Life Support Team
Mission Day Instructions

Overview

The Environmental Control and Life Support System (ECLS) on the space station maintains the astronauts' environment. It makes sure that the atmospheric pressure and mixture of gases stay within a normal, earth-like range and that the air is free of contaminants. It is also responsible for controlling the temperature and recycling or storing waste. A disruption to any part of the ECLS system could result in a dangerous situation.

As part of the Life Support Team, you receive atmospheric data from an instrument called the Major Constituent Analyzer. Once the data is received, your team is responsible for recording and graphing the data, and making calculations. You must communicate the conditions within the space station to the other teams. In the event of an emergency, you recommend ways to protect the space station and the crew.

Your Task

- Learn to analyze real-time data, record and graph it, and make calculations.
- Monitor all atmospheric changes, report the changes and the effects any changes in atmospheric conditions might have upon the astronauts.
- Recommend adjustments to the atmosphere to avoid a dangerous situation.
- Study your notes on the atmosphere. Read the information on hypoxia and carbon dioxide poisoning and review the various parts of the ECLS system.

To do your job effectively, the Life Support Team should be able to:

1. Describe the parts of the environmental control system critical to the health of the crew?
2. Know how the crew can get additional oxygen.
3. Know the effects of carbon dioxide.
4. Know what happens to human beings if oxygen levels fall below normal. (Hypoxia)
5. Review each atmospheric component:
    - O2: What happens when oxygen levels fall below normal?
    - CO2: What happens to humans when carbon dioxide levels rise above normal?
    - H2O: How can water vapor harm the Space Station?
    - Air Pressure & N2: What role does air pressure and nitrogen play in keeping air quality in balance?

Mission Day Materials
On mission day it will be critical to be prepared to assist the Space Station crew if it becomes necessary. To do this effectively your team will need the following:

- One computer to receive real-time atmospheric data advisories from the Space Station
- One or more copies of the Space Station Reference guide (found at http://www.wju.edu/clc/ssa/ssrefguide.htm)
- Mission Day Materials packet (one per team member):
  - Mission Day Instructions
  - Life Support Data Tracking Tables
  - Life Support Data Graphs
- 15 Blank Report Forms (see Mission Day Materials packet) on colored paper to deliver to the Communications Team (15 forms for O2 and 15 for CO2)
- Rulers for plotting data on graphs
- Ballpoint pens or pencils of various colors (optional)

Job Assignments
The following tasks must be completed during the mission. Next to each task, assign a team member.

Team Member(s) Assigned To This Task	Task
_____	**Data Recording**: Monitors real-time data for new readings and bulletins from mission control. The URL for the real-time data will be given by Mission Control at the start of the mission. This may be combined with other tasks.
_____	**Data Analysis (O2)**: Records real-time data in data tracking tables. Conducts analyses using data tracking worksheet. Completes Report Forms every five to six minutes or as needed.
_____	**Data Analysis (CO2)**: Records real-time data in data tracking tables. Conducts analyses using data tracking worksheet. Completes Report Forms every five to six minutes or as needed.
_____	**Data Graphing**: Records real-time data and projections on graphs. Uses ruler to make predictions. May be combined with Data Analysis tasks.
_____	**Crisis Management**: Makes sure all data is analyzed every five to six minutes. Determines priority level, whether there are any concerns, and helps team decide on any recommendations. Takes this information to the Crisis Management Team for further discussion.
_____	**Data Runner**: Gathers report forms every five to six minutes. Prioritizes any urgent recommendations. This may be combined with Crisis Management Tasks.
_____	**Research and Reference**: Assists team in finding necessary information to make recommendations to Mission Control. Reads and understands information provided in the Reference Guide. May be combined with other tasks above.
_____	**Reporter**: Assists team in recording the situation as the mission progresses. Tracks emergencies, options, choices, successes, and areas for improvement.

Data Tracking Instructions

You will be receiving readings every five to six minutes from the Major Constituent Analyzer on board Space Station Alpha. The data will have information on oxygen (O2) and carbon dioxide (CO2) and total atmospheric pressure. Occasionally there may be mention of other components such as nitrogen (N2), water vapor (H2O) and trace contaminants. It is imperative that your team is familiar with the data and that you are able to analyze it quickly and efficiently.

