POLARIS ASTRONAUTICS LTD.

POLARIS STANDARD NAVIGATION CONSOLE

Owner's Manual and Pilot Handbook

Edition 2.0 (2042)

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1. INTRODUCTION

DESCRIPTION

The Polaris Standard Navigation Console (PSNC) is the user interface for a comprehensive navigation system to assist in flying, docking, launching and landing your spacecraft. The PSNC system is designed to accommodate any spacecraft that uses an RCS and/or Fusion Reactor drives, regardless of vessel size or class.

FEATURES

- Highly accurate Virtual System Map
- Real-time docking assistance
- Long-range course assistance
- Precise near-space maneuvering
- Onboard diagnostics system
- Regular map data updates from Polaris servers
- RADAR/LADAR compatible
- Assists both Reaction Control System (RCS) and Fusion Reactor drives
- Celestial map time dilation

MAIN PANEL VIEW

Figure 1.1: *Primary Navigation Panel*

DEVICE KEYS AND TOGGLES

STN	Zooms map view to Station.
PLA	Zooms map view to Planet.
INR	Zooms map view to Inner Planets.
OUT	Zooms map view to Outer Planets.
+RATE	Increases time dilation rate on map
-RATE	Decreases time dilation rate on map
RESET	Returns map to real time
SHIP (TRACK.)	Sets focus of map view to ship
TRG (TRACK.)	Sets focus of map to selected target
OFF (TRACK.)	Turns off map tracking (free roam view)
TRG (FOCUS)	Focuses map to target
BARY (FOCUS)	Focuses map to barycenter between the ship and the target
RCS MAN.	Toggles Navigation Mode to Reaction Control System maneuvering
MAP CON.	Toggles Navigation Mode to Map Control travel
CLEAR	Turns off proximity warning bell
SET MAX	Set's acceleration to maximum G-force during long range travel
- (GS)	Decreases G-force maximum limit
+ (GS)	Increases G-force maximum limit
COURSE ENG.	Initiates currently plotted long range course
PRINT STATUS	Generates a ship systems report on Map Screen with general diagnostics

2. NAVIGATION MODES

Reaction Control System (RCS) - The PSNC-RCS navigation mode assists flight during RCS travel. Standard RCS travel uses blasts of inert, cold compressed gas (usually N2) controlled by an intake regulator to create thrust and adjust your ship's attitude under vacuum. RCS is the preferred method of conveyance for near-space maneuvering and, under command of a skilled pilot, is accurate down to the meter.

When the PSNC Nav Mode is toggled to "RCS MANEUVERS" the keyboard inputs (WASD + QE) operate any thruster packages installed on your ship that are connected to an intake regulator with operable fuel tanks. The PSNC terminal displays remaining gas fuel in kilograms as "RCS REMASS." This number updates constantly as you expend reactive mass to create thrust.

In addition to remass values, the PSNC terminal displays several other values crucial to RCS travel. This includes the ship's velocity (VREL in distance/time) and range (RNG in distance) relative to a selected target. The bottom right of the terminal displays the ship's remaining power (PWR RESERVE in kilowatt hours). The PSNC operates under battery power when connected to standard conduits in full circuit.

Map Controls - When the PSNC Nav Mode is toggled to "MAP CONTROLS" the keyboard inputs (WASD + QE) operate your map instead of your RCS. While toggled into this mode, you can freely pan through the map using WASD and rotate the map using Q/E. Note that tracking modes other than OFF can override manual panning through MAP CONTROLS (see Tracking Mode below.)

Note that when under both RCS MANEUVERS and MAP CONTROLS, your ship will activate a proximity chime when it is within 5 km of another celestial object. This proximity alert uses the RADAR/LADAR system to decrease intervals between chimes to produce an audio indication of how close you are to collision during flight and docking. To deactivate the chime, press the "CLEAR" button on the Nav Control panel.

