

Student Astronaut Engineering Challenge 2024



Briefing sent to the Coaches before competition:

The USS Endurance, a NASA spacecraft, is about to dock with an older Russian Space Station, Galaktika. A visiting crew of 3 NASA astronauts have been aboard the station for a few weeks. Their liaison, Sergei, has been training them in Space Station operations while they work to update the station. The Space Station's water filtration system has broken down and the remaining supply of clean water is running low. The part needed for the repairs is not on board. Both teams of 3 must work together to dock the Endurance with the Space Station and successfully repair the water filtration system before time and clean water runs out!

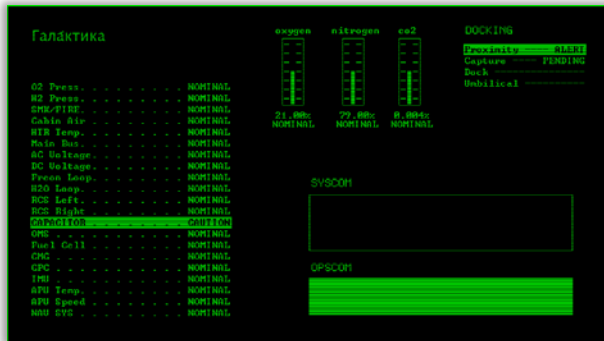
- ★ Teams may decide which team members will participate in each section of the simulator, 3 on each side.
- ★ All teams will have the ability to hear and speak to each other.
- ★ Each team will have to determine their "Comms format" and notify the judges upon arrival at the simulator. Suggestions:
 - Galaktika this is Endurance
 - Students may use first or last names:
 - Nicole Mann and Josh Cassada. "Josh this is Nicole" or "Cassada this is Mann"
- ★ The OpsComm screen is where teams will receive messages from Mission Control (Judges)
- ★ The SysComm screen will show messages from the computer system.
- ★ There will be a whiteboard on the Endurance side for students to use
- ★ Teams must select one member from each side of the challenge to look into the specified camera and state their school's name at the beginning of the challenge
- ★ There are no set roles, every team member may participate fully
- ★ Teams will have 45 minutes to complete their mission
- ★ 5 Free hints are available (Mercury) or 2 Free hints (Apollo)
- ★ Additional hints are available, but the entire team must agree (2-point deduction per hint)
- ★ Students will enter the simulator and put on their headsets, adjusting them as needed so they are comfortable during the mission
- ★ The judges will perform a comms check before beginning the mission
- ★ Items and cabinets marked "Staff only" are not to be touched or opened
- ★ There's no need to use force to move objects, information needed for the mission is NOT hidden
- ★ Sounds heard during the mission are part of the challenge, if a problem occurs, the judges will notify the students
- ★ Remember to stay calm, listen to each other and work as a team!

Galaktika resources and materials



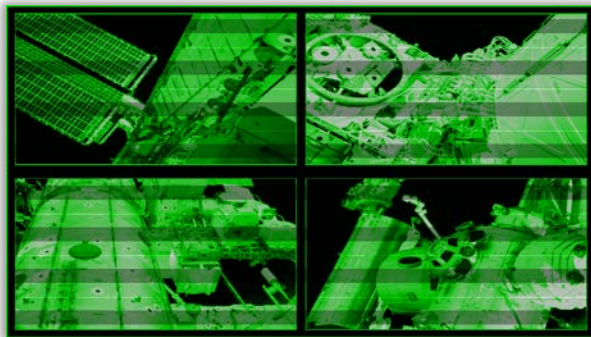
Sergei's notes

- Ship ID matrix
- Manual Docking Procedures



Status screen

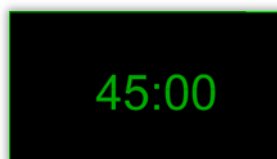
- System alerts
- Cabin air pressure
- Docking status
- System comms
- Operator comms



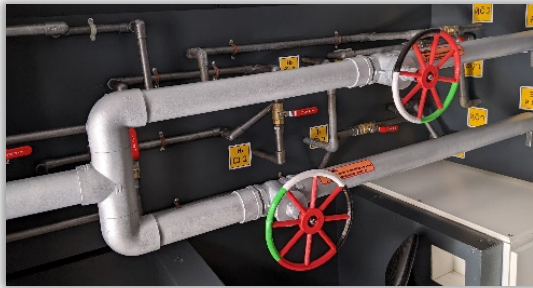
External cameras screen



Water filter screen



Challenge timer screen



Cabin air pressure regulators



Pipe system valves



Heater capacitor discharge levers



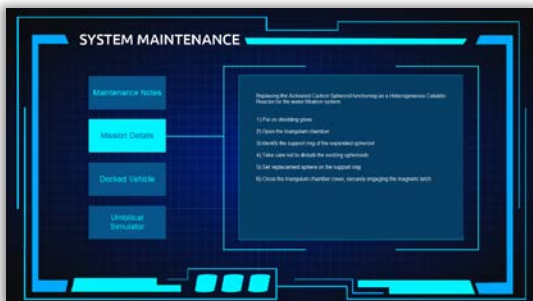
Water filtration system

Endurance resources and materials



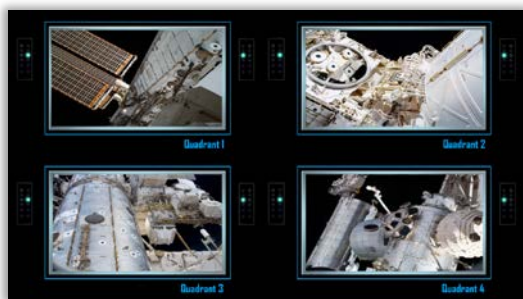
Status Screen

- System alerts
- Cabin air pressure
- Docking status
- System comms
- Operator comms



Maintenance screen

- Maintenance notes
- Mission details
- Galaktika vehicle schematics
- Translations
- Umbilical simulator



External cameras screens



Challenge timer screen



Orbiter screen



Umbilical cords and locked cabinet



- Flight stick for Orbiter screen
- Mouse for Maintenance screen
- Repair part for water filtration system
- Dry mark erase board



Prelude

1. Sergei welcome message played:

"Hello comrades. This is Sergei. Thank you for joining me on today's repair mission. I am sorry that I will not be able to join you because I am currently over in module four repairing the auxiliary power unit.