Using the instructions below and the attached spreadsheet, you should be able to conduct all the necessary calculations. **For O2, round all decimals to 2 decimal places. For CO2, round all decimals to 4 decimal places.**

First, find the spreadsheets labeled "Life Support Team- Data Tracking Table". There is one for O2 and one for CO2.

Column A: Coordinated Universal Time (UTC)
Record the time (UTC) in Column A.

Time is given in Coordinated Universal Time (UTC), a universal standard. To eliminate any errors, we use a 24-hour clock with no "am" or "pm". On a 24-hour clock, 00:00 or 24:00 is midnight and 12:00 is noon. 23:59 is one minute before midnight. One o'clock in the morning is 01:00. Four-twenty in the afternoon is 16:20, etc.

Column B: Real-Time Data: Atmospheric Pressure
Record the Total Atmospheric Pressure in Column B.

Column C: Real-Time Data
Record the current reading from the data for whatever gas you are tracking, O2, or CO2 in column C.

You will receive data for each component as a percentage, for example O2 = 25%. This indicates what percentage of the air inside the station is made up of oxygen.

Column D: Conversion to Partial Pressure
To convert the gas from a percent into millimeters of mercury, take the Total atmospheric pressure from Column B and multiply it by the current reading from Column C divided by 100. This will then convert the percentage into millimeters of mercury or mmHg.

Column D= Total atmospheric pressure (Column B) X Current Reading in Percent (Column C) Divided by 100

Measuring in millimeters of Mercury is the standard which scientists use most often when analyzing atmosphere components..

Column E: Change in Partial Pressure
To get the change in partial pressure over the past two readings, subtract the previous reading from Column D from the current reading in Column D.

Column E = Current reading from Column D minus the Previous reading from Column D

Column F: Rate of Change
To determine how fast things are changing, you will need to find the rate of change. To do this, you need to take the current reading from Column C and subtract the last reading from Column C. Now divide this answer by the amount of time that has elapsed between the two readings. This gives a rate of change in millimeters of mercury (mmHg) per minute. Record this number in Column F.

Column F =

$$\frac{\text{Current reading} - \text{Last reading}}{\text{Time elapsed}}$$

For example, if the CO2 reading for UTC 16:00 is 5.31 mmHg and the reading for UTC 15:40 is 4.68 mmHg, then the rate of change is (5.31 mmHg-4.68 mmHg)/20 or 0.0315 mmHg/min.

Column G: Time to Criticality

In this column, you must record the time to criticality. In order to find this number, take the critical value (given at the bottom of the data tracking table) and subtract from it the current reading from Column D. Divide this answer by the rate of change you calculated in Column F. Take the absolute value of your answer. This is the amount of time the crew members have before they enter into dangerous levels. [Note: *No calculations are necessary for Column G if the trend is not in the direction of criticality. You'll need to examine the graph to make this determination.*]

$$\text{Column G} = \left| \frac{\text{Critical value mmHg} - \text{Column D}}{\text{Column F}} \right|$$

This gives you the time to criticality.

Note, this equation comes to us from the general equation for the slope of a line: $y = mx + b$
If we convert this equation to solve for x, we get this

$$x = \frac{y - b}{m}$$

Instructions for Graphing the Data

The Life Support Team will be responsible for creating three graphs:
Use the data from Column B on each data tracking table for the y-axis values and plot them along the x-axis according to the correct UTC time. Use the numbers given below for the y-axis scale.

- Increase/Decrease in **Atmospheric Pressure**: y axis= 680 – 800 mmHg
- Increase/Decrease in Partial Pressure of **Oxygen**: y axis= 100 – 170 mmHg
- Increase/Decrease in Partial Pressure of **Carbon Dioxide**: y axis= 0.0 – 1.5 mmHg (in increments of 0.1)

Next, on each graph, draw lines across from left to right to represent "danger zones"

O2: Draw a line at 115 mmHg
CO2: Draw a line at 0.76 mmHg
Note: For **Atmospheric Pressure** there are no "danger zones". If atmospheric pressure is dropping or rising too quickly, this is dangerous because it could cause the partial pressure of oxygen to vacillate, making breathing difficult. When this happens, consult the tables and graphs for oxygen to determine if there is a danger.