Fusion Reactor Drive Systems - In addition to RCS travel, the PSNC assists flight during high-velocity burn under a Fusion Reactor drive or other high energy "torch" engines. The PSNC is designed to interface with any standard Inertial Confinement Fusion Reactor Drive and offers diagnostics for such systems and engines. Factory default PSNC firmware prevents access to its Fusion Reactor Drive Systems. To access these systems please obtain override softwares from local air traffic authorities.

WARNING

Operating a fusion reactor drive produces a controlled nuclear blast approximately 300 meters behind your spacecraft and an exhaust plume sometimes exceeding 50 kilometers. Local system and station authorities strictly regulate fusion reactor operation. Flying under torch without appropriate permissions is illegal and dangerous to yourself and others. Please alert said authorities and ensure you are in open space with adequate clearance before entering fusion burn. Polaris Astronautics Ltd. and its subsidiaries are not responsible for any damage to ships, stations or other parties suffered during fusion ignition and/or other high-velocity burn.

The PSNC terminal displays and constantly updates several values crucial to Fusion Drive travel and available through system diagnostics (see "Diagnostics" section below). In addition to tracking your ship's velocity (VREL in distance/time) and range relative to a selected target (RNG in distance), the diagnostic terminal displays your reactor type and remaining fuel supply in Helium (H3) and Deuterium Oxide (D2O aka "heavy water") in kilograms.

3. VISUAL SYSTEM MAP (VSM)

The Visual System Map (VSM) is a highly accurate rendering of both near and deep space objects produced through a combination of

onboard RADAR/LADAR systems, air traffic data fed to the Polaris Navigation Console from nearby station authorities, and device information gathered from other Polaris users. The VSM renders the position and velocity of your spacecraft relative to other selected objects in space, such as asteroids, stations, and other spacecraft. Using the VSM in combination with other Polaris console systems, a pilot can navigate both long-distance travel along a predetermined path as well as precise near-space maneuvering and docking.

Tracking Mode - The TRACKING MODE toggle switches your map view between your ship and any target selected on the map. When your ship is under thrust, the map will generate a four-part predictive outline indicating where your ship will be relative to a selected target in 2, 4, 6 and 8 seconds respectively.

Quick Zoom - Using the Quick Zoom buttons, you can toggle their VSM view among four navigation scales. The Station View (STN) offers the smallest scale and is suitable for operations around a station's local space. The Planet View (PLA) offers a scaled-up image suitable for operations near a celestial body classified as a planet or planetoid, including moons and large asteroids. The Inner Planets view (INR) shows a view of the Solar System scaled to the four inner planets (Mercury, Venus, Earth and Mars) and their orbits. The Outer Planets view (OUT) is the most scaled-out view, offering visual data on the locations and orbits of the entire Solar System as deep as Pluto, Sedna and Bowie.

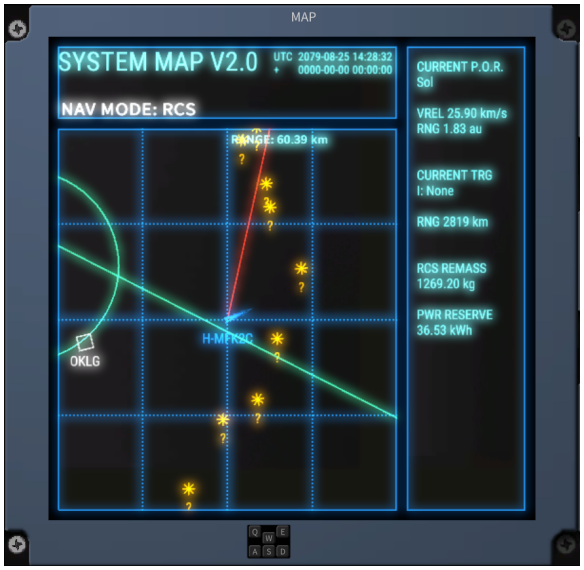

Figure 3.1: *Virtual System Map (VSM) zoomed to STN and tracked to SHIP at real time*

Predictive Time Dilation (FAST FORWARD) - The PSNC comes pre-installed with firmware that includes both a static map and celestial orbit predictions within the Solar System. Though the map is preset to remain static as a default, you can use the FAST FORWARD buttons on the main panel to increase and decrease the map speed to simulate orbits and other celestial movements. To bring the map back to static/real-time, press the RESET button.