For those of you aboard the Endurance, thank you also for bringing the much needed catalytic reactor for the water filtration system. I am not saying that things are dire at the moment, but the potable water is, well, starting to look a little funny, ha ha ha! This should be a fairly easy repair to make, just follow the instructions on the maintenance screen aboard the Endurance and you should have no problems.

For those of you aboard the Galaktika, a few house keeping items to remember. Firstly, make sure that the water filtration system does not overflow until the new part arrives from the Endurance. Also, I have been having problems with the capacitor system for the heating unit. One of the capacitors keeps overloading and causing a havoc with my electric systems. You may need to discharge it from time to time to avoid an overload. And lastly, you may watch my programs on the television if you have nothing better to do. Good luck team and dasvidaniya."

2. Mission Control counts down to dock: "5, 4, 3, 2..."
3. Audio of crash played.
4. Clock screens begin 45-minute countdown
5. Sergei message played:

"Comrades! It appears that we have had a malfunction in the docking process. You will need to repair the affected systems before the docking can be completed. Check the SysComm box on the status screen and make a plan for those repairs. I trust that you have things well in hand. But please, do hurry as I wish not to drink the system water as it is, and I am very thirsty."

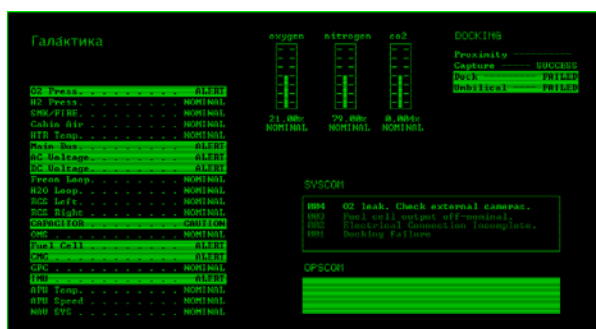

Student Astronaut Engineering Challenge 2024

Scenario

A micro meteor struck an Galaktika oxygen tank just before docking was complete. Resulting in:

- Endurance rotation
- Failed electrical connection between the vehicles
- Galaktika oxygen tank leak
- Galaktika fuel cell lacking oxygen due to tank leak
- Galaktika loss of external camera signals

The following status alerts and SYSCOM messages appear:

Galaktika	Endurance
 <p>The screenshot shows the Galaktika mission display with various system status indicators. Key alerts include 'O2 leak, Check external cameras', 'Fuel cell output off-nominal', and 'Docking Failure'. The display also shows 'SYSCOM' and 'OPSCOM' sections.</p>	 <p>The screenshot shows the Endurance mission display with various system status indicators. Key alerts include 'Docking failure', 'MAIN BUS', 'AC VOLTAGE', and 'DC VOLTAGE'. The display also shows 'FUEL CELLS' and 'SYS-COM' sections.</p>
Alerts <ul style="list-style-type: none"> • Docking failure • O2 Press • Main Bus • AC Voltage • DC Voltage • Fuel Cell • CMG • IMU 	Alerts <ul style="list-style-type: none"> • Docking failure • MAIN BUS • AC VOLTAGE • DC VOLTAGE
SYSCOM <ul style="list-style-type: none"> • Docking Failure • Electrical Connection Incomplete • Fuel cell output off-nominal • O2 leak. Check external cameras 	SYSCOM <ul style="list-style-type: none"> • Docking Failure • Electrical Connection Incomplete

After two minutes the following alerts appear:

Endurance



Alerts

- CMG
- IMU

SYS-COM

- Unexpected Rotation detected. Solar panels losing alignment.
- Power loss in 5 minutes

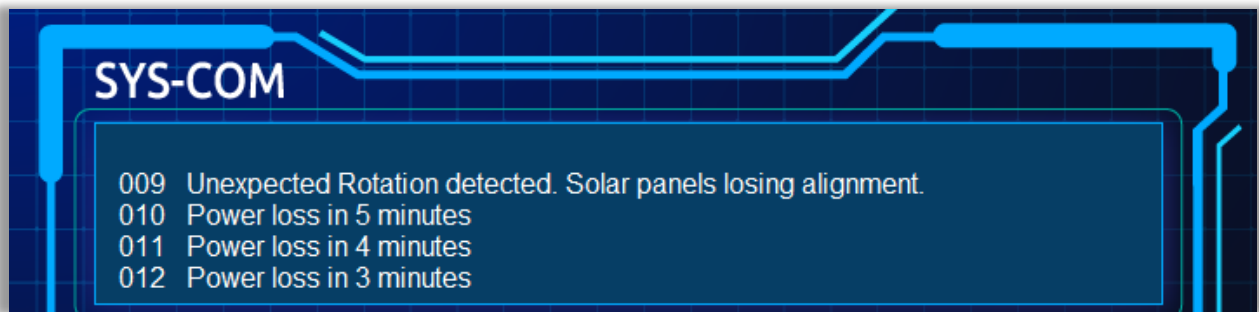
Additionally, the Orbiter simulation begins rotating, losing prograde attitude