Life Support Team- Data Tracking Table
Oxygen

Column	A	B	C	D*	E	F	G
Table Headings	**UTC**	**Total Atmospheric Pressure**	**Oxygen Content**	**O2 Partial Pressure**	**Change in O2**	**Rate of Change**	**Time to Criticality****
Units	**24 Hour Clock**	**mmHg**	**%**	**mmHg**	**mmHg**	**mmHg per minute**	**minutes**
Calculations	**From Data**	**From Data**	**From Data**	**D= B x C/100**	**E = Current D - Previous D**	**F = E/20**	**G= (Abs Value of) Critical Value-D / F**
Example	18:00	727	18.56	134.93	-2.59	-0.13	153.31
	15:00				**n/a**	**n/a**	**n/a**
	15:20						
	15:40						
	16:00						
	16:20						
	16:40						
	17:00						
	17:20						
	17:40						
	18:00						
	18:20						
	18:40						
	19:00						
	19:20						
	19:40						

* Graph this column.

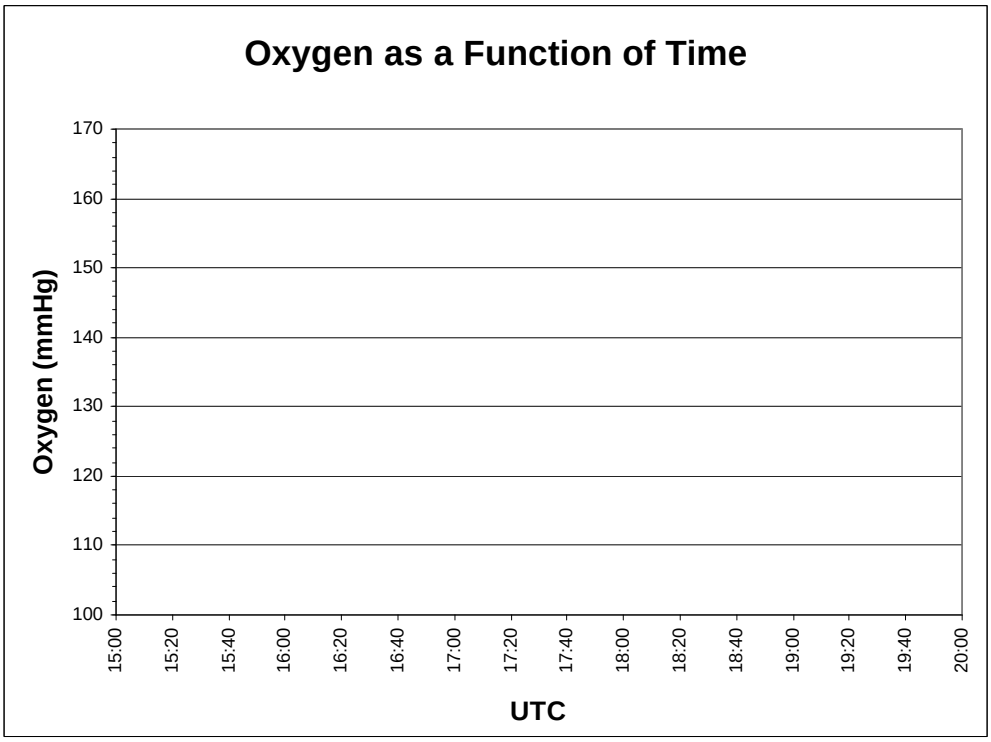
**Critical Value for O2 is 115mmHg. Note: No calculations for Column G are necessary if the trend is not in the direction of criticality. That is, if the rate of change from Column F is a positive number, then no calculations are necessary.