4. LONG RANGE COURSE PLOT

Using the VSM system you can plot a long range course for interplanetary travel. To plot such a course, select a target on your map and right-click. This creates a dotted red course trajectory line predicting your lane of travel through space.

WARNING

The PSNC long-range course plot system does not adjust for intervening objects in near or deep space. To avoid collisions when plotting a long-range course, please ensure that your red plot line does not intersect any objects on the VSM.

As part of your course plot you can set acceleration values measured in g-force (Earth Surface Gravity). While RCS systems are limited to low g-travel, Fusion Reactor Drive systems are capable of sustained high-g burn. Use the “+” and “-” keys beside the TRIP GS MAX LIMIT label on the LONG RANGE COURSE PLOT panel to set an upper limit to acceleration during the trip. To set the highest acceleration possible given your ship’s drive system, press the SET MAX button.

WARNING

Long-range interplanetary travel under high-g burn for sustained periods without proper equipment can cause serious injuries including internal bleeding, organ failure, and death. Please limit your travel to single-g burn unless your ship and crew have made adequate preparations.

After plotting your course, the panel will display the trip duration measured in variable time units including standard Earth days, weeks, months and years. The panel also displays the amount of fuel required to make the trip. After plotting a long-range course, press the COURSE ENGAGE button to begin travel.

5. DIAGNOSTICS

The PSNC onboard diagnostic system runs a preliminary scan of relevant ship systems and prints a status report on your map screen. The ship systems status report displays vital data not only for navigation systems (such as remaining fuel for both RCS and Fusion Drives) but also any installed environmental and power systems. To generate a ship system status report, press the “PRINT STATUS” button on the DIAGNOSTICS panel.

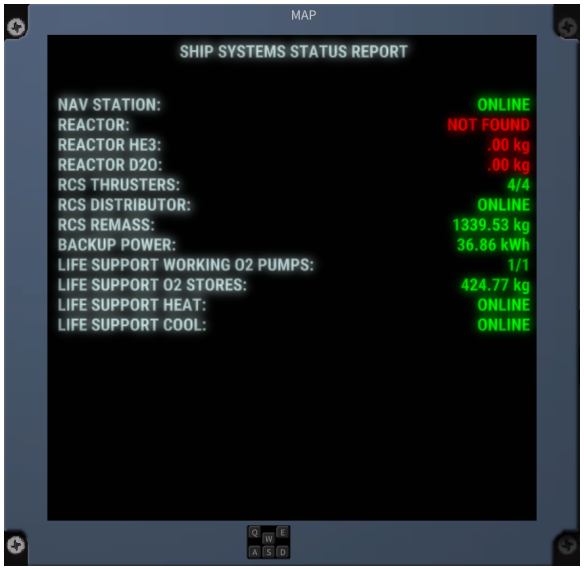

Figure 5.1: *Ship Systems Status Report printed after a diagnostics check*

6. FLIGHT CONTROL

Flying Under RCS - The PSNC system interfaces with RCS controls via any standard keyboard. As a default, the WASD keys control translational thrust while the Q/E keys control rotational thrust. As a piloting convenience and safety precaution to prevent hazardous spin, the console is equipped with an onboard gyroscope that will automatically stop ship rotation once it hits zero.