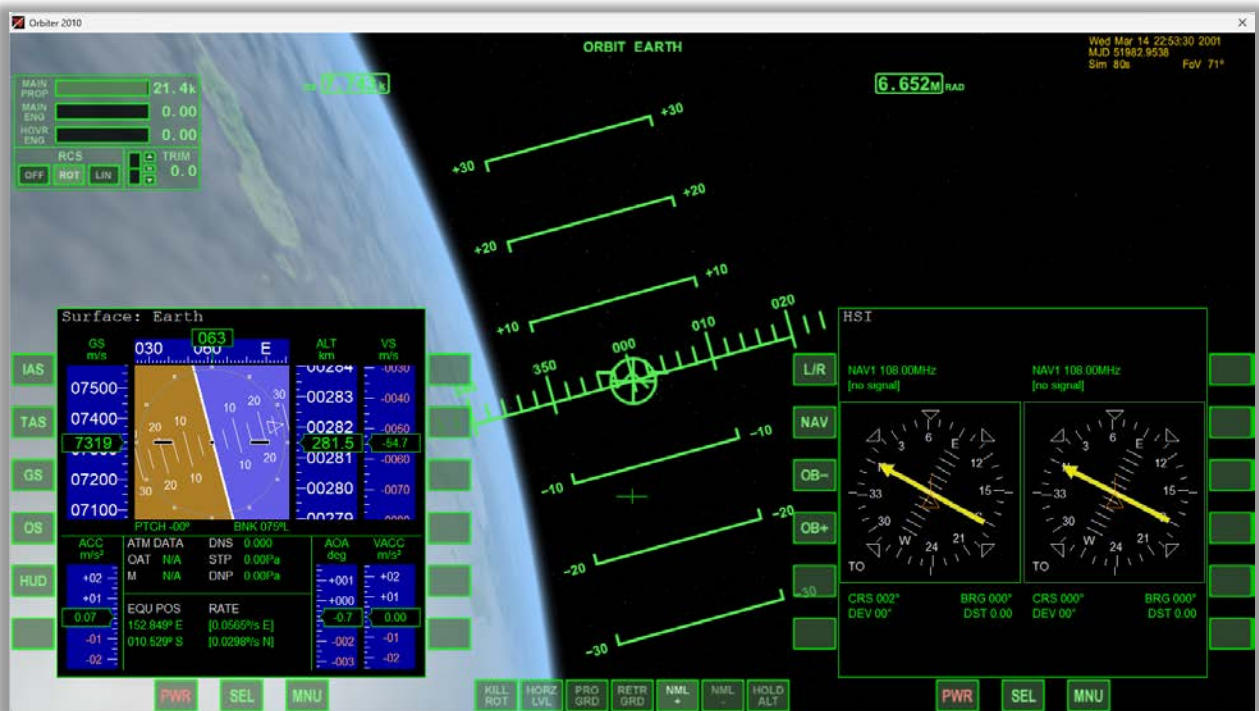
Challenge - Endurance power loss

The oxygen leak results in a slow rotation progressively misaligns Endurance's solar cells eventually resulting in a power loss.

The Endurance SYS-COM message reflects the status to the crew.



The Orbiter screen shows the vehicle attitude.

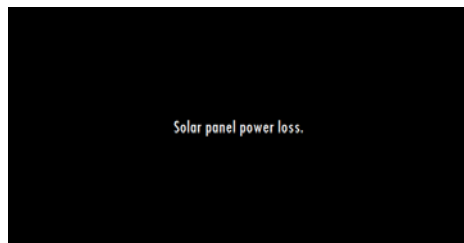


The notes direct the crew to maintain a prograde attitude.

Maintenance notes:

- Cabin air pressure should be maintained at 21% Oxygen, 79% Nitrogen
- Vehicle should be kept in a prograde attitude when possible ←
- The hand controller has a T1 switch to kill rotation if necessary
- Killing vehicle rotation will impede manual control for approximately 5 seconds
- Pressure regulators should be rotated in 1/4 turn increments to accurately calculate adjusted pressure
- English translations have been taped in various station locations. Please do not remove

The Endurance crew is required to manually use the flight stick to achieve a prograde attitude. If prograde attitude is not established before power loss, the following Endurance screens are turned off:



- Status screen
- Maintenance screen
- External cameras

Once prograde is re-established, power is restored (if it has been lost) and there is a two-minute delay before the next vehicle rotation cycle. This rotation/power loss cycle continues until:

Mercury league

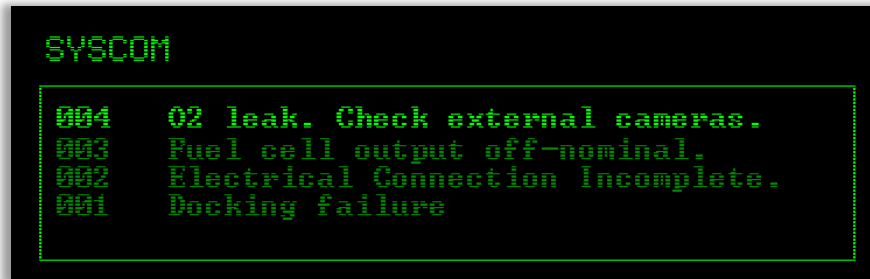
- The O2 leak is fixed
or
The prograde has been re-established three times

Apollo league

- The O2 leak is fixed and the vehicle is in a prograde attitude

Challenge - Galaktika Oxygen leak

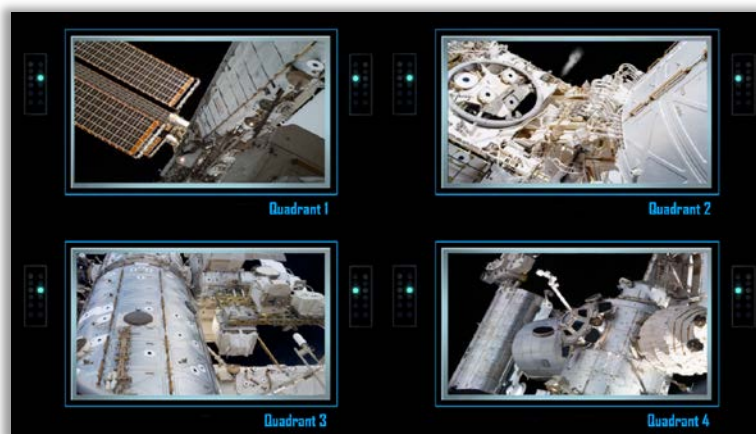
Galaktika crew receives a SYSCOM message regarding the O2 leak and an instruction to check external cameras.



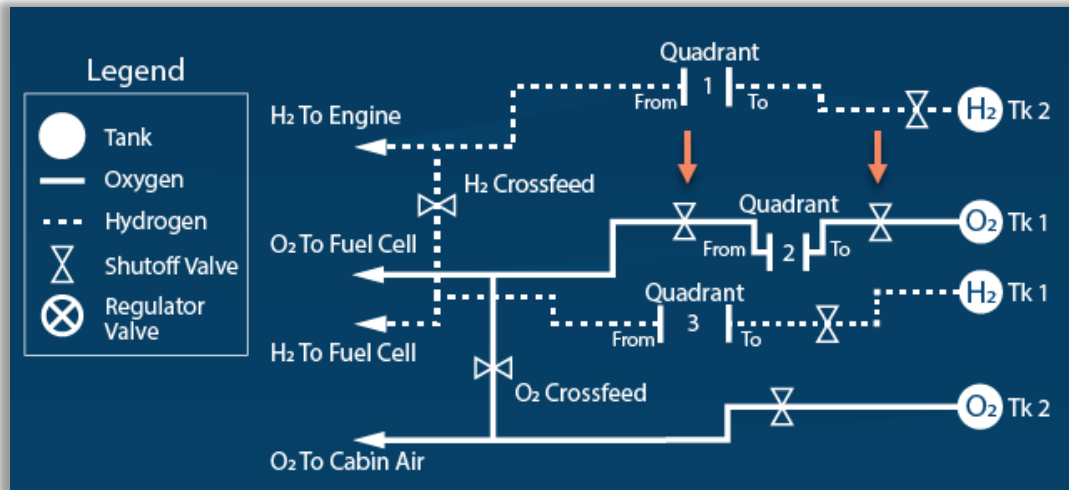
However, the Galaktika external camera signals were lost with the docking failure.