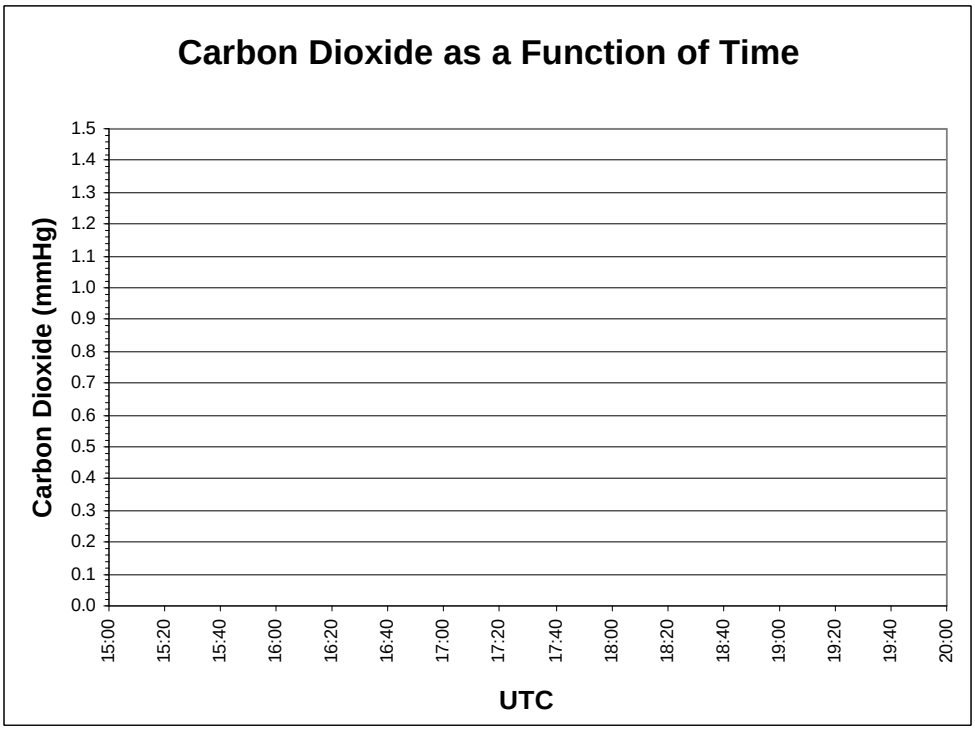
Life Support Team Data Tracking Table
Carbon Dioxide

Column	A	B	C	D	E	F	G
Table Headings	**UTC**	**Total Atmospheric Pressure**	**CO2 Content**	**CO2 Partial Pressure***	**Change in CO2**	**Rate of Change**	**Time to Criticality****
Units	**24 Hour Clock**	**mmHg**	**%**	**mmHg**	**mmHg**	**mmHg per minute**	**minutes**
Calculations	**From Data**	**From Data**	**From Data**	**D= B x C/100**	**E = Current D - Previous D**	**F = E/20**	**G= (Abs Value of) Critical Value-D / F**
Example	18:00	747.5	0.096	0.7176	0.0048	0.0002	212.0000
	15:00				**n/a**	**n/a**	**n/a**
	15:20						
	15:40						
	16:00						
	16:20						
	16:40						
	17:00						
	17:20						
	17:40						
	18:00						
	18:20						
	18:40						
	19:00						
	19:20						
	19:40						

* Graph this column.

**Critical Value for CO2 is 0.76mmHg. Note: No calculations for Column G are necessary if the trend is not in the direction of criticality. That is, if CO2 is below 0.76 and the Rate of Change is negative then Time to Criticality does not apply. If CO2 is above 0.76 and the Rate of Change is positive then Time to Criticality does not apply.


Oxygen as a Function of Time
Oxygen (mmHg)
170
160
150
140
130
120
110
100
15:00
15:20
15:40
16:00
16:20
16:40
17:00
17:20
17:40
18:00
18:20
18:40
19:00
19:20
19:40
20:00
UTC