When flying in vacuum, RCS blasts accelerate your spacecraft to a continuous and sustained velocity. For this reason it is vitally important to keep an eye on your VSM-HUD, which will display your velocity relative to a selected target at all times. Additionally, RCS systems rely on fuel in the form of inert gas (usually N2). This reaction mass (aka remass) is displayed on your VSM-HUD in kilograms (kg). As your remass value approaches zero this value will flash red and yellow on the VSM-HUD. When your remass value reaches zero your ship will be unable to maneuver. For this reason you should always travel with additional canisters of inert gas to convert to RCS remass when necessary.

Flying Under Fusion Torch - In accordance with local regulations, Polaris Astronautics Ltd no longer freely distributes information assisting flight under Fusion Drive and other so-called “torch” systems. For a copy of our “Flying Under Fusion Torch” Pilot Handbook, please send a request to Polaris Astronautics Ltd. and attach a valid and up-to-date drive permission certified by your local air traffic authority.

7. DOCKING CONTROL

General Principles - The PSNC docking system is a separate panel and view system that displays your ship’s docking ring in relation to a selected docking ring within 5km. The docking control screen and system is fully integrated with the standard VSM-HUD and operates using the same visualization principles scaled down to these rings. Safe docking requires precise RCS maneuvers, low speeds, and regular toggling between docking and VSM panels when necessary.

Communication Control - Docking permissions are granted by on-board ship systems or live ship/station operators, depending on the context. In either case, you must use the docking menu of the PSNC Communication Control Screen (CCS) to uplink your ship to a given docking target before you can access its ring on your docking control panel. To establish this uplink, use the buttons beside the CCS to navigate to “SELECT DOCKING TARGET.” The next screen will show any docking targets within 5km of your ship. Use the keys to select a named ship or an unidentified object (labeled as “?”) and then select “DOCKING” under the “CLEARANCE” menu. Once cleared for docking, press “ACCEPT” to display the target ring on your Docking Control Panel and begin docking maneuvers.

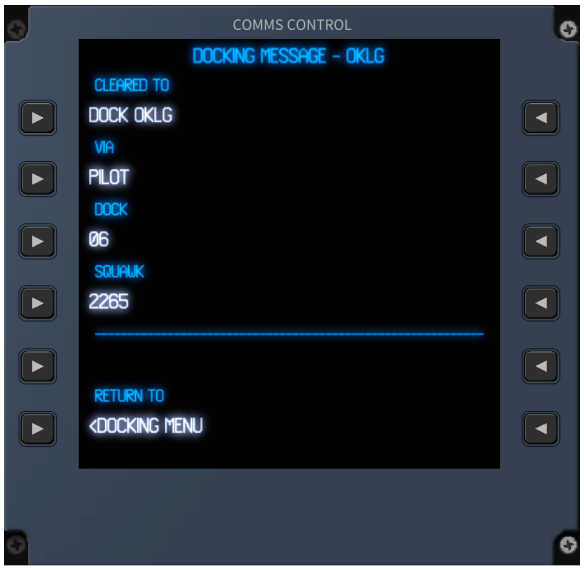

Figure 7.1: *Docking Clearance Granted on Communication Control Screen*

Docking Control Panel - The PSNC docking control panel consists of a large docking ring visualizer, two docking indicator lights, and a button to engage the clamp on your ship’s docking ring. The visualizer displays your ship’s docking ring and clamps in white and the docking ring of a given docking target in blue. When the given target is not within visual range of your docking ring because of your ship’s orientation, the screen displays a yellow arrow (left or right) to assist rotation. Additionally, the top right corner of your docking visualizer displays your ship’s velocity (VREL), range (RNG), and cross velocity (VCRS) in meters relative to your selected docking target.

Once a targeted docking ring is displayed on the Docking Control Panel, you can use standard RCS controls to approach the ring and align your ship’s ring clamps with the target. As you approach your docking target, the system will activate your onboard proximity chime to give you an audio indicator of how close you are to your target. To deactivate the chime, press the “CLEAR” button on the Nav Control panel.