The Endurance external cameras show a gaseous leak in Quadrant Two.



The Endurance maintenance screen contains a schematic of the Galaktika gas pipe systems. The schematics show oxygen tank 1 feeding into quadrant two and valves to and from the quadrant that can be closed to isolate and stop the leak.



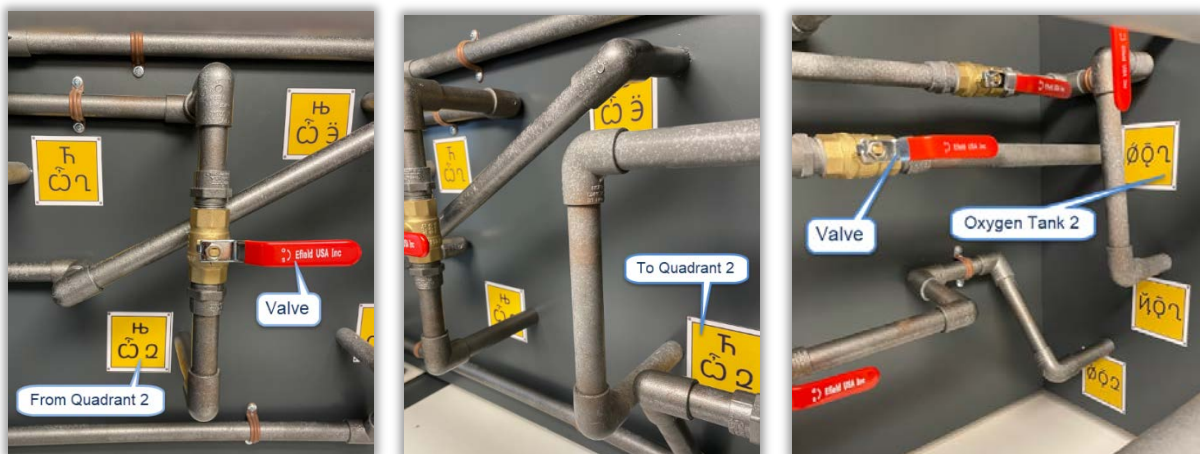
The Galaktika gas pipe system parts are labeled with symbols requiring translation to identify.



The Endurance maintenance screen contains a section on translations for the symbols.

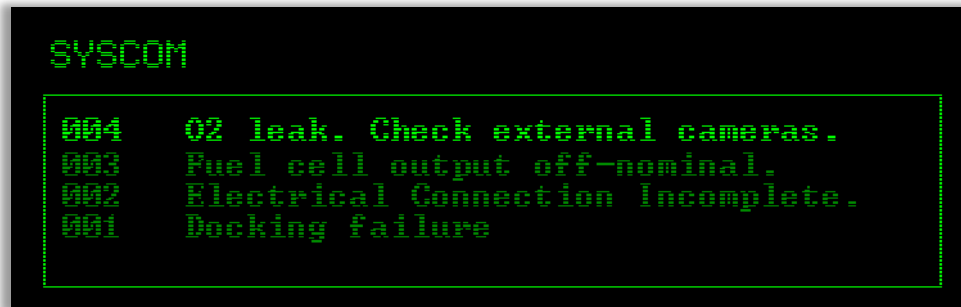
Helpful Translations for use aboard the Галактика (Galaxy)					
Oxygen	Ø	To	Т	Air	æ
Hydrogen	Й	From	Б	Fuel	Г
One	1	Quadrant	Ц	Cell	А
Two	2	Pressure	Р	Engine	ДЖ
Three	3	Regulator	Ж	Tank	О
Four	4	Cabin	М	Crossfeed	Ж
Five	5	Nitrogen	Н	Waste	Ψ

Once the correct valves are identified and closed the Oxygen pressure alert returns to nominal and the periodic rotations impacting the Endurance cease.



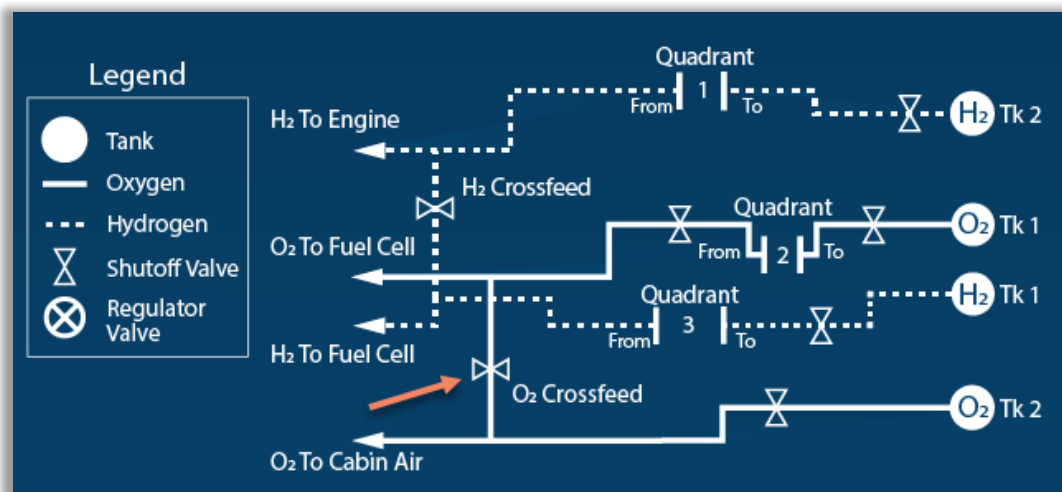
Challenge - Galaktika Fuel Cell Output Off-nominal

Galaktika crew receives a SYSCOM message regarding the fuel cell



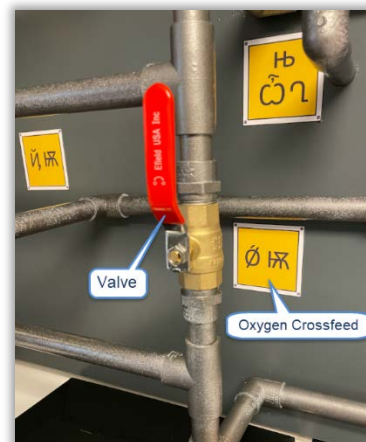
The oxygen leak in quadrant two disrupts the gas mixture going to the fuel cell. Stopping the quadrant two leak must be completed first, however, this leaves the fuel cell without oxygen.

