagnetic (or EM) fields. One hundred of them would fit in the same space as a single LED of the 1980s.

Entire walls are covered with tens of millions of OHDs, since they are manufactured in an inexpensive wide-roll circuit printing process. Dedicated high-speed computers, highly intelligent and with massive memories, drive these OHD displays much like computers drive video monitors today, even the ones with limited 3-D stereo display capability (actually available on some home computers). Which is where the similarity ends.

In addition to their ability to project full-color stereoscopic images, OHDs can manipulate EM fields in three dimensions to cause the Holodeck visitor to "feel" objects that aren't really there. This tactile stimulation provides the proper feedback the visitor might expect from, say, a rock on the ground or a tree growing in an imaginary forest. The only limiting factors to the number and kinds of objects so described by the Holodeck computers are memory and time to record (or calculate from scratch) the originals of the desired objects, be they models of real objects, or even objects that couldn't possibly exist in this universe; i.e. Klein bottles. More about the EM fields in a minute.

Other stimuli, such as sound, smell, and taste can be simulated by more traditional methods (speakers, atomizers, etc.). These will also be under computer control.

In some cases, real objects are created from a raw material supply, using technology derived from the ship's transporter. These objects may appear complex in shape, though their actual molecular structure cannot be complex (as in living tissue, etc.), due to the limitations inherent in transporter memory storage devices (see separate article on the transporter).

The optic section of an OHD emits a complete image of an overall environment, but the visitor sees only a tiny portion of any one OHD, like a fly's eye operating in reverse. As one moves around, the visible portions of the OHDs change, altering the view. The OHDs don't actually emit pictures like a film projector, but polarized interference patterns. The image is reconstructed where the patterns intersect at the lens of the eye. Since the right and left eyes see slightly different views, we can see depth. Admittedly, the system is almost purely Magic Box technology, so this explanation isn't 100% verifiable. But hey....

The EM field section of an OHD creates a tiny steerable forcefield. We will know their big cousins as the the tractor beam and navigational deflector. Under computer control, and over a vast number of OHDs, this can add up to something terrific. Imagine we know the surface coordinates of a rock. The computer driving the Holodeck will command certain OHDs to intersect their fields at those coordinates. If the field strength is high enough to say "rock", it feels like rock. If it is tuned down a touch, it feels like sandstone. Lower, it feels like Jello. Get the idea? Various substances can be simulated, even water. Even fog on little cat feet.

What this gives us is the power to creat terrain, structures, atmosphere — complete sensory environments. Things to walk over, sit on, swim under, or fly above. Combined with certain parts of a simulation being created by transporter technlology, the holodeck provides a complete distraction.

In our short discussion, a lot of ideas came out. Specific areas, perhaps small rooms outfitted with holo equipment, could be one-person "POV Cubicles". Walk through a forest, on a beach, or into a volcano. Fly a hang glider or practice EVA spacewalks. The treadmill is obsolete in this day and age, since the shaped EM fields will allow the visitor to move as fast as he or she can run by instantly sliding the imaginary terrain beneath the feet. The exact texture of sand, grass, concrete, rock, or steel is duplicated, depending on the resolution and density of the field.

The fields, being movable, can even simulate birds, animals, toys, other people, robots, flying saucers, or pink elephants. You could skim an imaginary stone on an equally imaginary lake. Or ride a dragon, complete with leathery wings and fiery breath.

Larger areas would be sized to accomodate groups of people, all experiencing the same environment. The larger areas would be bounded by the deck's walls, of course, but these could be cleverly disguised by things like rock walls, corral fences, sea cliffs, and the like. If you were getting close to the real walls, you might hear a soft but recognizable beep to get you back to the main illusion. Entries to the holo area could be simple standardized arches or doorways. (In fact, we have already seen rocks bounce off the wall).

In an environment like a Federation starship, where

safety is of prime importance and is engineered into every system, it will be necessary to allow the Holodeck visitor to believe — sometimes — that there may be dangers to be faced. More than a few thrillseekers will slip through Starfleet psych profile computers, and they will want to do more than take a leisurely stroll or hit a bucket of golf balls. Recreational fighter jocks and mountain climbers with marginal equipment will love the experience, and then go back to being clerk, cook, or captain. The Holodeck programmers might slip in a shark the next time you go swimming off the Australian north coast.

Tractor Beam Operation

Okay, here we go again with another lecture. This time, we'll examine a useful little gadget, the tractor beam.

Tractor beams, as we know from the past, are great for pushing, pulling, and generally holding onto different objects, usually other spaceships. These functions are accomplished using a tractor beam emitter, which is located under the battle section of the Enterprise, back near the hull undercut (see diagram).

The emitter is a forcefield device capable of focussing a wave/particle like gravitons and projecting that field toward its target. On the Enterprise, the emitter can pitch around 180 degrees and yaw 360 degrees, so that it can home in on most any angle.

If we wish to hold an object steady, we set the device to both attract and repel; this will lock the object in space relative to the ship. If we wish to really haul in an object, we set for attract only. For full push away, we set for repel only. Simple.

The tractor beam has its limits, however. Almost nothing can be touched by the beam at 20,000 kilometers, since the gravitons being emitted have a very short lifetime and will disintegrate into useless byproducts. Conversely, even with the device on a full power, you have to be almost touching the device if that object has a mass of 10,000,000 tons or more.

See the handy-dandy calculator for an example. It works like those mileage calculators you find on road maps.

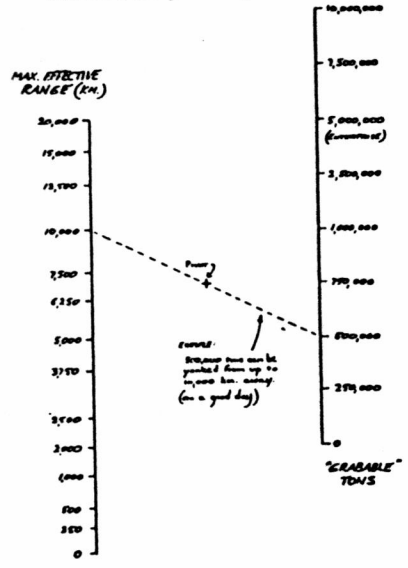
For most peaceful applications, we are able to maneuver ships equal or larger to the Enterprise (and smaller, of course). I am reminded of pictures showing one Army Chinook helicopter lifting another Chinook. According to the tractor beam calculator, the Enterprise could tow another Galaxy-class vessel from as far away as 2000 kilometers. Neat, huh?

To use: Lay piece of paper across pivot point, match up the tonnage you want to pull and read maximum range for that tonnage. Conversely, match your distance and read across to see how much you can pull from that distance.

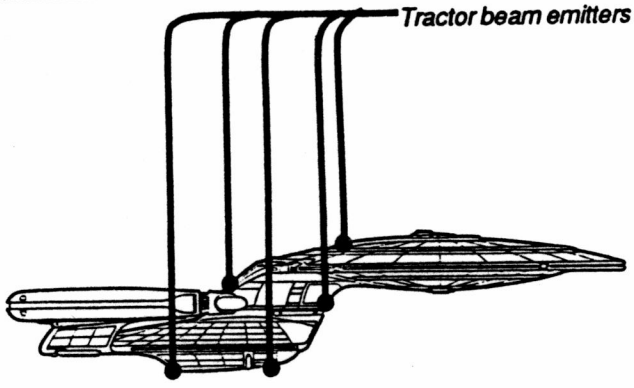
Basic Tricorder Operation (Revised 9/88)

This section deals with the proper operation of the Standard Tricorder, as well as the Medical Tricorder (which is a Standard unit with Medical Peripheral).

Rick's handy-dandy tractor beam calculator



Tractor beam emitters



The Standard Tricorder is a portable sensing, computing, and data communication device issued by Starfleet R&D to starship crewmembers. Its many functions may be accessed by touch controls or if necessary, voice command. Borrowing from the communicator of James T. Kirk's day, the control surfaces are protected from the elements with a flip-open cover.

When stowed, the only visible control is the power switch. It shows a red power-on light and a green power level indicator (see diagram). When deployed, all of the available controls are visible.

The controls are as follows:

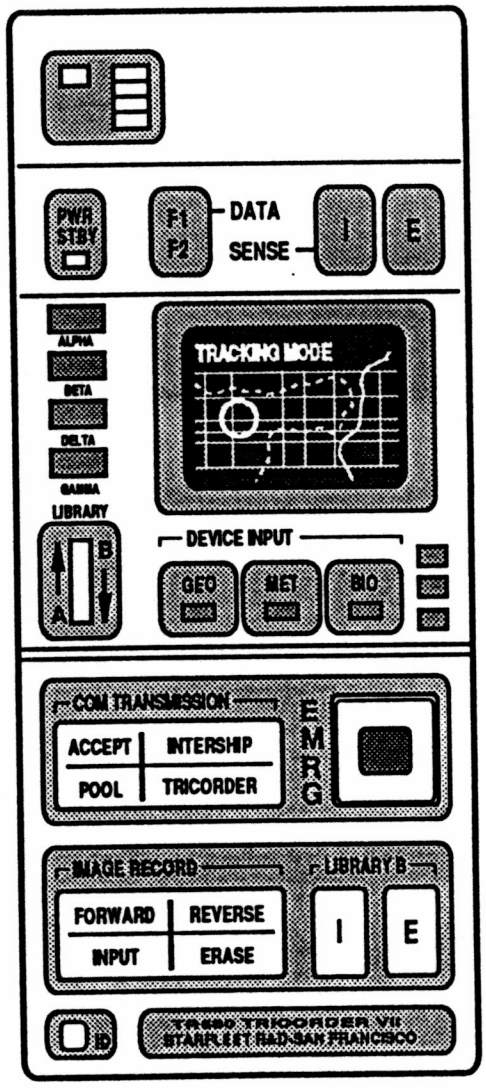
PWR STBY — Power standby light. If the tricorder is not used for more than ten minutes, it goes into low-power mode. Any new touch of any control will bring the device back up to full power.

F1-F2 — Control function select switch. Many buttons on the tricorder have more than one function. This selects alternate functions. This operates in data operations only.

I or E — These are two sensory controls, internal and external. They control the source of remote sensing information, either the tricorder itself (internal), or a remote device (external). The remote device can be any sensor that uses the same data collection machine language, even the Enterprise or other spacecraft.

ALPHA BETA DELTA GAMMA — These are lights indicating which tracks are being read off the library crystal cartridges.

Standard Tricorder controls



LIBRARY A/B — This is the slot for the cartridge (stowed in a pack in the back of the tricorder).

DISPLAY SCREEN — The blank area in the drawing is the main display, capable of showing any real-time, stored, or computed image (video, graphs, diagrams, etc.).

DEVICE INPUT — Three buttons labeled GEO, MET, and BIO select between external sensing devices. The three small lights to the right indicate which functions are active.

COM TRANSMISSION — The tricorder can receive and transmit pictures and data. The first button toggles between one way receive (ACPT and networking (POOL). The second button toggles between ship-to-tricorder links (INTRSHP) and other tricorders (TRICRDR). Both modes can be active at the same time.

EMRG — This is an emergency "dump everything to the ship" button; it is a non-error-checking burst mode data transmission.

IMAGE RECORD — This button has four divisions : Forward, Reverse, Input, and Erase. These are image memory controls for sequential image files (approximately 120 frames per second sampling rate).

LIBRARY B — Library B is primarily an image storage area. I and E control the source of the images.

ID — This touchpad may be used to personalize a tricorder for default power-up settings, or as a security device for one-person-only operation.

Basic Medical Tricorder Action

(Subject to change by individual directors, humidity, sunspots, stock market fluctuations, etc.)

The use of the medical tricorder depends on the technique of the particular user, but here are some basics about what this little gizmo is and what it can do.

Like the Standard Tricorder, the Medical Tricorder combines the functions of many present-day devices (and many others yet to come), such as radar, sonar, CAT scanner, EKG, supercomputer, television, VCR, laserdisc player, shortwave radio, et cetera. About the only things it can't do are darn socks and wash dishes.

When the tricorder is closed, all of the controls are covered up for protection. It can still record information though, by using its sensors (the little white and blue lites in the exposed front end.) With the the Medical Peripheral attached, these lites aren't visible, but we'll pretend the tricorder is still doing its job.

When the tricorder is open, and all the controls are accessable, most of the information you'll want to study would pop up on the little screen. The Medical tricorder is smart enough to know how to present it, like in graphs, lists of drugs, scanner pictures of broken bones, flow patterns of blood vessels, and that kind of thing.

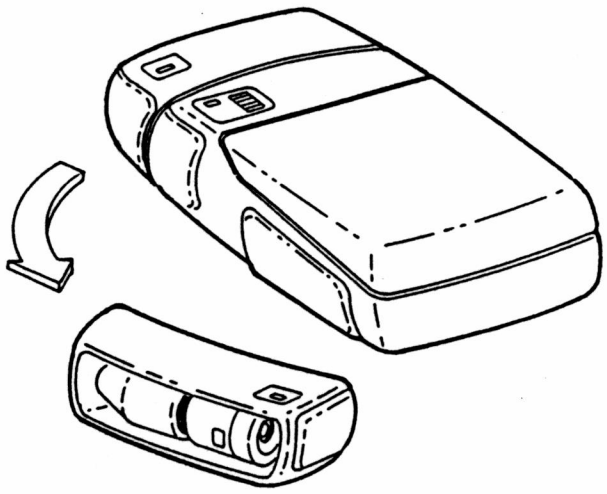
When you aim the front of the tricorder at the patient, what you need to know would be on the screen. You'll also be getting more detailed information about the specific body parts/functions by running the little silver scanner (the one with the red blinkie) around the patient. Dr. McCoy used to scan people all the time with his scanner in the first series, as we all know.

The scanner has two ends, one tapered, one flat (the flat end has the red lite). The flat end gets pointed at people, so we can see the blinkie (we love blinkies).

Without the Medical Peripheral attached, the tricorder can still do medical studies, but is more limited in its capabilities (maybe it works a little slower, maybe it doesn't have as much computer memory, etc.). Data has used his Standard Tricorder for scanning aliens, so it does some biological things. The Medical Peripheral just makes things easier.

The Medical Tricorder is real useful when working with the other instruments in Sickbay. Information re-

Tricorder medical peripheral attachment



corded "in the field" can be transferred to the Sickbay computers; it's a good general instrument to use during both routine and crisis situations.

Phasers -- Once and for all

Okay. There's been some honest confusion over what phasers do and what our new and improved phasers' capabilities are. This memo is specially formulated to eliminate that confusion, and get your 24th Century life in order. Once you have tried the best that Starfleet R&D has to offer, you won't want to go back to some run-of-the-mill black market molecular disruption weapon.

First of all, we have two main types of phaser: Type I and Type II. Easy. Type I is the small "keychain-light" device, and Type II is the "Dustbuster". Both work by drawing off energy stored in a small dilithium crystal, converting that energy into a collimated beam, which exits the emitter. We won't go into the exact nature of the energy beam; suffice it to say that the beam manages to excite water molecules like a microwave oven (at the low end of the scale), up to being able to negate the nuclear forces holding matter together (at the high end), and various steps in between.

Phaser Type I: This phaser has a power scale composed of eight steps. The capabilities of the small Type I phaser are as follows:

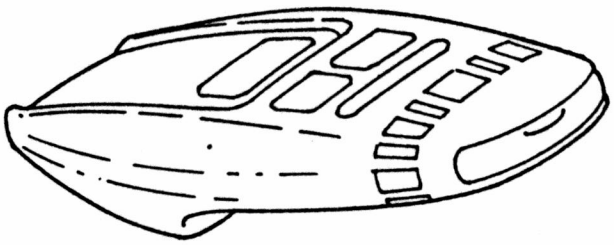
Setting 1: This is the lowest setting, your basic "stun". When aimed at a human/humanoid target, it knocks the subject out for a few minutes. When aimed at an inanimate object, it merely warms it up. You can cook popcorn with it if you left it on for a couple of minutes. You can also scramble a person's nervous system if hit for too long, so short bursts are preferred. This setting will NOT make a mark on a wall.

Setting 2: This is medium stun. Some humanoids are resistant to light stun, so try this if he/she/it keeps charging. When aimed at a chicken pot pie, it will cook in about five minutes or so. Hitting normal humans will knock them out for about the same amount of time. This setting will NOT mark the walls.

Setting 3: This is heavy stun. Normal humans will sleep it off in about an hour. Resistant humanoids and other bioforms will snooze for about fifteen minutes. Houseflies will boil a little. This setting will also NOT mark the walls.

Setting 4. This is where it starts to hurt. Humans will suffer neural damage, which is 90% reversible. Small

Type One Personal Phaser



pets will become vegetables. Some visible radiation burn is to be expected, as tissues will begin to come apart. This setting will discolor the walls, so call Maintenance to come with a bottle of Clorox.

Setting 5: Point-hits by the beam will ignite clothing and building materials. Skin and muscle will suffer definite radiation effects but, due to the water content, the deep layers will not char. Simple personal force-fields will be penetrated after five seconds. Large Away-Team fields will not be harmed.

Setting 6: THIS IS A DEFINITE "KILL" SETTING! A marked increase in damage is seen at this level, as higher nuclear disruption energies come into play. Point-hits will bore holes in building materials, as well as penetrate human tissue through an exit wound.

Setting 7: THIS IS A DEFINITE "KILL" SETTING! Human tissue damage will cause immediate death, even at apoint hit (as opposed to a fan-beam hit), since matter disruption is too widespread; typical hits destroy matter to a diameter of 20 inches or better. Building materials suffer structural breakdown, large penetrations and burning are common.

Setting 8: TOTAL "ZAP"! This setting will cause a human or humanoid to totally vaporize, as physical forces break down. About fifty percent of the disrupted matter disappears from this continuum as high-energy converted particles (the reaction takes place in a very short distance from the target, so thermal effects travel only a few inches). The remainder of the target becomes water vapor, carbon dioxide, calcium phosphate, and various other compounds. Building materials break down similarly, and their vaporization is dependent on density, thickness, etc. (Carbon-

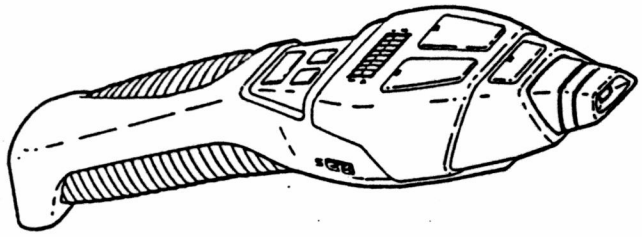
epoxy composite panels instantly fly to gas, while rock walls eat away slowly).

Phaser Type II: There are sixteen settings on this unit (each green LED indicator is divided in two halves). On the higher settings, geometrically greater energies are involved (NOTE! The following settings are revised from the first version of this memo, but as there was nothing established in the first season of a specific nature, the revised settings are usable).

Settings 1-8 are the same as the Phaser Type I.

Setting 9-10: Everything from here on is for various levels of structureal damage. This range will punch holes in 1-foot thick tritanium hull walls not protected by shields. (The Enterprise hull is typically two feet thick, and well-shielded).

Type II Personal Phaser



Setting 11-12: Rock walls can be "drilled" a rate of one foot per minute. Large trees will vanish. Most light alloys will disappear. Dense synthetic materials will begin to break down.

Setting 13-15: Large geologic structures will be disrupted (hillsides, boulders, etc.). These settings are VERY power-intensive and cannot be used repeatedly without a cool-down period and recharging.

Setting 16: This is the highest setting available on a hand-held phaser. The point-hit from this device can disrupt large artificial structures and geologic formations (typically destroying a volume of metamorphic rock some 100 meters across). The cool-down period for this setting is about six seconds; a Type II phaser can release about ten shots of this magnitude before depletion.

There are larger phasers available, the most popular of which is the Type III large rifle phaser. Its power output is roughly 1-1/2 times that of the Type II. Ground- and vehicle-mounted units exist, but they cannot be carried by a person and they radiate enormous amounts of thermal energy. The largest phaser in Starfleet's inventory is the LPA, or Large Phaser Array, a Type X device mounted externally on Starfleet spacecraft.

NOTE: There is a definite computer intelligence connection between the phasers and the Enterprise internal structure. There are enough "smarts" carried within either type phaser to allow it to communicate with the Enterprise computers. This allows the phasers to reach only limited power levels while on board the ship. This is to make sure that a random blast does not penetrate spacecraft bulkheads and hull walls. Once outside the vehicle, all levels are available.

Planets and Orbits

Now don't go running out of the room screaming just because we're going to have another little astrophysics lecture. It'll be painless, really.

We're going to look at planets and orbits (a couple of overdue topics when questions were being raised in the planning for "Encounter at Farpoint".

First of all, most of the planets which our Away Teams will visit will have characteristics very similar to those of Earth: Oxygen-nitrogen atmospher at about 14.7 PSI, approximately one G gravity, temperature between 0-120 degrees F. We may visit other bodies like asteroids or small moons, but those trips will require some portable environmental protection, be it spacesuit or force field device.

There are limits to the size of a human-habitable planet ("Class M", in *Star Trek* terms). This is an extremely important point to remember. The accompanying diagram from Stephen H. Dole's *Habitable Planets for Man* shows the smallest and largest permissible worlds, as compared to the Earth, the Moon, and Mars. Small planets, with their lower gravity, will tend to lose their atmospheres over geological time. The larger ones may retain a large amount of hydrogen, making the atmosphere unbreathable and life processes more difficult to maintain. Other factors, such as volcanic activity, atmospheric pressure, surface gravity, rotation rate, and

distance from the parent star(s), will all contribute to a planet's habitability, but the mass range shown here is a good guide. We'll get into a discussion of good candidate star types another time.

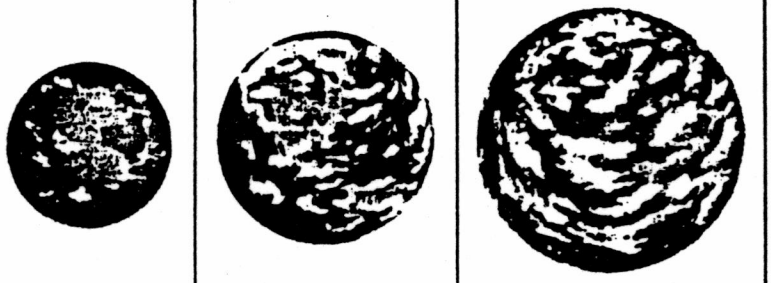
Consider yourself lucky that we aren't going to go deep into orbital mechanics. It's scary, even for those of us who understand fourth-order Runge-Kutta integrations. There has been a bit of confusion in the ranks over the term *synchronous orbit*, so an equal bit of explanation is necessary.

Let's look at the Earth for a start. We're on a planet about 8,000 miles in diameter, and about 25,000 miles in circumference. It rotates once in 24 hours, and the surface speed around the center of the planet is roughly 1,000 miles an hour. If one wishes to be in orbit around the planet, one must first be above most of the atmosphere, or drag will cause a craft to drop real quick. One hundred miles puts you outside 99.9% of the atmosphere. To be in orbit at 100 miles, one must exactly counter the pull of gravity with some velocity around the center of the planet (remember the old spinning weight at the end of the string?). There's a specific equation for calculating the circular orbital speed for a given altitude above a given planet; it's available on request.

How does this all pertain to synchronous orbit? The speed needed at 100 miles above the Earth is about 18,000 MPH, and that gets you around the world in about 90 minutes. The higher the orbit, the slower the velocity. It turns out that for a circular orbit to match the Earth's rotation rate of 24 hours and thus "float" over the same spot at all times, it must be at an altitude of 22,300 miles with a speed of just under

SIZE RANGE OF HABITABLE PLANETS

THE MOON AND MARS FOR COMPARISON TO SAME SCALE



	Smallest	The Earth	Largest	Moon	Mars
Mass	0.40	1.00	2.35	0.0123	0.1077
Radius	0.78	1.00	1.25	0.273	0.53
	3090 mi	3960 mi	4950 mi	1080 mi	2100 mi
Surface gravity	0.68	1.00	1.50	0.165	0.38

The extreme size range of habitable planets.

6,000 MPH. This is synchronous orbit.