When the docking rings are sufficiently aligned and close enough to clamp, the “CLAMP ALIGN” indicator will glow green, and the CLAMP

ENGAGE button becomes active. Press the CLAMP ENGAGE button to engage your ship's clamp and establish an airlock tight seal between your ship and the target. Once this is complete, the DOCK SYS CLAMP indicator will glow red. When you are docked with another ship or station your Docking Control display will issue a no clearance warning to notify you when you have not achieved permission to undock (see pushback/taxi below).

WARNING

Reckless maneuvering while docking can lead to collisions between your ship and the docking target that can result in catastrophic damage to both parties. Similarly, maneuvering while docked after clearance between rings reaches zero will cause damage to your ship and docking rings. For safe docking, maneuver at low velocity and refrain from using RCS or Fusion Drive navigation systems until safely undocked.

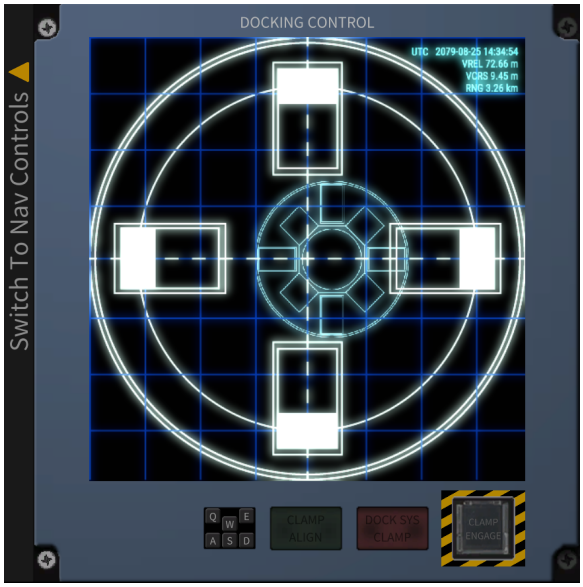

Figure 7.2: *Docking Control Panel View*

Pushback/Taxi - As with attaining docking permissions, you must use the docking menu of the PSNC Communication Control Screen (CCS) to attain permission to undock. This is called "Pushback/Taxi," and can be requested by selecting the docking target as usual and selecting "PUSHBACK/TAXI" under the blue "CLEARANCE" label. After accepting the docking message from your target the CLAMP ALIGN indicator will glow green and you can disengage your clamp by depressing the CLAMP ENGAGE button. When clamps are disengaged you can use standard RCS controls to slowly pushback and taxi away from your docking target.

8. GLOSSARY OF TERMS AND ABBREVIATIONS

Acceleration - Rate of change in velocity

Attitude - The orientation of your ship (which way is "up") relative to a given target.

BARY (barycenter) - center of mass and gravitational pull between two or more celestial bodies. During long range travel between two massive objects such as planets, the barycenter is the point at which a ship stops accelerating and begins decelerating, usually via the execution of a "flip and burn" maneuver.

Clearance - permission, usually to dock or undock from a given ship or station

D2O (Deuterium Oxide) - A form of water that contains only deuterium, an isotope of Hydrogen. Also known as "heavy water," used in combination with He3 (Helium-3) as fuel powering an Inertial Confinement Fusion Reactor

Exhaust plume - Tail of high energy gasses vented behind a ship as a byproduct of a fusion reaction. Air traffic control authorities strictly regulate fusion drives in order to avoid irradiation and/or damage to other vessels and stations by extended exhaust plumes

Fusion Reactor Drive - shorthand for an Inertial Confinement Fusion Reactor Drive, a fusion reactor drive uses precision lasers to fuse fuel pellets behind a spacecraft, creating a controlled nuclear blast that can propel a spacecraft forward at high acceleration. For more information on how the PSNC interfaces with

Fusion Reactor drives, please request a copy of the Polaris Ltd. “Flying Under Fusion Torch” Pilot Handbook by sending a request to Polaris Astronautics Ltd. with an attached drive permission certified by your local air traffic authority