The Endurance crew can use their schematics to identify the oxygen cross feed valve which needs to be opened to feed oxygen to the fuel cells from oxygen tank two.



Opening the cross feed will supply the fuel cell with oxygen and resolve the alert.

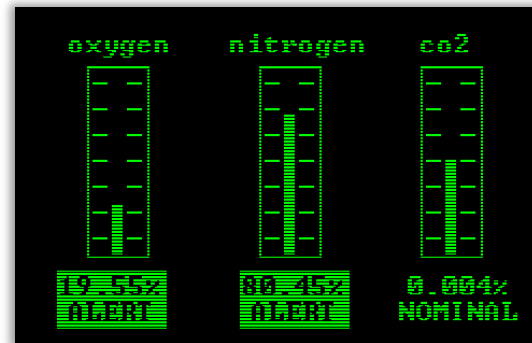
Opening the cross feed reduces the oxygen going to cabin air and triggers a cabin air pressure alert.



Challenge - Galaktika Cabin Air Mixture

Once the cross-feed valve is opened to correct the fuel cell issue, the cabin air mixture will be out of balance. The Galaktika crew will be notified through a status alert, cabin air alerts, and a SYSCOM message.

```
H2 Press. . . . . NOMINAL
SMK/FIRE. . . . . NOMINAL
Cabin Air . . . . . ABAND
HTR Temp. . . . . NOMINAL
```



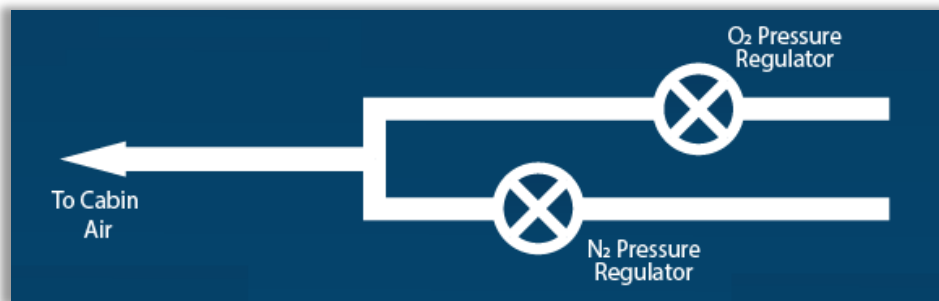
```
SYSCOM

008 Cabin air mixture off nominal.
007 Fuel cell output nominal.
006 O2 pressure nominal.
005 O2 leak. Check external cameras.
004 Fuel cell output off-nominal.
```

Galaktika has two regulators that are used to adjust the cabin air mixture.



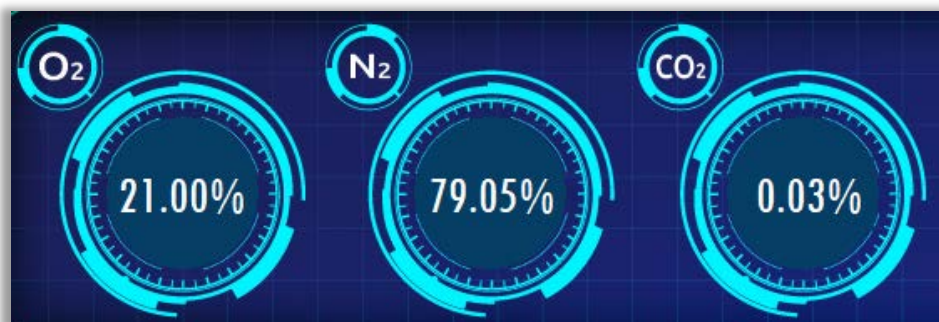
The Endurance maintenance screen has the schematics and translations for identifying the cabin air regulators.



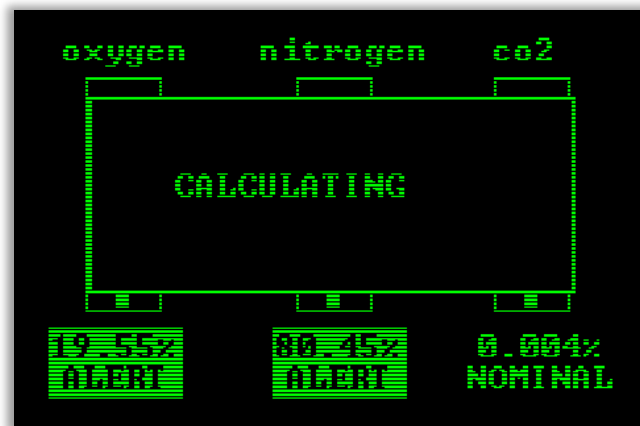
Helpful Translations for use aboard the Галактика (Galaxy)

Oxygen	Ø	To	Т	Air	æ
Hydrogen	Й	From	Ъ	Fuel	┐
One	1	Quadrant	Ω	Cell	⋈
Two	2	Pressure	Р	Engine	ДК
Three	Э	Regulator	Ж	Tank	Q̇
Four	Ч	Cabin	Э	Crossfeed	⌘
Five	fl	Nitrogen	≡	Waste	Ψ

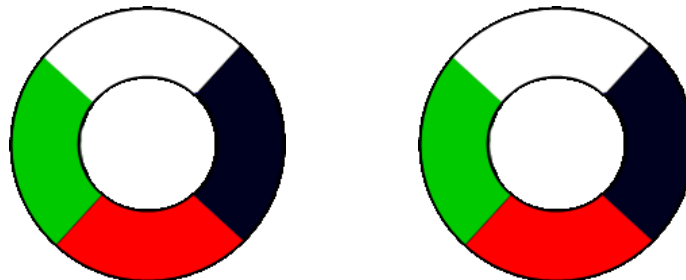
In addition, the Endurance status screen shows the proper Oxygen/Nitrogen mixture.