Dole writes: "Just what extremes of rotation rate are compatible with habitability is difficult to say. The extremes however, might be estimated at, say, 96 hours (four Earth days) per revolution at the lower end of the scale, and two or three hours per revolution at the upper end, or at angular velocities where the shape becomes unstable because of the planet's high rotation rate." The extremes will have adverse effects on plants and animals upon which human life depends.

The next important thing to remember is that synchronous orbit will differ from world to world and is directly tied to a particular world's rotation rate. Synchronous oribit around a super slow world will be very, very far away and may be difficult to maintain. A world with arotation period of only two hours will have a synchronous orbit only a few hundred miles up. Most of the worlds we're interested in will have synchronous orbits like that of earth, about 20,000 to 25,000 miles out.

The real point of this discussion centers on the visual aspects of the show. Realistically, a typical planet below the Enterprise will appear about 18degrees wide in a field-of-view of 50 degrees (see drawing). Thgis could be considered somewhat small. Shallower curves of the desired planet imply lower altitudes or a fast rotation. Since most planets' exact specs aren't given, we have a rationale for making the planet a bit larger in the frame, if we wish.

Star and Planet Names

The question of stellar nomenclature has always stuck in my mind, as far back as the original series. It never was made clear as to which star we were heading for, even with names like Ceti Alpha, which I assume is a simple reversal of the accepted standard in the astronomical community.

Now, I'm **not** proposing that we spend endless hours trying to get star names perfect, or that we hope to match up stars in the stories to real ones. No no no noooo.

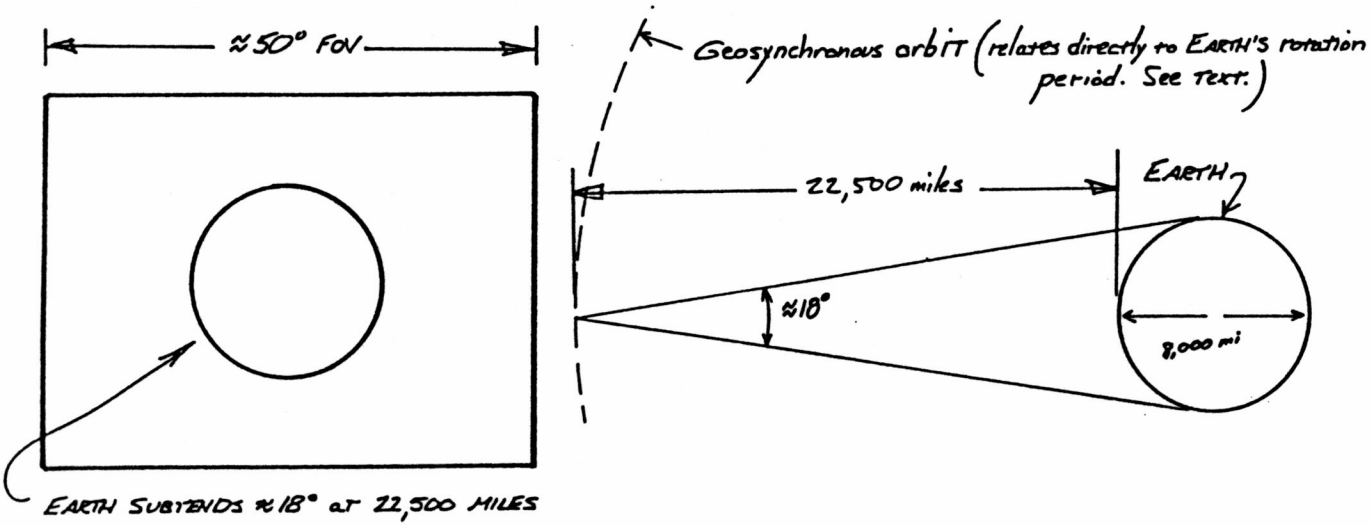
What I **am** suggesting is that we take a little time to conform to the established standard, which is as follows.

In any constellation visible from Earth, the brightest star gets the first Greek letter (alpha), followed by the name of the constellation. Example: The brightest star in the constellation Cygnus (the Swan) is alpha Cygni. the next is beta Cygni. And so on. If you've heard this all before, skip to the next memo.

When you've run out of Greek letters, you continue with numbers. Planets get Roman numerals; moons get small letters: alpha Cygni IVc is the third moon of the fourth planet.

Anyhow, that's the way that works. Now, finding a habitable planet around a promising star is another matter altogether. I have all the necessary books and astronomical references (star atlases, catalogues, etc.) to be able to tell you whether a particular star can even have planets with intelligent life, but you probably

What the camera sees at 50-degree field-of-view

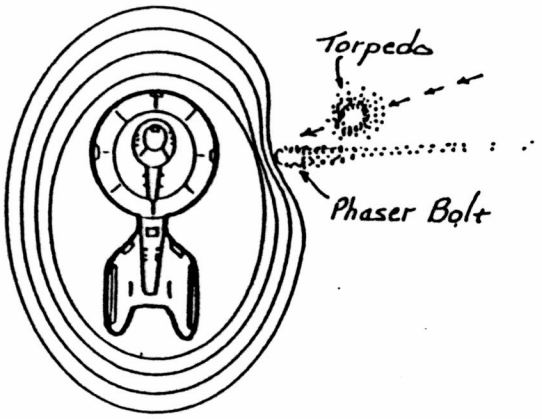


don't need to hear that. Unless you think it's necessary to be accurate.

Many stars have ancient names like Betelguese or Archenar. Made-up names like that are fine. The same scheme can apply here: Betelguese VI is valid. Altair IV is valid (though, as we all know, Altair IV blew up in 1956).

Now that we are into a new series, we have an excellent opportunity to come up with a consistant naming system, and even throw in some real astronomical science without beating people over the head with it. For us technical types, this stuff is easy (no, Bob, we don't stay up at night working these things out), and we're having fun with it.

You know where to find us if you need us.



Weapons and Tactics

Defensive Shield Penetration Technique — This involves a method by which it may be possible to penetrate a ship's shielding in a rather dramatic and heretofore untried fashion. The actual mechanics of the exercise were proved out in a Starfleet life-fire test on an obsolete cruiser, specially upgraded with the latest deflectors.

