ENGINEERING ABOVE AND BEYOND

Written communication in the technical workplace...

Vanderbilt University
October 20, 2014

Jay Perry
Lead Engineer, Environmental Control Systems
NASA-George C. Marshall Space Flight Center
Environmental control and life support systems (ECLSS)
  - Some basics

How does effective written communication fit?
  - The fundamentals

Conclusion

Helpful sources
The Daily Challenge

**Inputs**

- Oxygen 0.84 kg (1.84 lb)
- Food Solids 0.62 kg (1.36 lb)
- Water in Food 1.15 kg (2.54 lb)
- Food Prep Water 0.76 kg (1.67 lb)
- Drink 1.62 kg (3.56 lb)
- Metabolized Water 0.35 kg (0.76 lb)
- Hand/Face Wash Water 4.09 kg (9.00 lb)
- Shower Water 2.73 kg (6.00 lb)
- Urinal Flush 0.49 kg (1.09 lb)
- Clothes Wash Water 12.50 kg (27.50 lb)
- Dish Wash Water 5.45 kg (12.00 lb)

**Total = 30.60 kg (67.32 lb)**

**Outputs**

- Carbon Dioxide 1.00 kg (2.20 lb)
- Respiration & Perspiration Water 2.28 kg (5.02 lb)
- Food Preparation, Latent Water 0.036 kg (0.08 lb)
- Urine 1.50 kg (3.31 lb)
- Urine Flush Water 0.49 kg (1.09 lb)
- Feces Water 0.091 kg (0.20 lb)
- Sweat Solids 0.018 kg (0.04 lb)
- Urine Solids 0.059 kg (0.13 lb)
- Feces Solids 0.032 kg (0.07 lb)
- Hygiene Water 11.90 kg (26.17 lb) liquid
  0.60 kg (1.33 lb) vapor

**Total = 30.60 kg (67.32 lb)**
## ECLS System Functions

<table>
<thead>
<tr>
<th>Control Atmosphere Pressure</th>
<th>Condition Atmosphere</th>
<th>Respond to Emergency Conditions</th>
<th>Control Internal CO₂ &amp; Contaminants</th>
<th>Provide Water</th>
<th>Prepare for EVA Operations</th>
</tr>
</thead>
<tbody>
<tr>
<td>• O₂/N₂ Pressure Control Assemblies (USOS/RS)</td>
<td>• Cabin Air Temperature &amp; Humidity Control Assemblies (All)</td>
<td>• Smoke Detectors (All)</td>
<td>• CO₂ Removal Assembly (USOS/RS)</td>
<td>• Potable Water Processor (USOS/RS)</td>
<td>• O₂/N₂ Pressure Control Assemblies (USOS)</td>
</tr>
<tr>
<td>• Positive &amp; Negative Pressure Relief (USOS-Transport)</td>
<td>• Ventilation Fans (USOS, RS, MPLM)</td>
<td>• Portable Fire Extinguishers (All)</td>
<td>• CO₂ Vent (USOS/RS)</td>
<td>• Urine Processor (USOS/RS)</td>
<td>• O₂/N₂ Distribution (USOS)</td>
</tr>
<tr>
<td>• O₂/N₂ Storage (USOS, RS, Progress)</td>
<td>• Air Particulate Filters (All)</td>
<td>• Fire Indicators and Fire Suppression Ports (All)</td>
<td>• Trace Contaminant Control Assembly (USOS/RS)</td>
<td>• Process Control Water Quality Monitor (USOS)</td>
<td>• O₂/N₂ Storage (USOS)</td>
</tr>
<tr>
<td>• O₂ Generation Assembly, O₂ Solid Chemicals (RS)</td>
<td>• Intermodule Ventilation Fans &amp; Valves (All)</td>
<td>• Portable Breathing Apparatus and Masks (All)</td>
<td>• Major Constituent Analyzer (USOS)</td>
<td>• Condensate Storage (USOS/RS)</td>
<td>• Major Constituent Analyzer (USOS) (Shared)</td>
</tr>
<tr>
<td>• Major Constituent Analyzer (USOS) (Shared)</td>
<td>• Ducting (All)</td>
<td>• O₂/N₂ Pressure Control Assemblies (USOS) (Shared)</td>
<td>• CO₂ Reduction Assembly (RS)</td>
<td>• Fuel Cell Water Storage (USOS)</td>
<td></td>
</tr>
<tr>
<td>• Gas Analyzer (RS) (Shared)</td>
<td></td>
<td></td>
<td>• CO₂ LIOH Removal (RS)</td>
<td>• Waste Water Distribution (USOS)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
ECLS System Functional Interactions
Separations
- Physical adsorption
  - Process gas drying
  - CO₂ removal
  - Gaseous contaminant removal
- Absorption
- Filtration