Adjusting the Galaktika regulators triggers a re-calculation of the cabin air pressure which is reflected on the Galaktika status screen, followed by the new mixture values.



Each regulator wheel has four settings, indicated by color. Of the 16 color combinations, the below orientation restores the correct cabin air mixture.

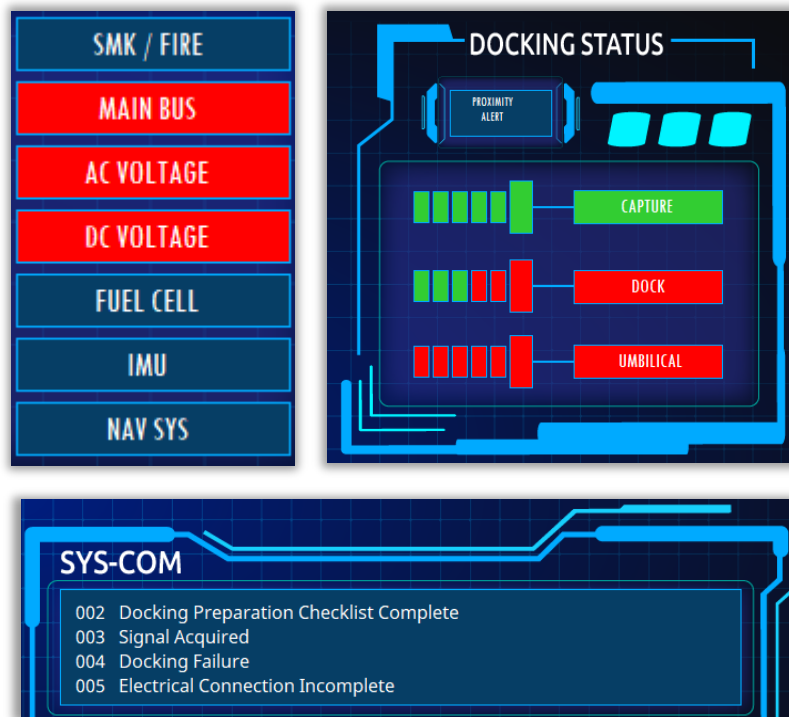


When adjusted correctly, the Galaktika cabin air alert is resolved, and the dock alert is resolved on both Endurance and Galaktika.

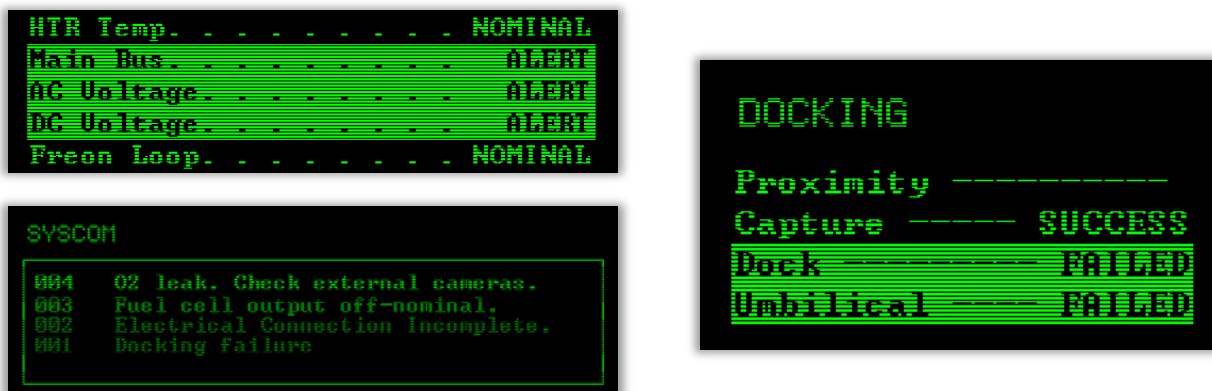
Challenge – Umbilical Connection

The failed umbilical connection is indicated by status alerts, umbilical alert, and a SYSCOM message.

Endurance:



Galaktika:





Sergei's notes contain the procedures for manually establishing umbilical electrical connections.

Manual docking may be required in the event of a failure in the automated hard docking and capture system. Power management systems will need to be turned on and hardline electrical connections will need to be made. Use the following procedure to determine the order of operations for power up and electrical connections between this vehicle and other docking vehicles. Power management simulations are available on Electrical Maintenance System screens. It is advised that simulations be completed for power consumption before hardline electrical connections are completed.

1. Determine the proper procedure number based on the vehicle identification numbers (Both this vehicle and the docking vehicle numbers are required).

This Vehicle Number		Docking Vehicle Number	
1	99984016356	1	3356
2	147403964	2	147403964
3	76594682	3	6100064
4	337696	4	711005833
5	10109945	5	191413

		This Vehicle				
		1	2	3	4	5
Docking Vehicle	1	Procedure 3	Procedure 2	Procedure 4	Procedure 9	Procedure 1
	2	Procedure 5	Procedure 6	Procedure 6	Procedure 1	Procedure 8
	3	Procedure 7	Procedure 8	Procedure 1	Procedure 10	Procedure 5
	4	Procedure 3	Procedure 1	Procedure 9	Procedure 3	Procedure 7
	5	Procedure 1	Procedure 3	Procedure 4	Procedure 10	Procedure 2

2. Follow the listed procedure for matching vehicle identification numbers located on the following pages.

Note: Take care to follow the proper procedure as some vehicle pairings may use the same procedure.

Note 2: Any vehicle docking with another vehicle of the same type will use Procedure 1.

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The vehicle numbers are found on plaques affixed to the walls of each vehicle.



Using vehicle ids in the procedure matrix indicates Procedure 3 should be used to fix the umbilical electric connection.

Procedure 3 has two sections.

- 1) System start and running amperage usage.