It is well known that the fields produced by Starfleet standard deflector grids, and those produced by alien "Threat" vessels, can be disturbed by various outside forces. Phaser bolts will interact with these fields, and it has been seen that even awhen a shield layer is not disabled, it does become thinner, dimpling inward. Heavy phaser exposure will compress all shield layers toward the tritanium hull.

At the point of maximum dipling, one targets a photon torpedo. The torpedo, a controlled mixture of matter and antimatter, would be affected by the adjacent phaser fire, but only slightly during the short flight to the target.

If timed correctly, the phaser is extinguished at the moment the torpedo hits the dimple. The shield rebounds, trapping the torpedo within the outer shield layers. When it detonates, the force of the explosion will be confined (if only for a split-second) within the shield. Bye-bye ship.

SECTION III: EMERGENCY PROCEDURES

The Enterprise is a finely honed system and is capable of dealing with most "routine" emergencies in an orderly manner. In many cases, automatic computer intervention will take care of problems so that the crew may not even be aware of them except by automatic notification on the bridge. Nevertheless, the voyages of the Enterprise will occasionally require extraordinary measures. (A lot of these are so catastrophic that we will probably never show them in full, but this stuff may be useful in suggesting the kind of preparations our crew may make in emergency situations.)

Auto-Destruct

As a last-ditch effort to prevent the Enterprise from falling into hostile hands, the computer can be programmed to destroy the ship. This procedure is performed at the master situation monitor (the "pool table") in Main Engineering, and requires the verbal authorization of both the Captain and First Officer.

Emergency Evacuation from ship

The ship is equipped with hundreds of lifeboat pods which can be ejected in an extreme emergency. Lifeboats are probably a lot safer if ejected at sublight. After ejection, lifeboat pods are designed to dock together into clusters to increase chances of survival. Additionally, the ship is equipped with six emergency evacuation transporters capable of one-way-only transport off the ship.

Emergency Evacuation to ship

During times of disaster on a planet or on another ship, the Enterprise is well-equipped to serve as a rescue vessel. Evacuation to the ship can be accomplished by Transporter. (In addition to the six personnel Transporters, the eight cargo Transporters can be used in a pinch.) The ship's shuttlecraft can also be used for emergency evacuation, but their total capacity is far less than Transporter usage. During such an evacuation, the ship's Shuttlebays (Main Shuttlebay, Deck 4, Shuttlebays 2 and 3, Deck 13) can be pressed into service as medical triage facilities and refugee accomodations, as can the Cargo Deck (Deck 4). Total capacity of the Enterprise in an emergency evacuation is probably about 10,000-15,000 people.

Fire

In case of fire on board the Enterprise, sensors immediately detect the change in temperature and air ionization. A forcefield is activated, containing the fire, sealing it off from further oxygen supply. This extinguishes most fires very quickly and with a minimum of damage. Handheld and other extinguishers can also be made available. As a last-ditch effort in the case of a major disaster, one or more sections of the ship can be vented into the vacuum of space, cutting off the fire's oxygen supply. This will probably be hazardous to the health of any crewmembers unlucky enough to be in the area.

Atmospheric supply failure

The Enterprise environmental support systems are highly sophisticated, multiply redundant, and very rarely subject to any significant problem. Even in the event of total loss of power to all air supply subsystems, there is sufficient air volume in the ship's interior to sustain the crew for many hours. Minimum power to ventilator fans could easily extend this for days, even without any new oxygen supply. In the event of a sufficiently severe systems failure, non-essential areas of the ship would be evacuated, and an emergency supply of air would be fed to selected areas only. Crew members working outside of these areas would probably have to don environmental

suits. A catastrophic loss of pressure in the ship (as might happen if the hull were breached) would likely be limited to a very small section of the ship because isolator doors would automatically seal off the damaged area. In most cases, a forcefield in the hull would temporarily stop the leak until the crew can actually repair the hole.

Inertial damping failure

The Enterprise travels at such tremendous speeds (even when under impulse power) that the acceleration and deceleration involved would instantly turn our crew to chunky salsa unless protected by the Inertial Damping field. Should this system (and its backups) fail, the ship would be limited to very gentle speed changes (compared to what it ordinarily does). It would take many months for the ship to accelerate to Warp One, or to change warp factor. This would mean that the ship would be essentially trapped at whatever speed it is travelling, for any significant speed change would take a very long time or would kill the crew and severely damage the structure of the starship.

Warp field collapse

When travelling at warp speed, the Enterprise is presumably enveloped in a warp field which suspends the ship in a bubble of subspace. In other words, the ship is partially existing in another universe. In order for the ship to return to "normal" space, the subspace field generators must be powered down in a properly synchronized sequence. This is not ordinarily a problem (infact, it is possible to simply "turn off" the generators, and the residual field collapse will normally be safe). On the other hand, should the fields collapse in an unsynchronized sequence, it is possible for different parts of the ship to be travelling at different warp factors. The result would be that the subspace field stress would immediately shred the ship and its crew.

Emergency landing

When seperated, the primary (saucer) hull can theoretically be maneuvered into the atmosphere of a Class M planet and (hopefully) safely landed. The structural strain of atmospheric entry and landing would mean that the ship could never return to space. No Galaxy Class starship has ever attempted this risky maneuver, but it is an option in an extreme emergency.

Warp core breach

One of the worst imaginable accidents in an antimatter reactor, the breach of the reaction vessel, exposing the ship to antimatter plasma and other high-pressure, high temperature gasses. In such an accident, a number of emergency safeguards automatically activate. First, a cylindrical forcefield is activated, isolating the engine from the rest of Engineering. Second, an emergency shutdown procedure automatically shuts off all fuel feeds and magnetic quenching fields are activated. Should these fail to work, a series of explosive bolts blow a hole in the bottom of the engineering hull and the entire warp reactor core is ejected into space. This will result in venting much of the engineering hull to the vacuum of space and the probable death of a significant number of engineering personnel. Additionally, without the warp core, the ship will be limited to impulse speed. Nevertheless, this procedure can prevent the loss of the entire starship in the event of a catastrophic loss of antimatter containment. (Note: This is probably similar to what happened to the USS Yamato in the episode "Contagion", except that the safety procedures failed and the ship blew up.)