“G” - Unit of measurement representing acceleration. A single “g” is equivalent to the acceleration of a falling object on Earth’s surface, or roughly 9.8m/s^2

He3 (Helium-3) - Stable isotope of Helium. Reactant used in combination with D2O (Deuterium Oxide, aka “heavy water”) as fuel powering an Inertial Confinement Fusion Reactor

Intake Regulator - A valve system that controls the amount and pressure of remass delivered to a ship’s thruster package as part of the RCS system

INR (Inner) - map view zoomed to the Inner Planets (Mercury, Venus, Earth Mars, and main asteroid belt)

LADAR (Laser Detection and Ranging) - onboard system that uses a combination of broadcast and so-called “tightbeam” lasers to detect the presence and movement of bodies in space. Also used in communication. See RADAR

N2 (Nitrogen) - Molecular nitrogen. Inert, colorless, odorless gas that is the primary component of Earth's atmosphere. Used in both life support and RCS systems

O2 (Oxygen) - Molecular oxygen. A major component of Earth's atmosphere, and critical to the human respiratory system, and therefore, life support systems.

OUT (Outer) - map view zoomed to the Outer Planets and planetoids (Jupiter, Saturn, Uranus, Neptune, Kuiper belt)

Pushback - a procedure by which a ship is directed away from a docking ring after un-clamping from another ship or station. Typically via external guidance (e.g. a tug or drone) or precision RCS maneuvers. See “taxi.”

PLA (Planet) - map view zoomed for operations near a celestial body classified as a planet or planetoid, including moons and large asteroids

PSNC (Polaris Standard Navigation Console) - user interface for a comprehensive navigation system to assist in flying, docking, launching and landing your spacecraft

RADAR (Radio Detection and Ranging)- onboard system that uses radio waves to detect the presence and movement of bodies in space. Also used in communication. See LADAR

RCS (Reaction Control System) - system for near-space travel and precise maneuvering. Typically uses blasts of inert, cold compressed gas (usually N2), controlled by an intake regulator and routed to a thruster package to produce thrust

Remass (Reaction Mass) - propellant, usually referring to a cold compressed gas such as N2 installed in an intake regulator as part of an RCS system. Sometimes refers to the H3/D2O mixture exhausted in an Inertial Confinement Fusion Reactor

RNG (Range) - distance between two objects in space measured in variable units

STN (Station) - smallest map view, zoomed for suitable operations around a station's local space

SYS CLAMP (System Clamp) - The clamp system on your ship’s docking ring. This appears as a red indicator on the DOCKING CONTROL panel when your clamp is engaged and your ship is fully docked with another ship or station

Thruster - propulsion device installed on the outside of a ship as part of an RCS package.

Thrusters interact with an intake regulator to blast cold compressed gas in order to adjust the momentum and attitude of a spacecraft

Torch - Colloquial term for a high energy spacecraft drive, usually an Inertial Confinement Fusion Reactor system

Taxi - precision RCS maneuvers executed in reference to another ship or station. Usually following un-clamping from another ship or station, or preceding docking ring alignment and clamping. See “pushback”

Tracking Mode - map view toggle that switches the VSM to follow either the piloted ship or the target (TRG) selected on the map

TRG (Target) - object in space selected by either left or right-clicking on it in the VSM

Vacuum - a space devoid of matter, including vital pressure elements such as oxygen

Velocity - Speed of an object measured as distance/time in variable units

VCRS (Cross Velocity) - The speed of the piloted ship perpendicular to the direction towards a selected target. In a coordinate system where y+ points at the target, VCRS is the x component of the piloted ship's current velocity vector.

VREL (Relative Velocity) - Speed of the piloted ship compared to the current target's velocity

VSM (Virtual System Map) - a highly accurate rendering of both near and deep space objects produced through a combination of onboard RADAR/LADAR systems, air traffic data fed to the Polaris Navigation Console from nearby station authorities, and device information gathered from other Polaris users