Procedure 3

System voltage: 32V (Per Fuel Cell)

System Amperage: Max 110A

Available Systems	Amperage Usage	
	(Start-up)	(Running)
AC Bus Distribution System	7	4
Automated HVAC Regulation System	32	8
Automated Safety and Security Protocol	22	8
Centralized Energy Management System	37	12
DC Bus Distribution System	14	5
Emergency Lighting and Guidance System	24	11
Environmental Control and Life Support System	10	3
Fire Detection and Suppression Interface	20	9
Hazardous Material Alert and Containment System	12	5
Lighting Efficiency Management Module	25	11
Power Distribution Control Unit	17	8
Power Reactants and Storage Distribution System	20	6
Station/Shuttle Power Transfer System	42	14

2) Required systems and their start up order.

When docking vehicle, power consumption must be regulated. Available amperage is limited.

In order to complete the manual docking process, the following systems must all be ON:

Power distribution system including:

Power Reactants and Storage Distribution System

Power Distribution Control Unit

DC Bus Distribution System

AC Bus Distribution System

Safety systems including:

Fire Detection and Suppression Interface

Emergency Lighting and Guidance System

Hazardous Material Alert and Containment System

Environmental Control and Life Support System

Automated HVAC Regulation System

Lighting Efficiency Management Module

NOTES:

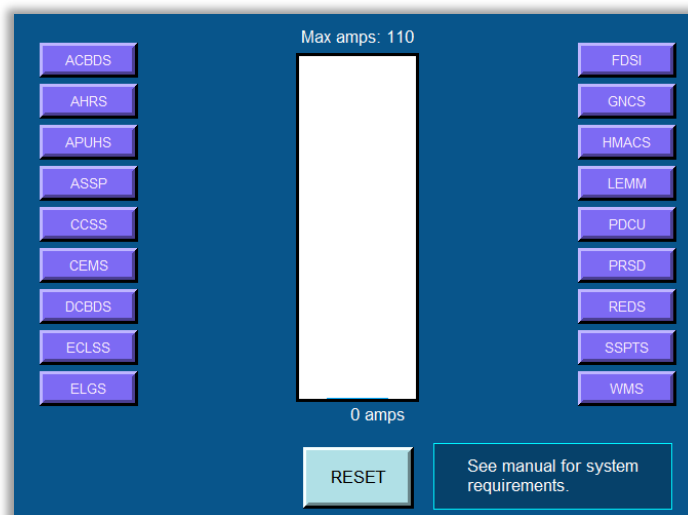
***Station/Shuttle Power Transfer System** must be turned on before any other system can be powered.

***Power distribution** requires the **Centralized Energy Management System** to be on before power can be supplied to downstream systems.

***Automated Safety and Security Protocol** must be on for fire suppression, emergency lighting, and hazardous materials alert systems to be turned on.

***Automated Safety and Security Protocol** is only required until other safety systems are online and can be turned off if power consumption needs are high.

The Endurance maintenance screen has an umbilical simulator for testing system start up.

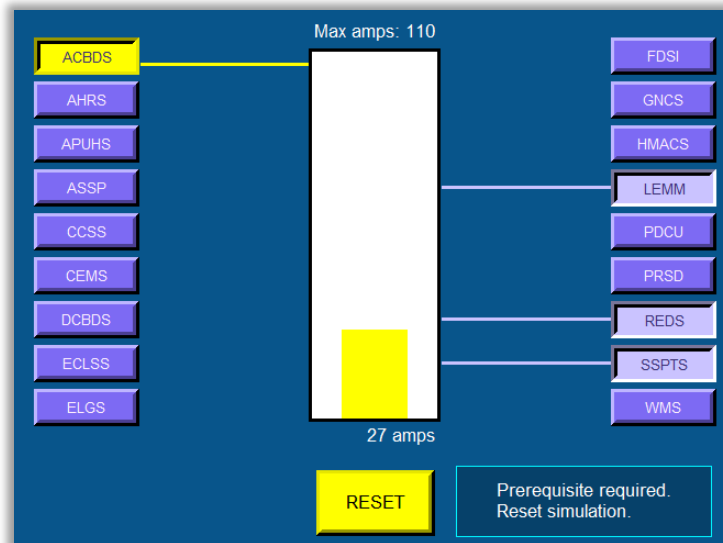


Student Astronaut Engineering Challenge 2024

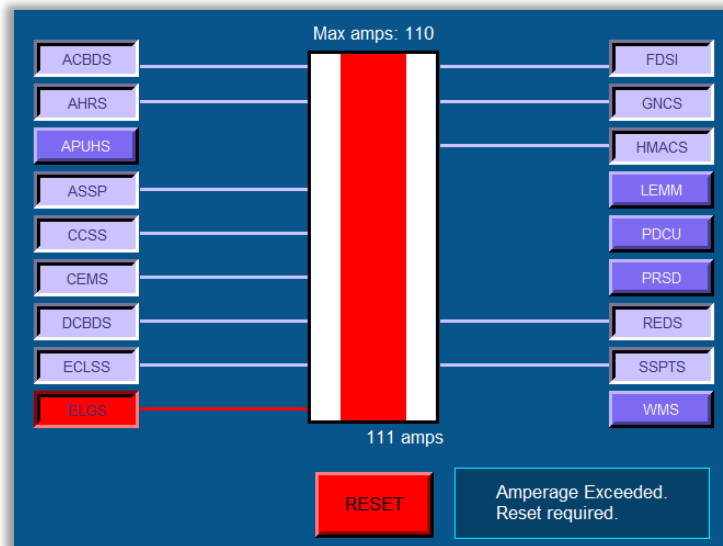


The Endurance crew uses the mouse to click systems to turn them on.

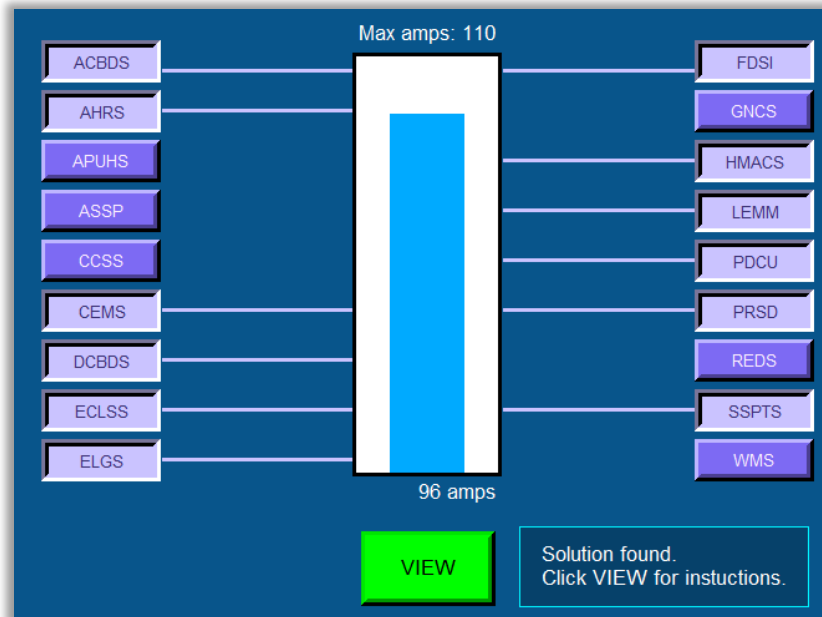
The simulator requires a reset if a system prerequisite is missed.



The simulator requires a reset if the maximum amps is exceeded.



When the correct systems have been started in the correct sequence the VIEW option appears.



Clicking the VIEW button gives direction for accessing the DUCPI umbilical connection panel. (note, the below photo does not reflect the solution configuration)

DUCPI override access granted.

- 1) Enter code 325 into access panel lock.
- 2) Rotate lock 90 degrees clockwise.
- 3) Lean the top of panel toward you three inches.
- 4) Lift the panel off retainer track.
- 5) Stow panel below umbilical cabinet.

Use connector cables to implement configuration:

B1-K6

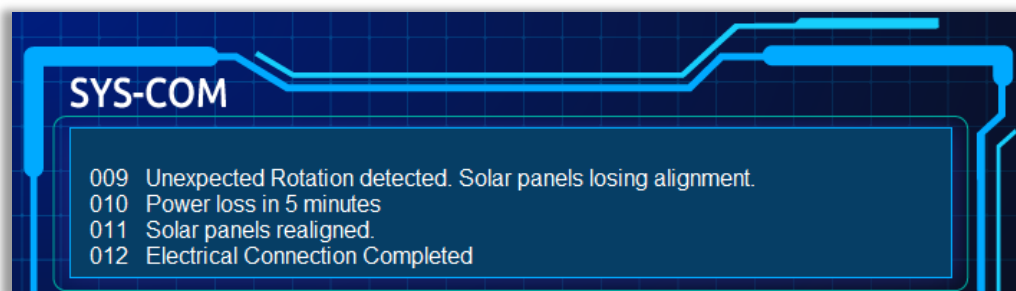
D6-I3

B11-G2

D13-L13



Connecting the umbilical cables correctly resolves the umbilical and electrical alerts.



SYS-COM

- 009 Unexpected Rotation detected. Solar panels losing alignment.
- 010 Power loss in 5 minutes
- 011 Solar panels realigned.
- 012 Electrical Connection Completed

Challenge – Heater Capacitors

One of Galaktika’s heater capacitors slowly overheats as indicated by its rising lights. If the lights reach the top of the panel a klaxon sounds, and the room lights switch from white to red.

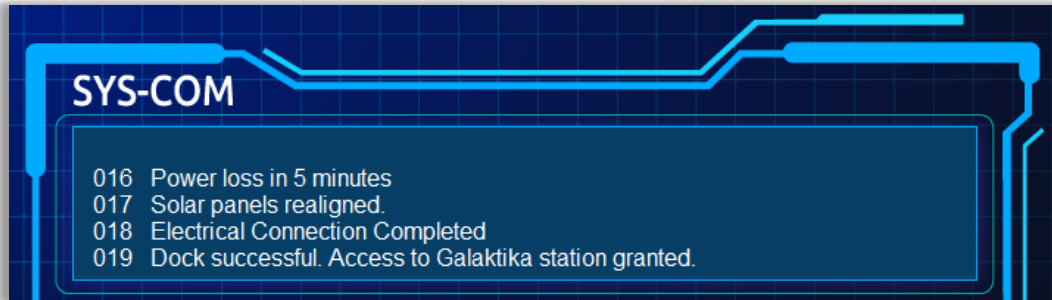
To discharge the capacitor heat the corresponding lever must be pulled and held down. The longer the lever is held down, the lower the indicator lights go.

Additionally, each time the capacitor heat is discharged, the Endurance maintenance screen experiences a power surge that initiates a ten second reboot, resetting the umbilical simulator.

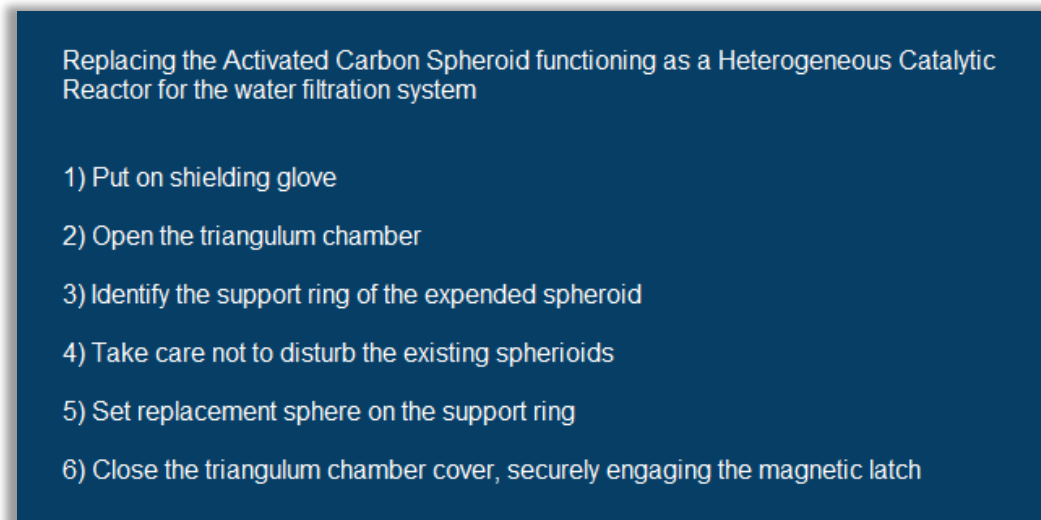


Challenge – Water Filtration

When all alerts are resolved, the Endurance crew is granted access to Galaktika to perform the water filtration repair.



The water filtration repair instructions appear in the Mission Details on the Endurance Maintenance screen.



Once performed, the mission is complete.

Galaktika Station



Endurance Shuttle