Antimatter containment failure

Equally dangerous as a warp core breach, this indicates a failure in the magnetic containment fields which isolate the volitile antimatter fuel from the rest of the ship. Should even a tiny quanity of antimatter come into contact with the "normal" matter in the Enterprise, the resulting explosion could very easily destroy the ship. Many backup power supplies and mag field generators exist to insure that such an accident never happens, but it is remotely possible. If such an accident occurs, the antimatter fuel supply can be vented into space. Emergency shutdown of the warp engine would be performed, and forcefields would attempt to contain the extent of any antimatter annihilation explosions. In a severe accident, explosive bolts would blow a hole in the bottom of the engineering hull and the antimatter storage pods would be ejected. (This is one reason why antimatter storage is located at the bottom of the engineering hull.) This procedure is somewhat similar to procedures invoked during a warp core breach.

SECTION IV: A CELESTIAL BESTIARY

Over the course of the past few seasons, our writers have frequently been called upon to devise various exotic-sounding planetary and stellar phenomena to serve as sources of danger for our heroes. Since this need seems likely to continue, we herewith present the *Star Trek* Celestial Bestiary of weird, dangerous, but scientifically semi-plausible phenomena. We hope that these might serve as springboards for our writers' imaginations.

Please note that many of these objects and phenomena are based on actual scientific theory, though a few are pure figments of the imagination. If you're contemplating using any of these in a story, we would be happy to discuss these at greater length.

Black Hole

One of the most fearsome objects in nature. This is a dead star which was once far larger than our Sun. After it burnt out, it gravitationally collapsed onto itself. So powerful was its gravity that it finally collapsed into an object smaller than an atom's nucleus. The resulting "black hole" is so-named because its gravity is so great than even light cannot escape. Near a black hole, this incredible gravity also causes terrible tidal stresses — more than enough to tear a planet or a starship to shreds. There would also be very severe (and probably dangerous) time/space distortions near the black hole. A wandering black hole is very capable of swallowing entire solar systems. (Note: It is very unlikely that any object or ship could survive falling "through" a black hole — it would be torn into sub-atomic particles by the gravitational stresses.)

White Hole

A hypothetical entity, some kind of opposite of a black hole from which radiation and matter appear to originate from nothingness.

Interstellar Strings

Also called "super strings". Incredibly long gossamers of incredibly dense material. Current theory describes them as a black hole that's one proton in diameter but light-years long, and virtually undetectable at a distance except by its intense gravity. If a ship were to fly through such a string, it would cut the ship neatly in half. If it got entangled in a solar system, it could slice the planets and star into pasta. If a way could be found to manufacture or control these objects, they could make a very potent weapon or defensive system.

Supernova

A star near death, which has exhaused almost all of its nuclear fuel. Lacking the ability to sustain itself, it collapses, triggering one final massive explosion. A sufficiently large supernova could very easily wipe out any inhabited planets in a solar system. The x-rays from a supernova could even threaten life in a solar system several light-years away. If the star was massive enough to begin with, it could ultimately collapse into a black hole. Out of the ashes of the supernova explosion can come the heavier elements which form the building blocks of life. Many of the atoms in our bodies were formed billions of years ago in such an explosion.

Pulsar

The dying embers of a large collapsed star. It rotates rapidly, sending a powerful jet of potentially dangerous radiation, thereby appearing to pulse at several times a second. Imagine a spinning searchlight, sending out a powerful beacon of radiation. (The Enterprise shields might not be able to protect the ship at a sufficiently close range.)

Subspace Anomaly

When the Enterprise is travelling at warp speed, it is presumably not entirely in normal space (where faster-

than-light travel is impossible), but in a hypothetical existance called "subspace". It is conceivable that subspace is not a uniform continuum, but that it has mysterious "anomalies" — density variations, field vortices, or other such things. These might be difficult to detect but could be very dangerous to the ship at warp speed.

Planetary Tidal Stresses

When a planet is in an orbit near a star, another planet, or a moon, the gravitational stress can cause tides, much as we have in Earth's oceans. If the tides are sufficiently great, it is conceivable that the stresses could affect the planet's structure — possibly enough to tear apart the planet.

Near-Collision of Two Planets

Another form of interaction between two planetary bodies might be a near-collision in which one or both planets is gravitationally slingshotted out of the solar system. This is a very unlikely occurence in a stable system, but would certainly be unwelcome news to anyone living there.

Comets Dislodged from an Oort Cloud

Yet another form of gravitationally induced threat. Many solar systems apparently have a large belt of frozen comets orbiting far beyond the planets' orbit. It is possible for some passing object to gravitationally "knock" a large number of these comets out of their distant orbits, to fall toward the sun. If this happens, it is possible that a number of these might hit one or more of the planets in the solar system. Such an occurance is one theory to the disappearance of Earth's dinosaurs.

Wormhole

A hypothetical "tunnel" through the structure of space. One would enter the tunnel and apparently travel a relatively short distance, emerging much further away. This would probably be a subspace phenomenon somehow related to our warp drive. The *Star Trek* features have established that a warp drive malfunction can pull the ship into a dangerous wormhole. In the episode "The Price" we have seen that most wormholes are very unstable, with both endpoints fluctuating wildly in both time and space.

Edge of the Galaxy

The first *Star Trek* series established that there is a mysterious energy barrier at the edge of our galaxy. This unexplained force is a spectacular curtain of shimmering energy, very dangerous to both ship and crew. Beyond the edge of our galaxy is a vast intergalactic void, millions -- even billions -- of light years to other galaxies.

Center of the Galaxy

The center of our galaxy is believed to be a very dense cluster of stars... a very spectacular sight to those used to the relatively sparse starscape visible from Earth. The relatively high density of the star population means that starship navigation is probably somewhat trickier than normal (though well within the abilities of our people and hardware), and radiation levels would probably be quite a bit higher. There may be a large, dangerous black hole at the very center of the galaxy. The movie *Star Trek V* established that there is a mysterious and dangerous energy barrier around the center, where Kirk and company discovered the mythical planet, Sha-Ka-Ree.

Dark Matter

Current scientific theory suggests that our galaxy may contain vast quantities of "dark matter" in the spaces between the arms of the galaxy and in the regions around its perimeter. If this stuff exists, it is probably very tenuous, but its total mass may be ten times greater than the visible galaxy.

Destruction of a Moon from Tidal Stresses

This might result in a new ring around the planet. Among planets with several moons, it is not uncommon for the gravity-induced tidal stresses between the moons and the planet to cause one or more of the moons to be torn apart, resulting in the creation of Saturn-like rings. This would certainly be a hazard to anyone living on that moon, or to a spacecraft in orbit near the moon. Additionally, it is possible that the moon's disintegration could cause an increase in meteor activity on the planet's surface.

Gas Exchange between a Binary Star Pair

Many stars in our galaxy are what we call binary pairs. That is, they orbit each other. In some such binary

pairs, the gravity of one star is so great that it actually pulls gas from the other star's photosphere. These streamers of ionized gas would be very spectacular and would be a threat to any spacecraft or planet in the vicinity.

Antimatter Star

Or an antimatter nebula. Probably originating from outside our galaxy, it is possible that an entire star could be composed of antimatter. If the entire star and its planets were pure antimatter, it would have a perfectly normal existance unless it came into contact with something composed of "normal" matter. Like the Enterprise. Possibly more insidious would be a gas cloud or nebula composed of anti-hydrogen. Although very thin (like a regular nebula), such a cloud might cause severe erosion of the ship's hull as it flew through.

Negative Matter

Not the same thing as antimatter. Negative matter would theoretically have the same properties as "normal" matter, except that it would have a gravity field which pushes away rather than attracting. When negative matter and positive matter come into contact, they would theoretically annihilate each other, but with no release of energy. Both particles would simply cease to exist.

Gravity Waves

Some scientists believe that gravity is transmitted through space by means of gravity waves. If this is the case, one might imagine some bizarre phenomena in which two sets of gravity waves somehow intersect, possibly causing strange (and probably dangerous) spatial distortions.

Cepheid Variable Star

An unstable star whose brightness varies considerably over a relatively short period of time (days). These tend to be rather large stars whose surface can trap the star's internal energy output until it builds up to a point where it erupts in a potentially dangerous burst. A related object is a "flare star" which can increase in brightness for periods as short as minutes.

Proto-Universe Event

A hypothetical occurance in which another Big Bang is occuring in a parallel universe, but somehow intrudes into ours. There would be severe space/time distortions accompanied by the release of a tremendous amount of energy and possibly some "new" matter created by the parallel Big Bang.

Dyson Sphere

Postulated by physicist Freeman Dyson, this would be an incredibly large structure built by some advanced culture. The sphere would completely enclose a star, harnessing the star's total energy output. A Dyson Sphere would easily be 200 million miles in diameter, dwarfing any other artifical construct we've yet seen on *Star Trek*, and would presumably have been built for some incredible purpose that our writers will devise. This could be detected by infra-red waste heat emissions that would probably leak through the sphere's surface.

Von Neumann Machine

Postulated by mathematician John Von Neumann, this is a concept of a semi-intelligent machine which is built to (1) find raw material, and (2) make copies of itself. Such devices could conceivably "eat" an entire planetary system, much as a virus can consume a host body. Von Neumann machines could be built for massive terraforming of an uninhabitable world, as homes for colonists, or as a terrible, self-replicating army of destruction.

Rogue Star Cluster

A globular cluster that's been gravitationally torn apart by passage through the galaxy. Most of it will go harmlessly through the galaxy, a relatively small number of stars could pass close enough to the heart of the Federation to whip a number of entire solar systems out of the galaxy. This could take place over a relatively short number of years, even though we would probably see the approaching cluster from Earth today.

Super-Jovian Planet Ignition

Imagine a gas giant planet, about 75 times the mass of Jupiter. If it should happen to collide with another Trans-Jovian planet (about ten times the mass of

Jupiter), it would become heavy enough for gravity to cause the planet to suddenly begin fusion. In other words, the planet would become a small star (to the great annoyance of nearby property owners).

Interaction of Two Supernovas

A very unlikely event in which the advancing pressure waves from two supernovas collide. Stretching theory, this could conceivably cause a "subspace anomaly" which could be dangerous to the ship travelling at warp speed. The time/space resonances of the waves could last for quite some time, tearing apart any starship unlucky enough to warp into the maelstrom. Ironically, a ship at sublight would only experience the radiation and blast from the stars — against which shields would probably protect the ship.

Maximum Entropy

The death of the universe as we know it. Current theory suggests that at an almost unimaginably distant time in the future, the energy in the universe will be spread equally across the cosmos. When there are no temperature differences, there can be no chemical or nuclear activity, and the universe will be effectively "dead". There is another theory which suggests that rather than "dying" at maximum entropy, the universe will collapse back onto itself to form another Big Bang, starting a whole new universe.

Gas Giant Planet

Several planets in our own solar system are Gas Giants, like Jupiter. Such planets tend to be characterized by poisonous atmospheres of methane and hydrogen, relatively high gravity, the absence of any stable surface, and very high magnetic fields and radiation belts. These latter two items are not a threat to the Enterprise under normal conditions because of its powerful (and normally very reliable) shielding systems. On the other hand, in the unlikely circumstance that those shields should fail....

Nebula

A large, tenuous cloud of interstellar dust and gas. Often the remnants of an exploded star or a solar system in the making. Although very thin, the dust and gas can be a hazard to the ship when travelling at high impulse (sublight) speeds. This is similar to re-entry into the Earth's atmosphere causes severe friction heating on the Space Shuttle. If the nebula is near a star, it could glow with the star's radiation, quite a spectacular sight, but possibly impairing the ship's sensors. Under certain conditions, a nebula can coalese into a whirlpool which can become a new solar system.

Stellar Fusion Ignition

The birth of a star. As suggested above, it is possible for a nebula or other gas cloud to (over millions of years) coalese into a swirling whirlpool. This can eventually condenses into a dense central object which can become hot enough to ignite into a new star. The leftover "debris" from such a star's formation can form planets. Although this process is extremely protracted, it is possible that our ship might arrive at such a gas cloud just in time to witness (and be threatened by) the star's birth.

SECTION V: INDEX

UNITED FEDERATION OF PLANETS
STARFLEET COMMAND