Reactions
- Chemical adsorption
- Catalytic oxidation
- Catalytic reduction
- Electrochemical
- Plasma

Resource management
- Gas storage & conditioning
- Atmospheric gas production & recycling
ISS AR Process Architecture

ISS Performance Basis
Hardware Schematic
Draft 4
5-15-2012

Symbols:
- Packed bed
- Heater
- Cooler
- Reciprocating heat exchanger
- Condensing heat exchanger
- Check valve
- Three-way automatic control valve
- Two-way hand-operated valve
- Dewpoint analyzer
- Carbon dioxide analyzer
- Pump
- Compressor
- Blower
- Flowmeter
- Oxygen analyzer
- Electrolysis stack
- Accumulator
- Separator
- Cooler
Successful Engineering...

or any worthwhile endeavor requires...

COMMUNICATION

“When I began working in industry, I learned quickly how written communication is tremendously important. An engineer can have great ideas or work, but ideas will never get implemented or noticed if they are not communicated to those who make the decisions.”

Gregory N. Tragitt, BE’78
Vanderbilt Engineering, Fall 2011

“Give me six hours to chop down a tree and I will spend the first four sharpening the axe.”

Abraham Lincoln
Communicating is a Process...
Preparation
- Define the objective and scope
- Identify the audience

Organization
- Select a method of development, i.e. chronological, comparison, analysis, cause-and-effect
- Prepare an outline

Clarity
- Use good sentence structure
- Use transition devices carefully
- Avoid ambiguity
- Avoid excessive jargon

Style
- Use active voice
- Use appropriate tone
- Be concise

Details, details, details
- Grammar
- Punctuation
- Mechanics
- Format
Impediments to Effective Writing

Personal
- Do not like to write—it’s hard, not fun

Organizational
- Project views as unimportant
- Pressure to move to next task

Budget
- No project resources allotted (time)

Schedule
- Planning and priorities

Cultural
- Perception there is no reward
Consequences

THE JOB IS NOT FINISHED
No job is complete without the final report!

THE PRODUCT FAILS
The service does not meet customer needs
The contract does not deliver what it should
The equipment does not work as desired

LOSSES MOUNT
Time and money
Corporate memory
Operational control
Configuration control
Equipment damage
LIVES CAN BE LOST!
The Shuttle Columbia—Findings from the CAIB

“The Board views the endemic use of PowerPoint briefing slides instead of technical papers as an illustration of the problematic methods of technical communication at NASA.” – CAIB Report

- Analysis findings presented in management briefing
- Title is confusing
- Inevitable Information loss
- Key information is misrepresented and demoted in hierarchy
- Most important item buried at the bottom of the slide
- Vaguely quantitative wording used
  - “Significantly” used 6 times to mean different things
- Inconsistent units of measure
Conclusion

- Writing is essential to technical success
  - Provides a foundation for other means of communication
  - Preserves corporate memory
  - Ensures that you get what you pay for
- Successful writing takes time
  - More than 90% of a job may be dedicated to documentation in some form
  - Practice by doing
- Strive to overcome obstacles
  - Set aside time to plan
  - Ensure project resources and schedules allow adequate time
  - Recognize that the rewards are gained over time as your products establish your credibility