Carbon Dioxide as a Function of Time
Carbon Dioxide (mmHg)
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
15:00
15:20
15:40
16:00
16:20
16:40
17:00
17:20
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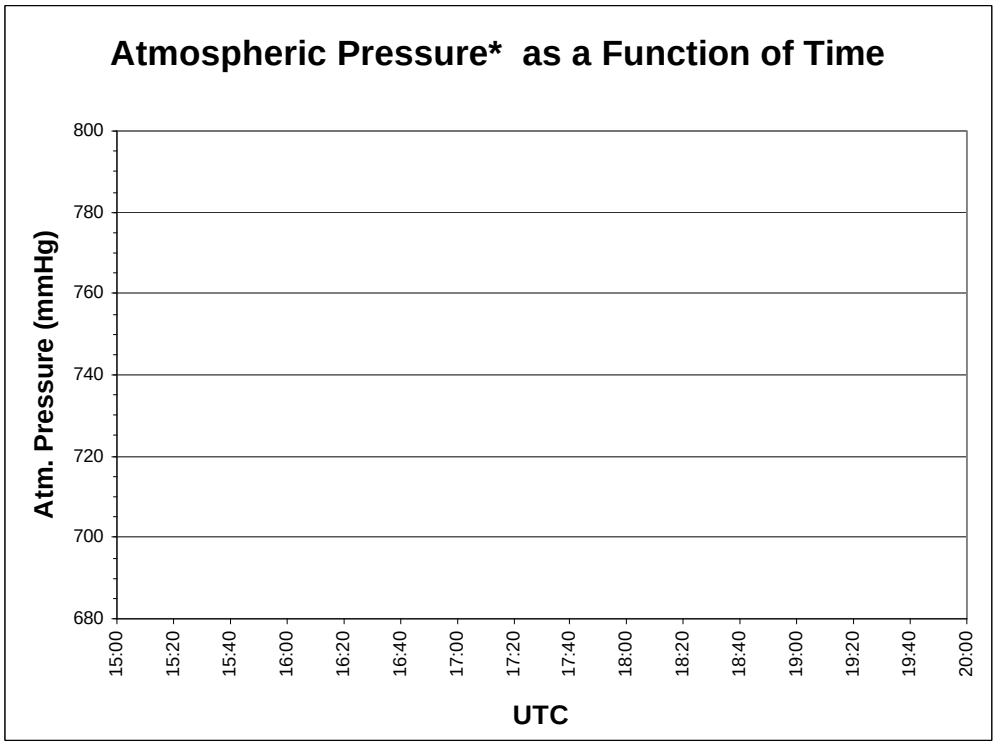
19:00
19:20
19:40
20:00
UTC



* Note: For Atmospheric Pressure, there are no "danger zones." If atmospheric pressure or Nitrogen levels are dropping too quickly, this is dangerous because it could cause the partial pressure of oxygen to vacillate, making breathing difficult. When this happens, consult the tables and graphs for oxygen to determine if there is a danger. Alert the Crisis Manager and all other Life Support Team members.

Practice Data

	Atm.Pres.	% O2	% CO2
15:00	758	21.57	0.086
15:20	752.5	21.44	0.091
15:40	747.5	21.50	0.099
16:00	742.5	21.36	0.104
16:20	735	21.14	0.096
16:40	729	20.94	0.098
17:00	725	20.88	0.104

Life Support Team Report Form

Priority Level (circle one): **1** Urgent – Inform Mission Control Immediately **2** Potential Danger—Monitor Closely **3** Maintaining Normal Levels

Please fill in ALL blanks in case Mission Control needs the information.

	A	C	D	E	F	G
Oxygen	UTC	O2 Content	Partial Pressure	Change	Rate of Change	Time to Criticality
	A	**C**	**D**	**E**	**F**	**G**
Carbon Dioxide	UTC	CO2 Content	Partial Pressure	Change	Rate of Change	Time to Criticality

Communication Team: Please do NOT report the shaded areas to Mission Control.

Recommendations:

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Life Support Team Report Form

Priority Level (circle one): **1** Urgent – Inform Mission Control Immediately **2** Potential Danger—Monitor Closely **3** Maintaining Normal Levels

Please fill in ALL blanks in case Mission Control needs the information.

	A	C	D	E	F	G
Oxygen	UTC	O2 Content	Partial Pressure	Change	Rate of Change	Time to Criticality
	A	**C**	**D**	**E**	**F**	**G**
Carbon Dioxide	UTC	CO2 Content	Partial Pressure	Change	Rate of Change	Time to Criticality

Communication Team: Please do NOT report the shaded areas to Mission Control.

Recommendations:
