

Abstract

TWO TECHNICAL COMMUNICATION PROJECTS PERFORMED DURING AN INTERNSHIP WITH ANALEX CORPORATION

by Sharon Ambro

This report describes and analyzes my work as a technical writer for Analex Corporation during my 16-week Master of Technical and Scientific Communication internship period. Analex's Cleveland branch works in the aerospace industry and primarily contracts for NASA's Glenn Research Center. This report details my work on two projects during this time: Combustion Module-2 (CM-2) and Fluids and Combustion Facility (FCF). For the CM-2 project, I wrote procedures for astronauts to run combustion science experiments on board the space shuttle. For the FCF project, I edited requirements documents for experiment hardware that will be on board the International Space Station. This report discusses background information for each project and analyzes my writing and editing processes in terms of the Anderson Problem-Solving Model for technical communication. The final chapter describes my learning experiences and how these experiences contributed to my development as a technical communicator.

**TWO TECHNICAL COMMUNICATION PROJECTS
PERFORMED DURING AN INTERNSHIP WITH
ANALEX CORPORATION**

An Internship

Submitted to the
Faculty of Miami University
in partial fulfillment of
the requirements for the degree of
Master of Technical and Scientific Communication

Department of English

by

Sharon Ambro

Miami University
Oxford, Ohio

2002

Advisor _____
Dr. Paul V. Anderson

Reader _____
Dr. Jean A. Lutz

Reader _____
Dr. Jerry E. Green

Table of Contents

Chapter 1	Introducing My Internship	1
	My Internship at Analex Corporation as a Systems Engineer	2
	Internship/Job Tasks I Performed	3
Chapter 2	Writing the Water Mist Procedures	4
	About the Combustion Module Project.....	5
	About the Water Mist Experiment	6
	My Process for Writing the Water Mist Procedures	7
	Defining the Problem.....	8
	Designing the Solution	11
	Testing the Solution	14
	Implementing the Solution.....	15
	Evaluating the Solution	16
Chapter 3	Editing FCF Hardware Specifications	17
	About the FCF Project	18
	About the FCF Hardware Specifications	19
	My Process for Editing FCF Hardware Specifications.....	20
	Defining the Problem.....	20
	Designing the Solution	22
Chapter 4	Learning from My Internship	25
	Being a Quick Study	26
	Working with Engineers and Scientists	27
	Working with Conventions	27
	Being Flexible with the Communication Project Process	28
	Report Conclusion	29
Appendix A	Sources Cited	31
Appendix B	Acronyms	33
Appendix C	Water Mist Procedure Sample.....	35
Appendix D	Water Mist Procedure Sample of a Change File....	41
Appendix E	NASA's Rules for Specifications Sample	46
Appendix F	Edited Specification Sample	51

Table of Figures

Figure 1. CM-2 Hardware	5
Figure 2. Steps of the Anderson Problem-Solving Model	8
Figure 3. Use of the Check Mark in the Water Mist Procedures	9
Figure 4. Use of Capital Letters and Bold Font in the Water Mist Procedures ...	10
Figure 5. Interacting with the Software in the Water Mist Procedures	12
Figure 6. Software Response in the Water Mist Procedures	12
Figure 7. Water Mist EMS Partly Installed in the CM-2 Combustion Chamber ..	13
Figure 8. Changes to the Mist EMS Preparation Procedure	15
Figure 9. FCF Hardware	18
Figure 10. Lettered Subparagraphs in the CIR B-Spec	21
Figure 11. NASA's Requirement for the Use of "Shall"	22
Figure 12. Use of "Shall" in the CIR B-Spec	22
Figure 13. Use of Abbreviations for Units in the CIR B-Spec.....	23
Figure 14. Use of Document Numbers in the CIR B-Spec.....	27

Chapter 1

Introducing My Internship

I was hired as a full-time employee at Analex Corporation on January 18, 2000. After a few months of becoming acclimated to my job, I performed my Master of Technical and Scientific Communication (MTSC) Internship from May 1, 2000 to August 19, 2000. The purpose of this report is to describe and analyze my work as a technical writer for Analex Corporation during this period. Although I continue to work on the projects I started during my internship, I discuss in this report only activities that took place during May 1 to August 19.

My Internship at Analex Corporation as a Systems Engineer

Analex Corporation is a small, woman-owned engineering company that specializes in the design, development, analysis, and testing of products and systems for the aerospace, hi-tech manufacturing, medical, telecommunications, and information technology industries (www.analex.com). Established in 1981, Analex has offices in Cleveland, Ohio; Denver, Colorado; Kennedy Space Center, Florida; and Phoenix, Arizona. I work for the Cleveland office, which mainly contracts with the National Aeronautics and Space Administration's (NASA) Glenn Research Center (GRC). GRC is primarily a research center that defines and develops propulsion, space electrical power, and communications technologies for NASA's aeronautics and space missions (www.grc.nasa.gov).

The workforce of Analex is composed of many types of engineers, for example mechanical, aerospace, electrical, systems, thermal, and structural engineers. Although the organizational structure of Analex is typical of most companies, with a Chief Executive Officer, Chief Financial Officer, human resources department, and so on, the organizational structure that its employees work within is defined by the government contract(s) or project(s) on which an employee works. This organizational structure often includes people from other contract companies or GRC. For example, both the Project Manager and Deputy Project Manager of one of my projects are GRC employees. This project is composed of various teams, such as the Operations Team, the Fluids Team, and the Systems Team. And each team has a lead engineer. The three-person Operations Team, of which I am a member, has a team leader who is an Analex employee, a member who is a GRC employee, and me.

Within the Analex structure, I am part of the Systems Engineering Group. My boss is the Systems Engineering Manager; he signs my timecards, and I report to him the progress of my work. Since I was the first technical writer that Analex had ever hired, the company did not have a technical writer job title or job description in place. As a result, I was hired with Systems Engineer as my title. A requirement for a Systems Engineer is not necessarily an engineering degree but

any science degree. With my Bachelor's of Science degree in Environmental Science, I was able to meet this requirement. Within Analex, many of my tasks as a technical writer fit within the job description of a Systems Engineer, such as looking at science experiments, hardware, and components at the system level and developing procedures or editing documentation.

Being the first technical writer at Analex, I was unsure of how the engineers would react to me, but I discovered they were very accepting and extremely open to using my skills to help them more easily and quickly produce better documents. I found that this acceptance and openness was reflective of the organizational culture of Analex. The employees worked together as a team, each employee supportive of one another and working towards the common goal of completing a project. The hierarchy of the company was still clear, but it was not obstructive to effectively and efficiently achieving project goals. Also, the company policies allowing flextime and business casual dress contributed to a relaxed atmosphere.

Internship/Job Tasks I Performed

During my internship, I divided my time between two projects: Combustion Module-2 (CM-2) and Fluids and Combustion Facility (FCF). Since each of these projects was part of a different contract with NASA, working on them was similar to having two different jobs. I charged my time spent on each to different charge codes, worked with different people, and even had different offices in different buildings. I was allowed to work on a project only while in the office designated for that project. I was supposed to divide my time 50/50 between the projects, but this fluctuated with the variation in workload for each project as well as impending project milestones.

Working on these two projects, I accomplished many different job tasks during my internship. Some functions I performed for both projects, including developing and editing presentations, interacting with engineers and scientists, and writing and editing technical documents. Other tasks were particular to a project. Specifically, for the CM-2 project I wrote procedures for running a science experiment, which I detail in Chapter 2. For the FCF project, I developed the Analex Internal Style Guide; created templates for various types of documents, such as test and analysis reports; formatted documents to follow the layout and styles of the template; and edited technical documents. In Chapter 3, I discuss my project that involved editing FCF hardware specifications.

Chapter 2

Writing the Water Mist Procedures

I wrote the procedures for performing a science experiment, called Water Mist. The Water Mist experiment will be performed on board the space shuttle as part of the Combustion Module-2 (CM-2) project. In this chapter, I include background information on both the CM-2 project and the Water Mist experiment. Following the background information, I discuss my process for writing the procedures. Appendix C includes a sample from a draft of the Water Mist procedures.

About the Combustion Module Project

The National Aeronautics and Space Administration's (NASA) Glenn Research Center (GRC) developed the Combustion Module project to perform multiple combustion science experiments on board the space shuttle. The Combustion Module is composed of several hardware components, such as a fluid supply system that provides the gases for combustion. These hardware components work together to perform the combustion science experiments. Figure 1 shows a picture of the CM-2 hardware.



Figure 1. CM-2 Hardware

Combustion Module-1 (CM-1) successfully flew on the space shuttle in 1997. The CM-1 shuttle mission included only two experiments: Laminar Soot Processes (LSP) and the Structure of Flame Balls at Low Lewis-number (SOFBALL). The objective of the LSP experiment was to better understand soot processes in flames, including soot formation, oxidation, and radiation. The objective of the

SOFBALL experiment was to study stationary, spherical flames, which are the simplest interaction of a chemical reaction.

Shortly after the CM-1 mission, the Water Mist scientists inquired about flying their experiment with the Combustion Module-2 (CM-2) shuttle mission. GRC planned a second Combustion Module mission to allow LSP and SOFBALL scientists to gather more data for their experiments. In 1998, GRC and the Water Mist scientists reached an agreement to add Water Mist to the CM-2 shuttle mission. GRC engineers refurbished, reconfigured, and upgraded the CM-1 hardware components to accommodate all three experiments of CM-2: LSP, SOFBALL, and Water Mist. The CM-2 shuttle mission will be the first time Water Mist will be performed in space. Currently, CM-2 is scheduled to fly on shuttle mission STS-107 (STS=Space Transportation System) in July 2002; however, this date is still subject to change.

About the Water Mist Experiment

The objective of the Water Mist experiment is to understand how water mist inhibits the spreading of flames. This knowledge can help engineers design more effective fire suppression systems. Bromine-based chemical fire suppression agents, such as Halons, have been used for years to protect spaces, such as aircraft and ships, where water is not usable because of water damage and weight limits. In 1995, the Montreal Protocol banned the manufacture of Halons because of their enormous potential to deplete the ozone layer. Since then, no effective and environmentally acceptable chemical fire suppression agent has been identified. As a result, researchers and scientists are turning their attention back to the oldest fire fighting technology, water, as a promising candidate for many applications.

Scientists cite several advantages of water mist systems: they are inexpensive compared to chemical-based systems, they are non-toxic and cause no environmental problems, they suppress a wide variety of fires, and they use water quantities a tenth or lower as compared to sprinkler systems. On earth, water mist systems could potentially be used as fire suppression systems for ships, submarines, aircraft, and telecommunication racks. In space, applications could include spacecraft fire suppression systems.

The Water Mist experiment will help scientists investigate the best water droplet size to extinguish a fire. The experiment requires the microgravity environment of space because in space water droplets are uniform, or perfectly spherical. Water droplets float in space similar to how bubbles float on earth. Since water droplets float, they are formed uniform in size and concentration when dispensed through a nozzle with standard-sized holes. These uniform water

droplets can then interact uniformly with the flames of a fire, allowing the scientists to study the water droplet size that is most effective for extinguishing fire.

My Process for Writing the Water Mist Procedures

Analex and NASA GRC brought me into the CM-2 project to write the procedures for performing the Water Mist experiment. I became part of a three-person Operations Team, which was responsible for creating the procedures the astronauts will use to run the three CM-2 experiments. Since LSP and SOFBALL were flown on CM-1, they already had procedures, which another Operations Team member revised to account for the updated hardware and changes in the experiments. The Water Mist experiment was not conducted on CM-1; therefore, I was required to draft the Water Mist procedures from the beginning.

As any technical communicator knows, a writing project involves more than just writing. The work of an effective writer includes many other responsibilities. To write this internship report, I reflected on all the steps, writing and otherwise, that I took to complete the Water Mist procedures. I discovered that my process, although not intentional, followed the Anderson Problem-Solving Model for technical communication that I studied during my MTSC coursework. I inherently used the foundation I built during my MTSC studies and remembered to define a purpose, analyze my audience, and perform user tests.

According to the Anderson Model, the aim of a technical communicator is to solve problems involving the management and communication of specialized information that is to be used for practical purposes. The first step of the model is to define the problem of the communication project, which involves stating a purpose and analyzing the context and audience. Once the objectives for the project are defined, a solution needs to be designed. Designing a solution includes making initial design and format decisions, gathering information, and preparing a draft of the communication project. The next step of the model is to test the solution, or to perform user tests and technical reviews of the draft. This step also includes gathering and analyzing the responses from these tests. After the solution is tested, it can be implemented. Implementing the solution consists of revising the draft based on the results from user tests and reviews as well as producing, packaging, and delivering the final communication project. Last, the solution needs to be evaluated, which entails developing and employing an evaluation method and analyzing the results. This evaluation provides insight into how to better manage communication projects. Figure 2 visually represents the steps of the Anderson Model.

Step 1. Define the Problem <ul style="list-style-type: none"> • State a purpose • Analyze project context and audience 	Step 2. Design the Solution <ul style="list-style-type: none"> • Make initial design and format decisions • Gather information • Prepare a draft
Step 3. Test the Solution <ul style="list-style-type: none"> • Perform user tests and technical reviews • Gather and analyze responses from tests and reviews 	Step 4. Implement the Solution <ul style="list-style-type: none"> • Revise draft • Produce, package, and deliver final project
Step 5. Evaluate the Solution <ul style="list-style-type: none"> • Develop and employ an evaluation method • Analyze the results 	

Figure 2. Steps of the Anderson Problem-Solving Model

In the remainder of this chapter, I discuss how my process for writing the Water Mist procedures both followed and deviated from the Anderson Model.

Defining the Problem

My first step in writing the Water Mist crew procedures was to learn as much as possible about the CM-2 project and the Water Mist experiment. I read various types of documents about the project and Water Mist experiment, including old CM-1 documents, the Water Mist experiment requirements document, and the LSP and SOFBALL procedures from CM-1. I also asked the Operations Team Leader and the Water Mist Lead Engineer numerous questions. I attended weekly team meetings, which not only helped me to learn about the project but also the project culture, including the ways individuals on the team and the sub-teams worked together and interacted. From attending the team meetings, I also learned the roles of each team member and who to ask my questions about different topics.

After gaining a basic understanding of the project and experiment, I then defined the purpose of the procedures both in content and format. I determined the purpose of the procedure content to be: To enable to astronaut to flawlessly perform the Water Mist experiment using the CM-2 hardware and software. I defined the purpose of the procedure format to be: To lay out the steps to perform the Water Mist experiment in an understandable, accessible, and succinct way. After the Operations Team Leader and I discussed these purposes, she informed me that we did not have control over the format of the procedures. At some point later in the project, we would turn over the procedures to Boeing,

with which NASA GRC contracts. Boeing would be responsible for the final layout of the procedures. This newly acquired knowledge led me to re-analyze my writing situation. I still planned to write the procedures understandably, accessibly, and succinctly. For example, I planned to begin each step with an action and to include only one action per step. However, I decided not to spend time on how the procedures would look since Boeing would have ultimate control over the visual layout.

I also learned from the Operations Team Leader that I needed to follow writing conventions from the CM-1 procedures. For example, one convention required using a check mark rather than the word “check” to tell the astronauts to check a valve position or some other condition of the hardware components. Appendix C is a sample from the CM-2 procedures that shows I used a check mark in step 8 of the Mist EMS Installation procedure (Figure 3). In this case, the check mark indicates to the astronaut to check that he or she is properly grounded, or safe from electric shock. The procedures in Appendix C are a sample of a rough draft I completed on May 10, 2000.

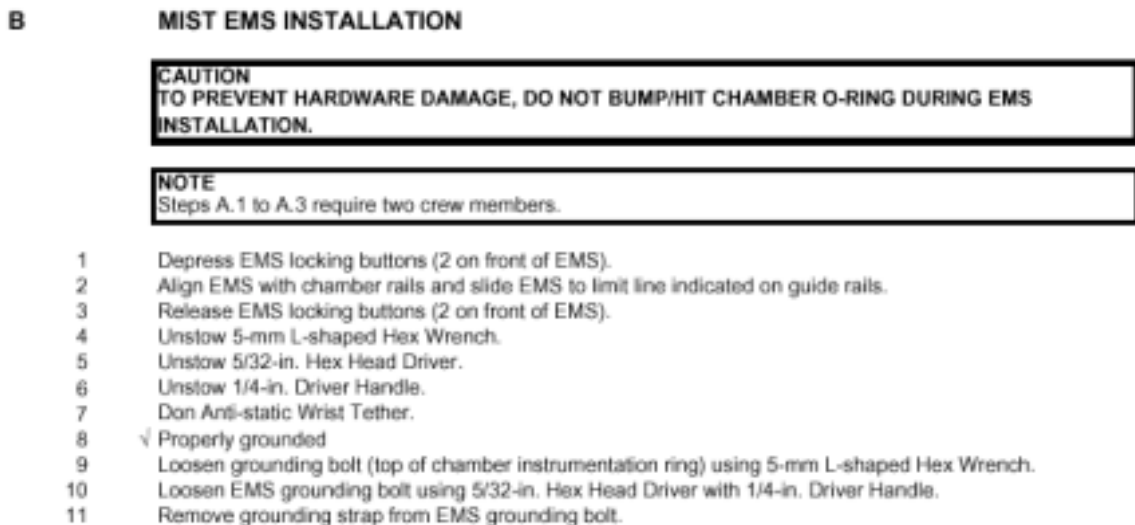


Figure 3. Use of the Check Mark in the Water Mist Procedures

Another example of a CM-1 writing convention was to use capital letters and bold font to indicate the position of a valve or switch. In the Mist Start-Up procedure of Appendix C, I used this convention in steps 5 through 27 to designate the correct positions for several valves and switches that the astronaut needed to check before starting the Water Mist experiment (Figure 4).

MIST START-UP**A****VERIFICATION****NOTE**

Ensure that each of the following circuit breakers (cb) are positioned properly.

- 1 Unstow FSP Torque Tool.
- 2 ✓ cb DC 1, 2, 3 (3) - **ON**
- 3 ✓ cb DC UTIL PWR - **ON**
- 4 Turn cb DC 4 **ON**.

NOTE

Ensure that each of the following valves are positioned properly.

- 5 ✓ CHAMBER ISO valve - **CLOSED**
- 6 ✓ VACUUM VENT valve - **OPEN**
- 7 ✓ EXPERIMENT VENT valve - **OPEN**
- 8 ✓ CLEAN-UP LOOP valve - **CLOSED**
- 9 ✓ ETHYLENE ISO valve - **CLOSED**
- 10 ✓ PROPANE ISO valve - **CLOSED**
- 11 ✓ HELIUM REGULATOR valve - **FULLY DECREASED (CCW)**
- 12 ✓ ARGON REGULATOR valve - **FULLY DECREASED (CCW)**
- 13 ✓ SUPPLY HEADER VENT valve - **OPEN**
- 14 ✓ PROPANE valve - **CLOSED**
- 15 ✓ HELIUM valve - **CLOSED**
- 16 ✓ ARGON valve - **CLOSED**
- 17 ✓ ETHYLENE valve - **CLOSED**
- 18 ✓ REGULATED AIR valves (2) - **CLOSED**
- 19 ✓ AIR REGULATOR valve - **FULLY DECREASED (CCW)**
- 20 ✓ OLIC AIR valve - **CLOSED**
- 21 ✓ AV AIR valve - **CLOSED**
- 22 ✓ SB01 through SB14 valves (14) - **CLOSED**
- 23 ✓ CHAMBER FILL/VENT valve - **OPEN**
- 24 ✓ GC ISO valve - **OPEN**
- 25 ✓ MON CH SEL - **OFF**
- 26 ✓ OLIC AIR SWITCH - **DISABLED**
- 27 ✓ IGNITOR SWITCH - **DISABLED**

Figure 4. Use of Capital Letters and Bold Font in the Water Mist Procedures

In addition, the Operations Team Leader required me to write the procedures in Microsoft Excel, which was the program that was used for the CM-1 procedures. The Operations Team Leader was unsure why the procedures for CM-1 were originally written using Excel. However, she said that she preferred using Excel instead of Word. Over time, I found that most of the engineers I worked with preferred using Excel for procedures as well as for all types of tables—even those that did not use any mathematical, statistical, or database functions.

While analyzing my writing situation, I also analyzed—as best as I could—the audience for the procedures: astronauts. At this point in the project, the crew for the CM-2 shuttle mission had yet to be picked. Consequently, I could not read the biographies for the specific crew, but I did read numerous biographies for several astronauts on the NASA Web site (www.jsc.nasa.gov/Bios/). Based on my readings, I made some basic assumptions about my audience. Astronauts typically are extremely well educated. Many have PhDs in disciplines such as aerospace engineering, medicine, and mechanical engineering. Many also have military and flying experience.

I also realized my audience had vast experience working with technically dense information, as well as experience working with procedures. I also knew the astronauts would be trained on the CM-2 hardware, software, and procedures. As a result, I did not have to “translate” technical information for them. Instead, I focused on accuracy and consistency, such as always using the same name to refer to a certain piece of hardware.

Designing the Solution

My second step in accomplishing the task of writing the Water Mist crew procedures was to design a solution for the problem explained above, which involved developing a draft of the procedures.

From studying the CM-1 procedures for LSP and SOFBALL, I learned that the Water Mist procedures would be made up of steps for running the CM-2 software on a laptop, for working valves and switches on the CM-2 hardware, and for removing and replacing Water Mist hardware. A software engineer on the CM-2 team was developing the CM-2 software for running all three of the experiments. The software engineer provided the team with demonstrations of the software at various points of completion. The demonstration software worked similarly to the real software, but it did not actually run any of the experiment hardware; thus, I could use it on my computer in my office. This demonstration software was very useful for helping me understand how the screen would look and what the buttons and menus would be named.

Governing the CM-2 software was a large and detailed document, the CM-2 Software Sequence of Events (SOE), which was written by the CM-2 software engineers. The SOE contained all the information about how the software would perform, including software commands and responses as well as error messages. Since the CM-2 software was a work-in-progress and the Water Mist portion had yet to be developed, the SOE provided the information I needed to include in the procedures for running the software. For example, in Appendix C, steps 2, 7, and 9 of the Activation section instruct the astronaut to interact with the software (Figure 5). In addition, step 1 of the GC Warm-Up section (Figure 6) shows a software response to a command the astronaut input in step 27 of the Activation section (GC=Gas Chromatograph).

- B** **ACTIVATION**
- 1 Turn PGSC Power **ON**.
- PGSC DESKTOP
- 2 Double click on Crew Interface icon on PGSC desktop.
 - 3 ✓ COMBUSTION MODULE - 2 CREW INTERFACE screen appears
 - 4 Turn cb CB 1 **ON**.
 - 5 Wait 5 seconds, then turn SW 1 **ON**.
 - 6 ✓ DEPP STAT blink code (1 second - ON, 1 second - OFF)
 - 7 Select 'openCom'.
 - 8 ✓ Status Msg: Communications Port Open
 - 9 Select 'chkHealth'.
- PGSC DEPP HEALTH STATUS
- 10 ✓ No error messages or stop signs appear
 - 11 Select 'ok'.
 - 12 Select 'syncTime'.
 - 13 ✓ Time display: GMT = DDS GMT (± 5 seconds)
 - 14 Turn cb CB 2, 3, and 4 **ON**.
 - 15 Wait 5 seconds, then turn SW 2, 3, and 4 **ON**.

Figure 5. Interacting with the Software in the Water Mist Procedures

- D** **GC WARM-UP**
- NOTE**
 GC Power-Up must be complete before beginning GC Warm-Up. May perform FO-37 and FO-38 A while waiting for this message.
- 1 ✓ Status Msg: GC Power-Up Complete
- PGSC GC CARRIER GAS STABILIZATION
- 2 Select 'Continue'.
 - 3 ✓ GC Carrier Gas Stabilization timer window closes
 - 4 Restore Gas Chromatograph window.
- PGSC GAS CHROMATOGRAPH
- 5 Select 'WarmMethod'.
 - 6 ✓ GC Warm-Up Timer window appears
- NOTE**
 GC Warm-Up will proceed for approximately 10 minutes.

Figure 6. Software Response in the Water Mist Procedures

Some procedural steps from LSP and SOFBALL were the same for Water Mist, such as starting up the laptop, which was called the PGSC (Payload Ground Support Computer). This action is step 1 of the Activation section in Appendix C (Figure 5). I reviewed the LSP and SOFBALL CM-1 procedures and determined, with the help of others on the team, which parts of the procedures were likely to be the same for Water Mist. These steps were good starting points and helped to fill in the outline of the Water Mist procedure. Another example of a procedure common among all three experiments is the GC Warm-Up shown in Figure 6. All three experiments use the GC to determine the components of gas mixtures used in their combustion events.

At this point in the project, I had yet to see the CM-2 hardware function, and I would not until the first user test, or Mission Simulation. Therefore, to understand how the hardware worked, I used engineering schematics, which showed where the separate hardware components were laid out in the CM-2 system and where they obtained their resources, such as propane. Schematics also revealed the locations of switches and valves and told what they did when turned on and off. I also used a schematic of the specific experiment hardware, or Experiment Mounting Structure (EMS), for Water Mist. The Water Mist EMS contains the hardware particular to the Water Mist experiment, such as a fine water mist nozzle and a plastic tube that will contain the flame and water mist. Similarly, LSP and SOFBALL each has its own EMS too. For each experiment, the specific EMS is installed into the CM-2 combustion chamber, which is hardware “shared” by all three experiments. Figure 7 shows the Water Mist EMS partly installed in the combustion chamber. The first page of Appendix C instructs the astronauts how to prepare and then install the Water Mist EMS into the CM-2 combustion chamber. Other “shared” hardware provided by CM-2 includes the GC, computer hard drives for storing data, and cameras for taking pictures of combustion events inside the chamber.

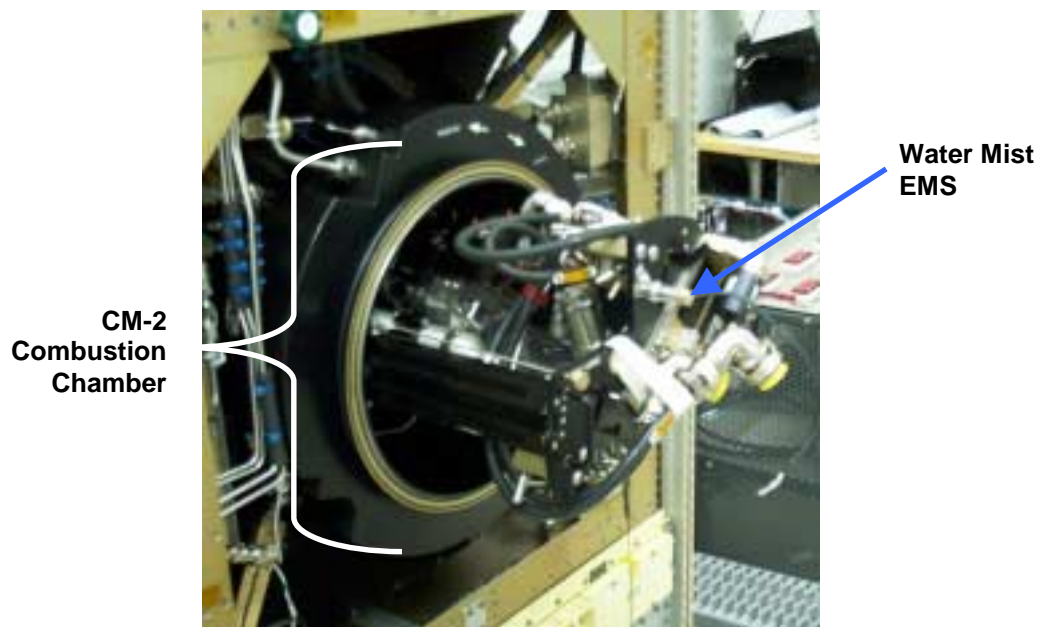


Figure 7. Water Mist EMS Partly Installed in the CM-2 Combustion Chamber

Working with the SOE, the demonstration software, CM-1 procedures, and engineering schematics helped me to not only assemble the content of the Water Mist procedures, but also to develop many questions. I compiled my questions and then set up an interview with the appropriate CM-2 engineer or Water Mist scientist. From these various resources, I created an initial draft that was destined to progress through countless revisions.

Testing the Solution

Once I developed an initial draft of the Water Mist procedures, it was time to begin testing it through user tests and technical reviews. The CM-2 team performed two user tests, or Mission Simulations, of the Water Mist procedures. These Mission Simulations were not typical user tests in that the users, the astronaut crew for the CM-2 mission, did not participate. Instead, members of the CM-2 engineering team acted as astronauts. However, once the CM-2 crew was named, they were trained on the procedures and more Mission Simulations were performed with their participation.

The initial two Mission Simulations were run on the CM-2 flight hardware and simulated the expected flow of how Water Mist will be run during the mission. The preliminary simulation took place during the week of June 12, 2000 and the final one took place during the week of July 24, 2000. Appendix D includes a sample from the procedures revised during the June 12 simulation. During these simulations, I edited a hardcopy of the procedures to show corrections to the draft, such as steps that I missed or that were in the wrong order.

In addition to these Mission Simulations, I also held two technical reviews of the procedures. I gathered the entire CM-2 engineering team and the Water Mist scientists, and we reviewed each step of the procedures. I took detailed notes and asked numerous questions.

Following these mission simulations and technical reviews, I gathered all the revisions the engineers, scientists, and I made to the procedures. I reviewed the revisions to ensure they made sense to me and clarified any confusion I had about them. I called both the engineers and scientists to ask questions about the revisions. For example, Appendix D shows several changes to the Mist EMS Preparation procedure (Figure 8). A Water Mist scientist showed me this procedure only one time, and I had to clarify which EMS locking buttons needed to be depressed and released at certain points in the procedure. (Refer to steps 4, 7, 16, 18, and 20.) After asking this question, I was able to add the parenthetical information for these steps stating whether the buttons were on the EMS front or back. I wanted to make sure I was not introducing errors into the procedures. Once, I understood and clarified all of the revisions, I was ready to incorporate them into the draft.

A

MIST EMS PREPARATION

NOTE

Steps A.1 to A.7 and A.15 to A.21 require two crew members.

- 1 Unstow ~~from foam~~ Mist Experiment Mounting Structure (EMS).
- 2 Place foam inserts (2) inside top and bottom half of foam cutouts and return foam to stowage.
- 3 Rotate EMS so the front plate will go into chamber first.
- 4 Depress EMS locking buttons (2 on back of EMS).
- 5 Align EMS with chamber rails.
- 6 Slide EMS into chamber until it hits reverse insertion stops.
- 7 Release EMS locking buttons (2 on back of EMS).
- ~~8 Remove, discard Kapton tape from around vent port plug and vent port plug retaining clip.~~
- 8 Remove, discard Kapton tape from muffler (free exit) on recirculation pump.
- 9 Remove, stow cap from muffler (free exit) on recirculation pump.
- 10 Remove, discard Kapton tape from teflon tubing between SV07 and atomizer head.
- 11 Make sure water line quick disconnect is secure.
- 12 Make sure coaxial cable to atomizer head is secure.
- PLACE HOLDER:
- 13 Exercise PROPANE (PR01) and AIR (PR02) REGULATORS (3/4 turn cw, 3/4 turn ccw).
- 14 OPEN MV01 (1/4 turn CCW). Valve should point in the direction of flow.
- 15 OPEN MV02 (1/4 turn CW). Valve should point in the direction of flow (towards blue regulator cap).
- 16 Depress EMS locking buttons (2 on back of EMS).
- 17 Slide EMS all the way from chamber.
- 18 Release EMS locking buttons (2 on back of EMS).
- 19 Rotate EMS 180°. (Back plate will go into chamber first).
- 20 Depress EMS locking buttons (2 on front of EMS).
- 21 Align EMS with chamber rails.
- 22 Slide EMS to limit line indicated on the guide rails (~halfway).
- ~~23 Remove, discard Kapton tape from EMS grounding strap.~~
- ~~24 Remove, discard Kapton tape from gunbolt handles (2).~~
- ~~25 Remove, discard Kapton tape from GC sample line.~~
- ~~25 Verify atomizer head WMC-7300 installed in EMS.~~

Figure 8. Changes to the Mist EMS Preparation Procedure

Implementing the Solution

The next step involved in writing the Water Mist crew procedures was to incorporate the revisions from the Mission Simulations and technical reviews into the draft. After I gathered all of my handwritten edits from the simulations or technical reviews, I incorporated the changes into two types of electronic files. In the “change file,” I kept electronic track of all the changes, showing the added-in items in blue and the deleted items in red strike-through text. Appendix D is an example of a change file. In the “clean file,” I integrated all the changes without keeping electronic track of them. This clean file became the latest draft of the procedures. I emailed both of these files to the CM-2 engineering team and the Water Mist scientists to keep them updated on the progress of the procedures.

The benefit of the change file was to highlight only those modifications I made to the previous draft, which avoided questions, such as “What is different on this draft compared to the last?” For example, the first page of Appendix D (compared to the first page of Appendix C) clearly illustrates the extensive

changes I made to the Mist EMS Preparation procedure as a result of the June 12 Mission Simulation (Figure 8).

After incorporating all the revisions from the Mission Simulations and technical reviews, the procedures were ready to be turned over to Boeing. This turnover took place in August 2000, just before the end of my internship period on August 19. After the turnover, we trained a representative from Boeing on the procedures and the CM-2 hardware and software. Following the training, this Boeing employee made all updates and revisions to the procedures as well as evaluated how well the procedures met their objective: To enable to astronaut to flawlessly perform the Water Mist experiment using the CM-2 hardware and software.

Evaluating the Solution

Unfortunately, I did not participate in evaluating the final procedures; however, I will have the opportunity to informally evaluate them during the mission. Boeing took over ownership of the procedures and evaluated them directly with the CM-2 astronaut crew.

Chapter 3

Eediting the FCF

Hardware Specifications

For the Fluids and Combustion Facility (FCF) project, I edited technical documents used for designing and building the FCF hardware. In this chapter, I include background information about the FCF project and the type of documents I edited. I also explain how I defined the problem of my editing projects and designed their solutions.

About the FCF Project

The FCF will be a permanent modular and multi-user facility that will accommodate combustion science and fluid physics experiments in the microgravity environment of space. It will be on board the US Laboratory Module, the Destiny, of the International Space Station (ISS). The FCF is a three-rack facility. A rack is a metallic structure—similar to a bookcase with doors—that houses and organizes the smaller pieces of hardware. Figure 9 shows an engineering drawing of the FCF. The three racks are:

1. Combustion Integrated Rack (CIR), which will support the performance of combustion science experiments
2. Fluids Integrated Rack (FIR), which will support the performance of fluid physics experiments
3. Shared Accommodations Rack (SAR), which will help both the CIR and the FIR by providing extra space for support hardware for the experiments and computing and data analysis

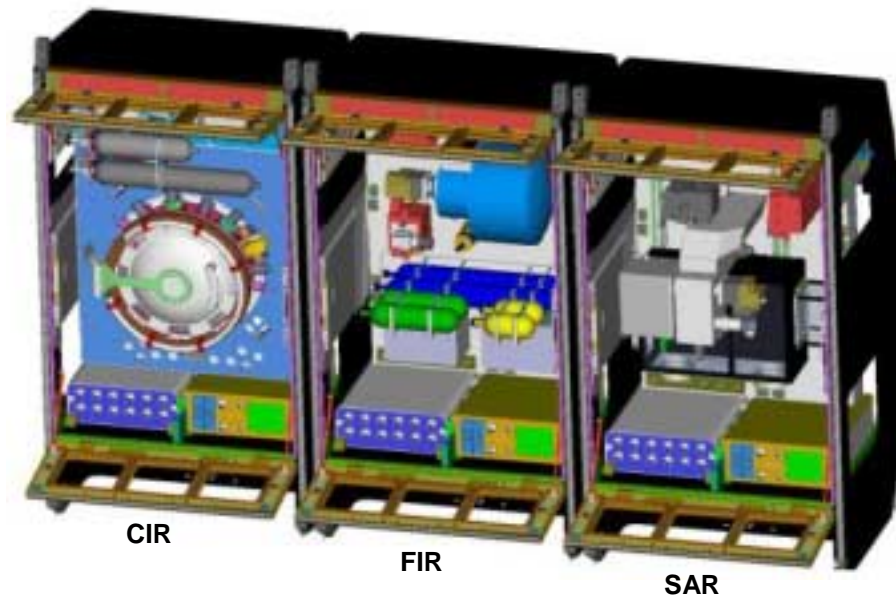


Figure 9. FCF Hardware

The study of combustion is important because we use combustion everyday to heat homes, power cars, and manufacture products. Combustion is a part of fire safety, environmental issues, and health issues. The National Aeronautics and Space Administration's (NASA) Glenn Research Center (GRC) asserts that knowing more about combustion could lower costs in many areas of our lives while improving health and safety. Combustion experiments need to be performed in space because on Earth gravity distorts flames. For example, gravity causes the pointed shape of a candle flame; in space, candle flames are perfectly spherical.

According to GRC, microgravity combustion experiments in the FCF should result in the following benefits:

- Billions of dollars in energy costs saved every year
 - US commercial processes and competitiveness improved
 - Incidence of fire and other public health hazards reduced
 - Environmental pollution lessened
- (<http://fcf.grc.nasa.gov/pages/overview.html>)

The study of fluid physics is important because the human body is mainly composed of fluids. As a result, the development of new drugs and disease treatments often depend on fluid physics. Also, many high-value commercial processes, such as petroleum production and semiconductor production, rely on fluid physics. Fluid physics experiments need to be performed in space because on Earth gravity interferes with the formation of uniform water droplets. Similar to the way gravity distorts flames, gravity "pulls" on water droplets, which explains the raindrop shape as well as why rain falls to the ground. In space, water floats with the water droplets perfectly spherical in shape (<http://fcf.grc.nasa.gov/pages/overview.html>).

According to GRC, microgravity fluid physics experiments in the FCF should result in the following benefits:

- Advances in public medicine and treatment of disease
- Improved commercial processes and competitiveness in a wide range of US industries
- Greater success in applying the results of other experiments conducted on ISS to benefit the public (<http://fcf.grc.nasa.gov/pages/overview.html>)

About the FCF Hardware Specifications

For the FCF project, I edited hardware specifications. A specification is a document that includes all of the requirements imposed by NASA that hardware must meet, such as pressure requirements, temperature requirements, and

requirements for labeling the hardware. A specification is written in report format and includes an introduction and a description of the hardware as well as the hardware's detailed requirements. Since the ISS is limited in such resources as electricity and water and since it will house many more experiment facilities than FCF, the FCF system can only use so many resources. These requirements that are imposed by NASA ensure that the FCF system will use only the allotted amount of resources. Also, the requirements ensure the safety of the astronauts running the experiments and of the ISS.

There are three levels of hardware specifications: A, B, and C. The A-level specification is the highest level and includes all requirements that the FCF system must meet in order to safely run on the ISS. The B-level specifications are the next highest and FCF project engineers wrote one for each of the three racks (CIR, FIR, and SAR). C-level specifications are the lowest level and the most specific. An FCF project engineer will write a C-level specification for all components of the FCF system. The engineers use these specifications as guidelines for designing and building the FCF hardware.

My Process for Editing FCF Hardware Specifications

In contrast to my process for writing the Water Mist crew procedures, my process for editing the FCF hardware specifications only followed the Anderson Problem-Solving Model with respect to defining the problem and designing the solution. Testing, implementing, and evaluating the solution were not part of my assigned task.

My first project at the start of my internship was to edit the CIR B-Spec. Since the CIR B-Spec was the first specification of all the FCF specifications that I edited, I used it as the model for the style and editing conventions I would use in the other specifications. I finished editing the CIR B-Spec in the beginning of July 2000, and then I began editing the FCF System A-Spec. Also during July, I began editing work on my first component-level specification, the Water Thermal Control System (WTCS) C-Spec. I continued work on the A-Spec and WTCS C-Spec through the end of my internship on August 19, 2000.

Defining the Problem

First, I read as much as possible about the project and studied the FCF project concepts. Although my purpose while editing specifications was not to check technical content, a basic understanding of the subject matter was helpful to ensure that my suggested revisions did not introduce errors. My purpose for the

editing project was to make a specification grammatically and stylistically correct and consistent within itself as well as with other specifications.

Second, to be certain that I knew the specific goals the authors had for my editing, I met with each author to discuss his or her ideas. I learned, for example, that the CIR B-Spec author wanted me to use Microsoft Word cross references to link figure references in the text to the associated figures. When linked, a figure reference in the text would update to the new number when the figure number changed. I decided that cross-referencing was valuable to use in all the specifications. In addition to understanding the author's goals, during this meeting we also determined a mutually acceptable timeframe for the editing project.

Third, I studied the NASA document that outlined its rules for writing specifications. A sample from this document is in Appendix E. One rule required authors to use certain headings. For example, the heading, Touch Temperature Warning Labels, had to be in every specification. In addition, another rule required authors to use only numbered and lettered lists, not bulleted lists because the location of each paragraph of the specification must be traceable (such as paragraph 3.2.5.1 a.). Appendix F is a sample from the edited CIR B-Spec. Paragraph 1.1.1.2 shows how each requirement for the CIR Weight Characteristics is broken down into a lettered subparagraph (Figure 10). Paragraph 1.1.1.2 b refers to the requirement for the on-orbit mass of the CIR.

1.1.1.2 CIR weight characteristics.

- a. The CIR shall not exceed a launch mass of 804.2 kg (1773 lbs) ~~launch mass~~, excluding stowage hardware.
- b. The CIR, with applicable PI hardware, shall not exceed a an on-orbit mass of 804.2 kg (1773 lbs) ~~on-orbit mass~~, excluding stowage hardware. (See Appendix H ~~to~~ for exceptions to this requirement.)
- c. CIR spares and resupply equipment shall not exceed an up-mass of 125 kg (275 lbs) ~~up-mass~~.

Figure 10. Lettered Subparagraphs in the CIR B-Spec

NASA also required authors to use the word “shall” to define a requirement. The second page of Appendix E includes NASA’s requirement for the use of “shall” (Figure 11). In paragraph 1.1.1.9 of Appendix F, the author used “shall” to indicate that NASA requires the CIR to interface with the ISS and CIR internal assemblies as stated in the referenced paragraph (Figure 12). “Shall” could not be used in any other context, or it would be considered a requirement that the hardware must meet. For instance, in paragraph 1.1.1.8, the author did not use

“shall” because the sentence does not indicate a hardware requirement; instead, it refers the reader to other paragraphs (Figure 12).

- f. “Shall,” the emphatic form of the verb, shall be used throughout the specification sections 3, 4, and 5 whenever a requirement is intended to express a provision that is binding. For example, state a requirement as “The indicator shall be designated to indicate . . .” Or in the section containing test provisions “The indicator shall be turned to zero and 230 volts alternating current applied.” For specific test procedures, the imperative form may be used provided the entire method is preceded by “the following test shall be performed,” or related wording. Thus, “Turn the indicator to zero and apply 230 volts alternating current.”

Figure 11. NASA’s Requirement for the Use of “Shall”

1.1.1.8 Transportation and safety requirements.

This ~~section~~-paragraph is covered in ~~sections~~-paragraph 3.2.7 and section 5.0.

1.1.1.9 Interfaces.

The CIR, with applicable PI hardware, shall interface with the ISS and CIR internal assemblies in accordance with paragraph 3.1.5.

Figure 12. Use of “Shall” in the CIR B-Spec

In addition to NASA’s rules for the specifications, Analex also had rules for the format of its documents, which I compiled into the Analex Internal Style Guide. I learned Analex’s rules by examining previously written documents and talking to the engineers. Also, I created rules for items that did not already have established guidelines. The Analex Internal Style Guide, for example, dictated the fonts for headings and body text as well as the amount of space between paragraphs. The sample in Appendix F shows the heading fonts in 12pt Arial Bold and the body text font in 12pt Times New Roman. Analex required that this convention be used for all documents, not only hardware specifications.

Designing the Solution

After I had sufficient understanding of the specification subject matter and conventions, I first edited the document format to fit within the Analex Internal Style Guide. After ensuring that the document format met these guidelines, I edited the document text for grammar, punctuation, and spelling. I also made certain that the specification included all the parts required by NASA and followed all the stylistic conventions. Finally, I checked for the consistent use of terms within the specification as well as among other FCF hardware specifications.

While editing the specification, I maintained an editing log. I used a Microsoft Excel spreadsheet to keep track of the date, the total time I spent editing for that period, a summary of my editing activities, and the place in the document to begin editing next time. When I finished editing a specification, I was able to determine the overall time I spent editing the entire document. I estimated my editing time per page and the amount of time I spent doing various editing activities.

I also kept an editing notebook. I wrote down stylistic conventions that arose while editing, such as capitalization and hyphenation conventions. For example, paragraph 1.1.1.8 of Appendix F shows that I decided to use “section” to refer only to first-level headings and “paragraph” to refer to all subheadings (Figure 12). As another example, paragraph 1.1.1.9.2 b illustrates my convention to use only abbreviations for units (Figure 13). I wrote down these types of conventions in my editing notebook to remind myself to be consistent while suggesting revisions.

1.1.1.9.2 MPLM interfaces.

- a. The CIR shall interface to the MPLM structural attach points in accordance with SSP 41017 Part 2, paragraph 3.1.1.
- b. The CIR shall maintain positive margins of safety for MPLM depress rates of 890 Pa/~~second~~ (7.75 psi/~~minute~~) and repress rates of 800 Pa/~~second~~ (6.96 psi/~~minute~~).
- c. The CIR shall be limited to producing interface attach point loads less than or equal to those identified by SSP 41017 Part 1, paragraph 3.2.1.4.3, based upon an acceleration environment as defined in SSP 41017 Part 1, paragraph 3.2.1.4.2.

Figure 13. Use of Abbreviations for Units in the CIR B-Spec

I also kept a “To Do” list of items in my notebook that I would revisit, like double-checking a reference to a paragraph in another document. I did not want to interrupt my “editing rhythm” by stopping to verify a reference to another document. Instead, I went through my “To Do” list either at the end or start of the time I planned for editing. Additionally, in my notebook I kept track of acronyms and abbreviations the author used, which I later compiled into an appendix. I also noted other technical documents that the author cited in the specification, which I later compiled into a specification section entitled “Applicable Documents.”

I kept track of my suggested changes with Microsoft Word’s revision functions. These functions allowed the author to see my revisions and to either accept or reject them, which also helped to ensure I was not introducing technical errors. The sample in Appendix F shows that Word highlighted added-in text in blue with underlines and deleted text in red with strike-throughs. Word’s revision functions allow for comments to be inserted into the document, which enabled

me to explain my reasoning for an editing suggestion. In paragraph 1.1.1.1.2 of Appendix F, I inserted a comment to explain why I added in “shall follow” and to state that I was not certain the suggestion was correct. The comment is denoted by my initials and the number one surrounded by brackets, which is visible only when the paragraph markers are shown. The last page of Appendix F includes all the comments I made during this sample of the specification. I did not always include comments for my revisions because the author would be overwhelmed with all the explanations for why I made editing decisions. I never made a revision based on my own stylistic preferences, and I only made revisions for which I could produce a reason if asked.

To help ensure the accuracy of my editing suggestions, I often referred to grammar handbooks and other useful technical writing and editing resources. For example, I used the US Government Printing Office (GPO) Style Manual (Washington: 1984 & 2000) as a guideline for all decisions concerning grammar. This manual is considered the standard for government documents. I also used references as “proof” to justify my revisions to the author when they were challenged.

Since I had many specifications to edit and because of the length of these documents, I had to be efficient yet still effective with my editing. Consequently, I read through each document only one time, and I distinguished between style suggestions and grammar corrections. I did not spend too much time deliberating over problems with the author’s writing style; instead, I concentrated more on grammar problems. After I was finished editing the specification, I returned the document to the author and was available for questions. There was not time for a formal meeting to review the revised specification; I had to continue on to the next editing project.

Chapter 4

Learning from My Internship

Throughout my internship period I was constantly learning: learning about hardware, software, engineering, and project dynamics and learning to be a professional technical communicator. In this chapter, I discuss the four most important lessons I learned during my internship experience. These experiences greatly contributed to my development as a technical communicator.

Being a Quick Study

For both projects, I learned the importance of being a quick study. As soon as I started on the projects, I was expected to produce results quickly. Consequently, I had to learn about the projects while simultaneously beginning to edit and write. My workdays were interspersed with learning about the project and making progress on my work. For example, before I began editing my first FCF specification, I read about the FCF hardware as a system; I learned how all the components work together to support a combustion science experiment. However, I did not understand how each separate component achieves its own purpose and did not need this information to edit the upper-level system specification. When I began to edit my first component-level specification for the Water Thermal Control System (WTCS), I did need to learn the purpose of the WTCS. Thus, I referred back to FCF reference materials to learn that the WTCS provides water-cooling to prevent the components from overheating.

Being a quick study enabled me to shorten the initial time I spent defining the problem and still successfully design a solution. Learning about the project and editing at the same time enabled me to reach milestones in my work fairly quickly. Nevertheless, I discovered that this process was not without setbacks. For instance, I did not decide how to consistently write references to other documents before I began editing. About halfway into editing the CIR B-Spec, I realized that there were a multitude of references to other documents and that the author was not consistent in writing them. The author sometimes included document and paragraph titles and sometimes used only document and paragraph numbers in references. Paragraphs 1.1.1.9.1 a and c of Appendix F show that I decided to delete all titles and use only numbers (Figure 14). I thought that including titles muddled the sentences, making the requirements too difficult to decipher. In order to be consistent, I had to revisit the first half of the specification to make the appropriate changes. If I had taken more time to compile a thorough list of prevalent style issues before editing, I might have avoided backtracking. I learned that even when being a quick study, it is important to identify the common style issues before beginning to write or edit.

1.1.1.9.1 Ground Support Equipment (GSE) interfaces.

- a. The CIR shall interface to the Kennedy Space Center (KSC) GSE Rack Insertion Device in accordance with SSP 41017 Part 1, paragraph 3.2.1.1.2 ~~Static Envelope, and 3.2.1.4.3 Interface Loads,~~ and SSP 41017 Part 2, paragraph 3.3.2 ~~Upper Attachment Interfaces~~ and 3.3.3 ~~Ground Handling Attachment Interfaces.~~
- b. The CIR shall interface to Rack Shipping Containers in accordance with the Teledyne Brown Engineering (TBE) as-built drawing 220G07500.
- c. The CIR shall interface to Rack Handling Adapters (RHA) in accordance with the following TBE as-built drawings: 220G07455 ~~Upper Structure~~, 220G07470 ~~MSFC Lower Structure~~, and 220G07475 ~~KSC Lower Structure~~.
- d. The CIR shall be limited to ground transportation accelerations of 80% of flight accelerations defined by SSP 41017 Part 1, paragraph 3.2.1.4.2.

Figure 14. Use of Document Numbers in the CIR B-Spec

Working with Engineers and Scientists

Through my internship experience, I learned to work with engineers and scientists in two roles: as authors for the FCF project and as subject matter experts for the CM-2 project. Having an undergraduate degree in science, I have worked with scientists and have conducted scientific experiments myself. As a result, I already had a good foundation for interacting with scientists and being able to speak the “language of science,” and I discovered that working with engineers and speaking the “language of engineering” was very similar.

I found that engineers and scientists become more comfortable working with a technical writer when they see that the writer has a basic understanding of the subject matter and can learn quickly. To build their confidence in me, I learned to ask questions and make comments that showed the scientists and engineers what I understood about their project. For example, a CM-2 engineer was explaining the CM-2 hardware to me and began to describe a GC (or gas chromatograph). I had worked closely with a GC in my undergraduate studies and made a comment to assure the engineer that I knew what a GC was as well as how it functioned. I noticed that the engineer was impressed and relieved that she did not have to provide me with such details. I knew that I had gained her confidence, and she treated me accordingly from that point on.

Working with Conventions

I also continued to learn more about writing and editing within the confines of pre-defined formats and conventions. I had experience working with conventions from my MTSC coursework, and my internship built upon that

foundation. For example, while working on the FCF project, I had to follow NASA's rules for writing specifications while I edited the A-, B-, and C-level specifications (Appendix E). For the CM-2 project, I had to follow the conventions from CM-1 and had no input about the format. I found it frustrating to know that I could improve a document but was not allowed to make any changes. For example, I would have suggested using Microsoft Word for writing the Water Mist procedures instead of Excel, which was not designed to be a word processor. To create a change file following a review, I could have used Word's revision functions instead of having to "manually" format the text to show added-in and deleted items.

I learned that identifying these conventions and writing constraints while defining the problem—before I began writing or editing—could save me valuable project time. Otherwise, I might waste time incorrectly writing or editing a document. Before starting to edit the CIR B-Spec, if I had not learned about the "shall" convention I might have changed the shall's to a less formal verb. Or, I might not have spotted the places where the author accidentally missed using "shall." An error like that could have negatively affected the design of the CIR hardware. In addition to avoiding mistakes, understanding the conventions stopped me from spending time on items out of my control, such as the format for the Water Mist procedures.

Being Flexible with the Communication Project Process

When reflecting on my writing and editing processes to write this report, I found that while working on a project I sometimes modified a step of the Anderson Problem-Solving Model or skipped steps entirely, if they did not apply to the project. I learned that the process for a communication project does not always follow textbook descriptions of that process. I realized that my MTSC foundation enabled me to be flexible with the model based on the context of the individual project.

For the Water Mist procedures, defining the problem was difficult because I was not able to directly analyze my audience. As a result, I had to make some assumptions based on the research I did about my audience. I found that these assumptions were enough for me to successfully achieve my goal of producing a draft to submit to Boeing, which later revised the procedures.

In addition, I had to be flexible in my process for testing the Water Mist procedures. Part of testing the solution involved Mission Simulations, which did not include the users but instead engineers unfamiliar with the procedures.

Astronauts are extremely busy, important, and highly paid people, and NASA does not want them in the procedure-development process too early. The astronauts are assigned to a project about a year before the project will fly on the space shuttle. Before astronaut involvement, a project could be in development for years. In spite of the unavailability of the astronauts, I was able to test the Water Mist procedures, and these tests did offer me insights into improving the procedures. Consequently, I did perform this step of the model, although not in its most ideal form. After Boeing received my draft, it performed actual user tests with the astronauts.

With respect to the FCF project, I learned that even though all the steps of the Anderson Model work together and build on one another, some of the steps could stand alone. For my editing projects, I was able to successfully define the problem and design a solution and still deliver a finished and useful project—within the context of the FCF project—without testing, implementing, or evaluating the edited specification.

Since I was the author of the Water Mist procedures, I followed the progress of the project more or less from cradle to grave, at least until the point when I submitted the procedures to Boeing. In contrast, I was not the author of the FCF hardware specifications. As editor, I played only one part in each specification's completion; my editing was a small project within a larger one. The larger project—the start to finish of a specification—was governed by the document author. From the viewpoint of the author, my editing project was only part of the author's task of developing a draft, or designing the solution. Within this part of the larger project, I defined the problem and designed the solution for my editing projects, which I detailed in Chapter 3.

After I finished editing a specification, I returned it to the author and moved on to the next specification. I was available to answer questions the author had about my suggested revisions, but my process did not formally include testing, implementing, or evaluating my editing job. These steps were simply not part of my assigned task. In terms of the larger project, the author then took over these steps. I realized that to achieve my project goals, I had to be flexible with the process for completing a communication project. I used the Anderson Model within the context of the project, and in this case, testing, implementing, and evaluating the project did not apply.

Report Conclusion

My internship was a great hands-on learning experience: a chance to put the theory of my MTSC coursework, such as the Anderson Problem-Solving Model, into practice. My understanding of this theory enabled me to successfully

complete milestones while writing the Water Mist procedures and editing the FCF hardware specifications. My internship experience was a stepping-stone in my growth as a professional technical communicator.

Appendix A

Sources Cited

“Astronaut Biographies.” Astronaut Office Flight Crew Operations Directorate
NASA/Lyndon B. Johnson Space Center. 23 Aug. 2001.
<<http://www.jsc.nasa.gov/Bios/>>

“Corporate Information.” Analex Corporation. 2002. <<http://www.analex.com>>

“Fluids and Combustion Facility Overview.” The Fluids and Combustion
Facility for the International Space Station. 29 Jan. 2002.
<<http://fcf.grc.nasa.gov/pages/overview.html>>

NASA Glenn Research Center. <<http://www.grc.nasa.gov>>

US Government Printing Office Style Manual. Washington: United States
Government Printing Office, 1984 and 2000.

Appendix B

Acronyms

CIR	Combustion Integrated Rack
CM-1	Combustion Module-1
CM-2	Combustion Module-2
EMS	Experiment Mounting Structure
FCF	Fluids and Combustion Facility
FIR	Fluids Integrated Rack
GC	Gas Chromatograph
GPO	Government Printing Office
GRC	Glenn Research Center
ISS	International Space Station
LSP	Laminar Soot Processes
MTSC	Master of Technical and Scientific Communication
NASA	National Aeronautics and Space Administration
PGSC	Payload Ground Support Computer
SAR	Shared Accommodations Rack
SOE	Sequence of Events
SOFBALL	Structure of Flame Balls at Low Lewis-number
STS	Space Transportation System
WTCS	Water Thermal Control System

Appendix C

Water Mist Procedure Sample

EMS INTEGRATION**A****MIST EMS PREPARATION**

- 1 Unstow Mist Experiment Mounting Structure (EMS).
 - 2 Place foam inserts (2) inside top and bottom half of foam cutouts and return foam to stowage.
 - 3 Remove, discard Kapton tape from EMS grounding strap.
 - 4 Remove, discard Kapton tape from gunbolt handles (2).
 - 5 Remove, discard Kapton tape from around vent port plug and vent port plug retaining clip.
 - 6 Remove, discard Kapton tape from teflon tubing between SV07 and atomizer head.
 - 7 Remove, discard Kapton tape from muffler (free exit) on recirculation pump.
 - 8 Verify atomizer head WMC-7300 installed in EMS.
- PLACE HOLDER:**
- 9 Exercise PROPANE (PR01) and AIR (PR02) REGULATORS (3/4 turn cw, 3/4 turn ccw).
 - 10 **OPEN** MV01 (CCW).
 - 11 **OPEN** MV02 (CW).
 - 12 Remove, discard Kapton tape from GC sample line.

B**MIST EMS INSTALLATION**

CAUTION
TO PREVENT HARDWARE DAMAGE, DO NOT BUMP/HIT CHAMBER O-RING DURING EMS
INSTALLATION.

NOTE
 Steps A.1 to A.3 require two crew members.

- 1 Depress EMS locking buttons (2 on front of EMS).
 - 2 Align EMS with chamber rails and slide EMS to limit line indicated on guide rails.
 - 3 Release EMS locking buttons (2 on front of EMS).
 - 4 Unstow 5-mm L-shaped Hex Wrench.
 - 5 Unstow 5/32-in. Hex Head Driver.
 - 6 Unstow 1/4-in. Driver Handle.
 - 7 Don Anti-static Wrist Tether.
 - 8 ✓ Properly grounded
 - 9 Loosen grounding bolt (top of chamber instrumentation ring) using 5-mm L-shaped Hex Wrench.
 - 10 Loosen EMS grounding bolt using 5/32-in. Hex Head Driver with 1/4-in. Driver Handle.
 - 11 Remove grounding strap from EMS grounding bolt.
 - 12 Connect and tighten instrumentation side grounding strap to bolt using 5-mm L-shaped Hex Wrench.
 - 13 Remove GC sample line from retaining clip on EMS (labeled "GC").
 - 14 Connect GC sample line to GC port on instrumentation ring.
 - 15 Remove vent line fitting from retaining clip on EMS (labeled "vent").
 - 16 Insert EMS vent line fitting into instrumentation ring fill/vent port (fill/vent port hole lies above the gun bolt at top of instrumentation ring).
 - 17 Depress EMS locking buttons (2 on front of EMS).
 - 18 Slowly insert EMS into chamber far enough that the unconnected end of grounding strap is able to reach ground lug on EMS.
 - 19 Release EMS locking buttons (2 on front of EMS).
 - 20 Connect grounding strap to EMS using 5/32-in. Hex Head Driver with 1/4-in. Driver Handle.
 - 21 Depress EMS locking buttons (2 on front of EMS).
 - 22 Slowly insert EMS completely into chamber making sure that fluid hoses do not pinch.
 - 23 Release EMS locking buttons (2 on front of EMS).
 - 24 Engage gun bolts (2).
 - 25 ✓ Bolt (tapered end) aligns with mating hole
 - 26 Connect Data harness to instrumentation ring (single line).
 - 27 Connect Power harness to instrumentation ring (double line).
- PLACE HOLDER:**
- 28 ✓ Indicator (blue) on connector plug properly aligned
 - 29 Remove Anti-static Wrist Tether.
 - 30 Stow 5-mm L-shaped Hex Wrench.
 - 31 Stow 5/32-in. Hex Head Driver.
 - 32 Stow 1/4-in. Driver Handle.

- 33 Verify atomizer switch settings using the table below (UP=ON, DOWN=OFF).

CAUTION TO AVOID DAMAGING ATOMIZER, FOLLOW THE BELOW SETTINGS CAREFULLY.

SERIAL NO.	SW1	SW2	SW3	SW4	SW5	SW6	SW7
WMC-7300	DOWN	DOWN	DOWN	DOWN	UP	DOWN	UP

NOTE SW8 should always be in the UP position.

- C**
- 1 **CLOSE CHAMBER**
Perform CM2-1b "CHAMBER ACCESS" (cue card).

MIST START-UP**A****VERIFICATION****NOTE**

Ensure that each of the following circuit breakers (cb) are positioned properly.

- 1 Unstow FSP Torque Tool.
- 2 ✓ cb DC 1, 2, 3 (3) - **ON**
- 3 ✓ cb DC UTIL PWR - **ON**
- 4 Turn cb DC 4 **ON**.

NOTE

Ensure that each of the following valves are positioned properly.

- 5 ✓ CHAMBER ISO valve - **CLOSED**
- 6 ✓ VACUUM VENT valve - **OPEN**
- 7 ✓ EXPERIMENT VENT valve - **OPEN**
- 8 ✓ CLEAN-UP LOOP valve - **CLOSED**
- 9 ✓ ETHYLENE ISO valve - **CLOSED**
- 10 ✓ PROPANE ISO valve - **CLOSED**
- 11 ✓ HELIUM REGULATOR valve - **FULLY DECREASED (CCW)**
- 12 ✓ ARGON REGULATOR valve - **FULLY DECREASED (CCW)**
- 13 ✓ SUPPLY HEADER VENT valve - **OPEN**
- 14 ✓ PROPANE valve - **CLOSED**
- 15 ✓ HELIUM valve - **CLOSED**
- 16 ✓ ARGON valve - **CLOSED**
- 17 ✓ ETHYLENE valve - **CLOSED**
- 18 ✓ REGULATED AIR valves (2) - **CLOSED**
- 19 ✓ AIR REGULATOR valve - **FULLY DECREASED (CCW)**
- 20 ✓ OLIC AIR valve - **CLOSED**
- 21 ✓ AV AIR valve - **CLOSED**
- 22 ✓ SB01 through SB14 valves (14) - **CLOSED**
- 23 ✓ CHAMBER FILL/VENT valve - **OPEN**
- 24 ✓ GC ISO valve - **OPEN**
- 25 ✓ MON CH SEL - **OFF**
- 26 ✓ OLIC AIR SWITCH - **DISABLED**
- 27 ✓ IGNITOR SWITCH - **DISABLED**

B**ACTIVATION**

- 1 Turn PGSC Power **ON**.

PGSC DESKTOP

- 2 Double click on Crew Interface icon on PGSC desktop.
- 3 ✓ COMBUSTION MODULE - 2 CREW INTERFACE screen appears
- 4 Turn cb CB 1 **ON**.
- 5 Wait 5 seconds, then turn SW 1 **ON**.
- 6 ✓ DEPP STAT blink code (1 second - ON, 1 second - OFF)
- 7 Select 'OpenCom'.
- 8 ✓ Status Msg: Communications Port Open
- 9 Select 'ChkHealth'.

PGSC DEPP HEALTH STATUS

- 10 ✓ No error messages or stop signs appear
- 11 Select 'OK'.
- 12 Select 'SyncTime'.
- 13 ✓ Time display: GMT = DDS GMT (± 5 seconds)
- 14 Turn cb CB 2, 3, and 4 **ON**.
- 15 Wait 5 seconds, then turn SW 2, 3, and 4 **ON**.

- 16 Select 'System' \ 'Experiment' \ 'Mist'.
- 17 Select 'Yes'.
- 18 ✓ EMS: Mist
- 19 **ENABLE IGNITOR SWITCH.**
- 20 Select 'OpMode' / 'Mist'.
- 21 Select 'PwrUp'.
- 22 ✓ MFC Warm-Up Timer window appears

NOTE
MFC Warm-Up will continue for approximately 30 minutes.

- 23 ✓ Status Msg: Power-Up Complete (up to 4 minutes)
- 24 ✓ PowerMode: Full
- 25 Enable Exception Monitoring:
Place Holder for Exception Monitoring Command String
Place Holder for Exception Monitoring Command String
- 26 Select 'Gas Chromatograph'.

PGSC GAS CHROMATOGRAPH

- 27 Select 'GC PwrUp'.
- 28 ✓ GC Carrier Gas Stabilization timer window appears

NOTE
GC Power-Up will continue for approximately 20 minutes. Continue through Step C.

- 29 Select 'setGCReg'.
- 30 **OPEN ARGON valve.**
- 31 **OPEN HELIUM valve.**

CAUTION
DO NOT EXCEED 97 PSIA WHILE ADJUSTING THE HELIUM AND ARGON REGULATOR VALVES.
OVER PRESSURIZATION AND/OR DELAY IN MISSION TIMELINE MAY OCCUR.

NOTE
Once regulator deadband is reached, the PSIA will increase approximately 40 PSIA per turn. There will be an approximate four second delay between regulator action and PGSC display response. The alarm triggers at 102 PSIA, the overpressure valve relieves at 105 PSIA.

- 32 Rotate HELIUM REGULATOR valve CW to deadband (approximately 5 turns).
Adjust until H016 = 95 PSIA \pm 2.
- 33 Rotate ARGON REGULATOR valve CW to deadband (approximately 5 turns).
Adjust until A016 = 95 PSIA \pm 2.

PGSC GC REGULATOR PRESSURE

- 34 ✓ Display Values:
- 35

<u>Transducer</u>	<u>PSIA</u>
Helium Line (H_016)	95 PSIA \pm 2
Argon Line (A_016)	95 PSIA \pm 2
- 36 Select 'Continue'.

C CONFIGURE VIDEO PATCHES

- 1 Connect VIP patch cords
- 2 J to 2
- 3 W to 8
- 4 L to 1
- 5 S to 14
- 6 Connect VIP terminators to patch point T, X.
- 7 Select MON CH-4.

D GC WARM-UP

NOTE

GC Power-Up must be complete before beginning GC Warm-Up. May perform FO-37 and FO-38 A while waiting for this message.

- 1 ✓ Status Msg: GC Power-Up Complete
- 2 *PGSC GC CARRIER GAS STABILIZATION*
- 3 Select 'Continue'.
- 3 ✓ GC Carrier Gas Stabilization timer window closes
- 4 Restore Gas Chromatograph window.

PGSC GAS CHROMATOGRAPH

- 5 Select 'WarmMethod'.
- 6 ✓ GC Warm-Up Timer window appears

NOTE

GC Warm-Up will proceed for approximately 10 minutes.

E MFC WARM-UP COMPLETION

- 1 ✓ Status Msg: MFC Warm-Up Complete
- 2 *PGSC MFC WARM-UP TIMER*
- 2 Select 'continue' on the MFC Warm-Up Timer window.
- 3 ✓ MFC Warm-Up Timer window closes

NOTE

GC Warm-Up must be complete before beginning GC Calibration (FO-19).

Appendix D

Water Mist

Procedure Sample of a Change File

EMS INTEGRATION

A

MIST EMS PREPARATION

NOTE

Steps A.1 to A.7 and A.15 to A.21 require two crew members.

- 1 Unstow ~~from foam~~ Mist Experiment Mounting Structure (EMS).
- 2 Place foam inserts (2) inside top and bottom half of foam cutouts and return foam to stowage.
- 3 Rotate EMS so the front plate will go into chamber first.
- 4 Depress EMS locking buttons (2 on back of EMS).
- 5 Align EMS with chamber rails.
- 6 Slide EMS into chamber until it hits reverse insertion stops.
- 7 Release EMS locking buttons (2 on back of EMS).
- ~~5~~ Remove, discard Kapton tape from around vent port plug and vent port plug retaining clip.
- 8 Remove, discard Kapton tape from muffler (free exit) on recirculation pump.
- 9 Remove, stow cap from muffler (free exit) on recirculation pump.
- 10 Remove, discard Kapton tape from teflon tubing between SV07 and atomizer head.
- 11 Make sure water line quick disconnect is secure.
- 12 Make sure coaxial cable to atomizer head is secure.
- PLACE HOLDER:**
- 13 Exercise PROPANE (PR01) and AIR (PR02) REGULATORS (3/4 turn cw, 3/4 turn ccw).
- 14 **OPEN** MV01 (1/4 turn CCW). Valve should point in the direction of flow.
- 15 **OPEN** MV02 (1/4 turn CW). Valve should point in the direction of flow (towards blue regulator cap).
- 16 Depress EMS locking buttons (2 on back of EMS).
- 17 Slide EMS all the way from chamber.
- 18 Release EMS locking buttons (2 on back of EMS).
- 19 Rotate EMS 180°. (Back plate will go into chamber first).
- 20 Depress EMS locking buttons (2 on front of EMS).
- 21 Align EMS with chamber rails.
- 22 Slide EMS to limit line indicated on the guide rails (~halfway).
- ~~3~~ 23 Remove, discard Kapton tape from EMS grounding strap.
- ~~4~~ 24 Remove, discard Kapton tape from gunbolt handles (2).
- ~~12~~ Remove, discard Kapton tape from GC sample line.
- ~~8~~ 25 Verify atomizer head WMC-7300 installed in EMS.

B

MIST EMS INSTALLATION

CAUTION

TO PREVENT HARDWARE DAMAGE, DO NOT BUMP/HIT CHAMBER O-RING DURING EMS INSTALLATION.

NOTE

Steps A.1 to A.3 require two crew members.

- ~~4~~ Depress EMS locking buttons (2 on front of EMS).
- ~~2~~ Align EMS with chamber rails and slide EMS to limit line indicated on guide rails.
- ~~3~~ Release EMS locking buttons (2 on front of EMS).
- ~~4~~ 1 Unstow 5-mm L-shaped Hex Wrench.
- ~~5~~ 2 Unstow 5/32-in. Hex Head Driver.
- ~~6~~ 3 Unstow 1/4-in. Driver Handle.
- ~~7~~ 4 Don Anti-static Wrist Tether.
- ~~8~~ 5 ✓ Properly grounded
- ~~10~~ 6 Loosen EMS grounding bolt using 5/32-in. Hex Head Driver with 1/4-in. Driver Handle.
- ~~11~~ 7 Remove grounding strap from EMS grounding bolt.
- ~~9~~ 8 Loosen grounding bolt (top of chamber instrumentation ring) using 5-mm L-shaped Hex Wrench.
- ~~12~~ 9 Connect and tighten instrumentation side grounding strap to bolt using 5-mm L-shaped Hex Wrench.
- ~~13~~ Remove GC sample line from retaining clip on EMS (labeled "GC").
- 10 Remove, discard Kapton tape from GC sample line.

CAUTION

WHEN CONNECTING GC SAMPLE LINE, KNURLED FITTING WILL COME LOOSE IF TURNED CCW. BE SURE TO TURN KNURLED FITTING CW TO PREVENT IT FROM GETTING LOST IN CHAMBER.

NOTE

Be sure to position the GC sample line so it does not conflict with the grounding strap.

- 14 11 Connect GC sample line to GC port on instrumentation ring. Place sample line to right of iris assembly. When engaged, turn knurled fitting on GC sample line CW until tight.
- 15 Remove vent line fitting from retaining clip on EMS (labeled "vent").
- 12 Remove, discard Kapton tape from vent line fitting.
- 16 13 Insert EMS vent line fitting into instrumentation ring fill/vent port (fill/vent port hole lies above the gun bolt at top of instrumentation ring). Vent line fitting should slide into place.

NOTE

While sliding EMS into chamber, watch GC sample line connection to make sure it does not loosen if bumped by the other lines.

- 17 14 Depress EMS locking buttons (2 on front of EMS).
- 18 15 Slowly insert EMS into chamber far enough that the unconnected end of grounding strap is able to reach ground lug on EMS-EMS grounding bolt.
- 19 16 Release EMS locking buttons (2 on front of EMS).
- 20 17 Connect grounding strap to EMS using 5/32-in. Hex Head Driver with 1/4-in. Driver Handle.
- 21 18 Depress EMS locking buttons (2 on front of EMS).
- 22 19 Slowly insert EMS completely into chamber making sure that fluid hoses-lines do not pinch.
- 23 20 Release EMS locking buttons (2 on front of EMS).
- 25 21 ✓ Gun Bbolts (tapered end) aligns with mating holes (2)
- 24 22 Engage gun bolts (2).
- 26 23 Connect Data harness to instrumentation ring (single line).
- 27 24 Connect Power harness to instrumentation ring (double line).
- PLACE HOLDER:
- 28 25 ✓ Indicator (blue) on connector plugs (2) properly aligned
- 29 26 Remove Anti-static Wrist Tether.
- 30 27 Stow 5-mm L-shaped Hex Wrench.
- 34 28 Stow 5/32-in. Hex Head Driver.
- 32 29 Stow 1/4-in. Driver Handle.
- 33 30 Verify atomizer switch settings using the table below (UP=ON, DOWN=OFF).

CAUTION

TO AVOID DAMAGING ATOMIZER HEAD, FOLLOW THE BELOW SETTINGS CAREFULLY.

SERIAL NO.	SW1	SW2	SW3	SW4	SW5	SW6	SW7
WMC-7300	DOWN	DOWN	DOWN	DOWN	UP	DOWN	UP

NOTE

SW8 should always be in the UP position.

C**CLOSE CHAMBER**

- 1 Perform CM2-1b "CHAMBER ACCESS" (cue card).

MIST START-UP**A****VERIFICATION****NOTE**

Ensure that each of the following circuit breakers (cb) are positioned properly.

- 1 Unstow FSP Torque Tool.
- 2 ✓ cb DC 1, 2, 3 (3) - **ON**
- 3 ✓ cb DC UTIL PWR - **ON**
- 4 Turn cb DC 4 **ON**.

NOTE

Ensure that each of the following valves are positioned properly.

- 5 ✓ CHAMBER ISO valve - **CLOSED**
- 6 ✓ VACUUM VENT valve - **OPEN**
- 7 ✓ EXPERIMENT VENT valve - **OPEN**
- 8 ✓ CLEAN-UP LOOP valve - **CLOSED**
- 9 ✓ ETHYLENE ISO valve - **CLOSED**
- 10 ✓ PROPANE ISO valve - **CLOSED**
- 11 ✓ HELIUM REGULATOR valve - **FULLY DECREASED (CCW)**
- 12 ✓ ARGON REGULATOR valve - **FULLY DECREASED (CCW)**
- 13 ✓ SUPPLY HEADER VENT valve - **OPEN**
- 14 ✓ PROPANE valve - **CLOSED**
- 15 ✓ HELIUM valve - **CLOSED**
- 16 ✓ ARGON valve - **CLOSED**
- 17 ✓ ETHYLENE valve - **CLOSED**
- 18 ✓ REGULATED AIR valves (2) - **CLOSED**
- 19 ✓ AIR REGULATOR valve - **FULLY DECREASED (CCW)**
- 20 ✓ OLIC AIR valve - **CLOSED**
- 21 ✓ AVIONICS AIR valve - **CLOSED**
- 22 ✓ SB01 through SB14 valves (14) - **CLOSED**
- 23 ✓ CHAMBER FILL/VENT valve - **OPEN**
- 24 ✓ GC ISO valve - **OPEN**
- 25 ✓ MON CH SEL - **OFF 5**
- 26 ✓ OLIC AIR SWITCH - **DISABLED**
- 27 ✓ IGNITOR SWITCH - **DISABLED**

B**ACTIVATION**

- 1 Turn PGSC Power **ON**.

PGSC DESKTOP

- 2 Double click on **Crew-Interface-COMBUSTION MODULE-2** icon on PGSC desktop.
- 3 ✓ COMBUSTION MODULE - 2 CREW INTERFACE screen appears
- 4 Turn **cb-CB 1 ON**.
- 5 Wait 5 seconds, then turn SW 1 **ON**.
- 6 ✓ DEPP STAT blink code (1 second - ON, 1 second - OFF)
- 7 Select '**openCom**'.
- 8 ✓ Status Msg: Communications Port Open**ed**
- 9 Select '**chkHealth**'.

PGSC DEPP HEALTH STATUS

- 10 ✓ No error messages or stop signs appear
- 11 Select '**ok**'.
- 12 Select '**syncTime**'.
- 13 ✓ Time display: GMT = DDS GMT (± 5 seconds)
- 14 Turn **cb-CB 2, 3, and 4 ON**.
- 15 Wait 5 seconds, then turn SW 2, 3, and 4 **ON**.

- 16 Select 'System' \ 'Experiment' \ 'Mist'.
- 17 Select 'Yes'.
- 18 ✓ EMS: Mist
- 19 **ENABLE IGNITOR SWITCH.**
- 20 Select 'OpMode' / 'Mist'.
- 21 Select 'PwrUp'.
- 22 ✓ MFC Warm-Up Timer window appears

NOTE

MFC Warm-Up will continue for approximately 30 minutes. [Continue through Step D of this FO and stop at Step E until MFC Warm-Up complete.](#)

- 23 ✓ Status Msg: Power-Up Complete (up to 4 minutes)
- 24 ✓ **PowerMode**: Full
- 25 Enable Exception Monitoring:
Place Holder for Exception Monitoring Command String
Place Holder for Exception Monitoring Command String
- 26 Select '~~Gas~~-Chromatograph'.

PGSC GAS CHROMATOGRAPH

- 27 Select 'GC~~PwrUp~~'.
- 28 ✓ GC Carrier Gas Stabilization timer window appears

NOTE

GC Power-Up will continue for approximately 20 minutes. Continue through Step C [of this FO and stop at Step D until GC Power-Up complete.](#)

- 29 Select 'SetGCReg'.
- 30 **OPEN ARGON valve.**
- 31 **OPEN HELIUM valve.**

CAUTION

DO NOT EXCEED 97 PSIA WHILE ADJUSTING THE HELIUM AND ARGON REGULATOR VALVES. OVER PRESSURIZATION AND/OR DELAY IN MISSION TIMELINE MAY OCCUR.

NOTE

Once regulator deadband is reached, the PSIA will increase approximately 40 PSIA per turn. There will be an approximate four second delay between regulator action and PGSC display response. The alarm triggers at 102 PSIA, the overpressure valve relieves at 105 PSIA.

- 32 Rotate HELIUM REGULATOR valve CW to deadband (approximately 5 turns).
Adjust until H016 = 95 PSIA ± 2.
- 33 Rotate ARGON REGULATOR valve CW to deadband (approximately 5 turns).
Adjust until A016 = 95 PSIA ± 2.

PGSC GC REGULATOR PRESSURE

- 34
- 35 ✓ Display Values:

<u>Transducer</u>	<u>PSIA</u>
Helium Line (H_016)	95 PSIA ± 2
Argon Line (A_016)	95 PSIA ± 2
- 36 Select 'Continue'.
- 37 [Minimize Gas Chromatograph window.](#)

C CONFIGURE VIDEO PATCHES

- 1 [Unstow 4 patch cords and 2 terminators.](#)
- ~~4~~ 2 Connect VIP patch cords
 - ~~2~~ J to 2
 - ~~3~~ W to ~~8~~-12
 - ~~4~~ L to 1
 - ~~5~~ S to 14
- ~~6~~ 3 Connect VIP terminators to patch point T, X.
- ~~7~~ 4 ✓ ~~Select~~ MON CH [SEL-4-5](#).

Appendix E

NASA's Rules for Specifications Sample

4.2.2 Symbols.

- a. The only symbols normally used in text are “+”, “-”, “+/-”, to express ranges or tolerances, the degree symbol, and metric symbols, such as “mm” and “mg”.
- b. Other symbols may be used in equations and tables and shall be in accordance with IEEE 260.
- c. Graphic symbols, when used in figures, shall be in accordance with Department of Defense (DoD) adopted standards.
- d. Any symbol formed by a single character should be avoided if practicable, since an error destroys the intended meaning.
- e. Metric symbols need not be spelled out. The symbols for physical quantities (both metric and inch-pounds), which are often thought of as abbreviations, may be used in accordance with FED-STD-376.

4.2.3 Proprietary names.

- a. Trade names, copyrighted names, or other proprietary names applying exclusively to the product of one company shall not be used unless the item(s) cannot be adequately described because of the technical involvement, construction, or composition.
- b. In such instances, one, and if possible, several commercial products shall be included, followed by the words “or equal” and a description of the required salient features or particular characteristics to ensure wider competition and that bidding will not be limited to the particular make specified. The same requirement applies to manufacturer’s part numbers or drawing numbers for minor parts when it is impracticable to specify the exact requirements in the specification.
- c. The salient features or particular characteristics required to define “or equal” shall be included.

4.2.4 Commonly used words and phrases.

Certain words and phrases are frequently used in a specification. The following rules shall be applied:

- a. Applicable documents shall be cited as follows:
 - (1) “conforming to . . .”
 - (2) “as specified in . . .” or
 - (3) “in accordance with . . .”
- b. “Unless otherwise specified” shall be used to indicate an alternative course of action. The phrase shall always come at the beginning of the sentence, and if possible, at the beginning of the paragraph. This phrase shall be used only when it is possible to clarify its meaning by providing a reference, such as to section 6 of the specification, for further clarification in the contract or order or otherwise.

- c. When making reference to a requirement in the specification and the requirement referenced is rather obvious or not difficult to locate, the simple phrase “as specified herein” is sufficient and may be used.
- d. The phrase “. . . to determine compliance with . . .” or “. . . to determine conformance to . . .” should be used in place of “. . . to determine compliance to . . .”. In any case use the same wording throughout.
- e. In stating limitations, the phrase shall be stated thus: “The diameter shall be no greater than . . .” for a maximum limit or, “The diameter shall be no less than . . .” for a minimum limit.
- f. “Shall,” the emphatic form of the verb, shall be used throughout the specification sections 3, 4, and 5 whenever a requirement is intended to express a provision that is binding. For example, state a requirement as “The indicator shall be designated to indicate . . .” Or in the section containing test provisions “The indicator shall be turned to zero and 230 volts alternating current applied.” For specific test procedures, the imperative form may be used provided the entire method is preceded by “the following test shall be performed,” or related wording. Thus, “Turn the indicator to zero and apply 230 volts alternating current.”
- g. Capitalize the words “drawing,” “bulletin,” etc., only when they are used immediately preceding the number of a document. However, Federal and military standards, and handbooks shall be identified in the text only by their symbol and number; thus “MIL-E-000,” not, “specification MIL-E-000.”
- h. Use “should” and “may” wherever it is necessary to express nonmandatory provisions. “Will” may be used to express a declaration of purpose on the part of the contracting agency. It may be necessary to use “will” in cases where the simple future tense is required, i.e., power for the motor will be supplied by the ship.
- i. The term “flammable” shall be used in lieu of the term “inflammable,” and “nonflammable” shall be used in lieu of “unflammable,” and “noninflammable.”
- j. Indefinite terms, such as “and/or,” “suitable,” “adequate,” “first rate,” and “best possible” shall not be used. Use of “e.g.,” “etc.,” and “i.e.,” should be avoided.

4.2.5 Use of decimals.

Decimals shall be used in documents instead of fractions wherever possible.

4.2.6 Metric practices.

Metric practices shall conform to ASTM E380 and IEEE 268.

4.2.6.1 Metric units

The metric units for commonly used quantities shall be in accordance with FED-STD-376. Metric sizes will generally be expressed in whole numbers. There shall be no soft conversion of units merely for the sake of conversion. In those instances where an inch-pound item is the primary item in the international marketplace, a document with soft conversion of units can be prepared.

4.2.6.2 Dual dimensions.

The use of both metric and inch–pound measurements on drawings or other pictorial illustrations to be used in a specification shall be avoided. The use of tables to translate the specific inch–pound used to metric equivalents is acceptable. For text material, when preference is given in the specification to inch–pound units, acceptable metric units may be shown in parentheses. When preference is given to metric units, inch–pound units may be omitted or included in parentheses. In general, where it has been the standard practice to cite metric units alone (such as citing temperatures only in degrees Celsius), inch–pound equivalents may be omitted. In a specific repetitive equivalent, for example 1.00 inch, the “(25.4 mm)”, need be inserted only the first time it appears in a paragraph of a specification.

4.2.7 Underlining.

- a. Portions of paragraphs shall not be underlined and words or phrases not be capitalized for the sake of emphasis with the exceptions identified within this standard.
- b. Paragraph titles and table and figure identifications may be underlined.
- c. Preambles and acquisition notes shall not be underlined.

4.2.8 Paragraph numbering.

- a. Paragraph numbering shall be limited to seven levels.
- b. Each paragraph shall be numbered sequentially within each section of the specification, using a period to separate the number representing each breakdown.
- c. Itemization within a paragraph or subparagraph shall be identified by lowercase letters followed by a period.

An example format is given below. Alternate formats are acceptable provided paragraph numbers, titles, and content are not changed.

EXAMPLE:

“3. REQUIREMENTS

“3.1 First paragraph. Indented with the paragraph numbers aligned and text wrapped to the margins.

“3.1.1 First subparagraph. Indented with the paragraph numbers aligned and text wrapped to the margins.

“3.2 Second paragraph. Indented with the paragraph numbers aligned and text wrapped to the margins.

“3.2.1 First subparagraph. Indented with the paragraph numbers aligned and text wrapped to the margins.

“3.2.2 Second subparagraph. Indented with the paragraph numbers aligned and text wrapped to the margins.

- a. Item 1.
- b. Item 2.
- c. Item 3. These paragraphs shall be aligned under the first character of the preceding paragraph and may wrap to the left margin.

“A. APPENDIX A

“A.3 REQUIREMENTS

“A.3.1 Paragraph one.

“A.3.2 Paragraph two.”

4.2.9 Paragraph identification.

- a. Each paragraph and subparagraph shall be given a subject identification.
- b. The first letter of the first word in the subject identification shall be capitalized.
- c. The subject identification text may be written in title format.
- d. If there is no requirement pertinent to a paragraph, then one of the following shall appear below the paragraph and heading:
 - (1) ”Not applicable.”
 - (2) ”This paragraph is not applicable to this specification.”
 - (3) ”This paragraph is not applicable for this specification.”

4.2.10 Page layout.

- a. Specifications shall be generated so that they may be placed onto 8.5 by 11 inch paper.
- b. Title pages shall be laid out as specified in 4.2.17.
- c. Paper copies of specifications shall have one–inch margins on the left and right, a one–inch header, and a one–inch footer.
- d. The specification identifier shall be placed on each page, at the upper left corner of each page.
- e. The date of the specification, as of the latest revision, shall be in the upper right corner within the header of each page.
- f. Text and appendixes pages, beginning with 1.0 Scope, shall be sequentially numbered with Arabic numerals and centered within the footer.
- g. Introduction pages of the document, which includes the title, table of contents, etc., shall be sequentially numbered with lower case Roman numerals centered within the footer.

Appendix F

Eedited Specification

Sample

1.1.1 Physical characteristics.

1.1.1.1 CIR dimensional characteristics.

1.1.1.1.1 CIR launch envelope.

The CIR in launch configuration shall not exceed the envelope as specified in SSP 41017, Part 1, paragraph 3.2.1.1.2.

1.1.1.1.2 CIR on-orbit envelope.

The CIR, with applicable PI hardware, shall have an on-orbit envelope as specified in SSP 41017, Part 1, paragraph 3.2.1.1.2 and shall follow the on-orbit payload protrusion requirements as specified in SSP 57000, paragraph 3.1.1.7. (See Appendix H ~~to~~for exceptions to this requirement.)

1.1.1.1.3 CIR stowage volume.

The CIR, with applicable PI hardware, shall not exceed a stowage volume of 1 standard rack equivalent.

1.1.1.1.4 CIR maintenance item stowage.

The CIR maintenance items shall not exceed a volume of 1/3 standard rack equivalents.

1.1.1.2 CIR weight characteristics.

- The CIR shall not exceed a launch mass of 804.2 kg (1773 lbs) ~~launch mass~~, excluding stowage hardware.
- The CIR, with applicable PI hardware, shall not exceed an on-orbit mass of 804.2 kg (1773 lbs) ~~on-orbit mass~~, excluding stowage hardware. (See Appendix H ~~to~~for exceptions to this requirement.)
- CIR spares and resupply equipment shall not exceed an up-mass of 125 kg (275 lbs) ~~up-mass~~.

1.1.1.3 CIR power.

- The CIR, with applicable PI hardware, shall have the capability to use a maximum of 6,000 W of power.
- The CIR, with applicable PI hardware, when integrated into the FCF, shall not exceed a power draw of 2,000 W.

1.1.1.3.1 CIR environmental control system power allocation.

The CIR environmental control system power allocation shall not exceed, over a period of 30 minutes, 30 W or 8% of the input power to the CIR, ~~over a thirty minute period~~, whichever is greater.

1.1.1.3.2 CIR power to PI avionics.

The CIR shall provide a minimum of ~~two~~ 2 channels of 8A, 28 Vdc power for PI avionics.

1.1.1.3.3 CIR power to PI hardware inside combustion chamber.

The CIR shall provide ~~three~~ 3 channels 4A, 120 Vdc, ~~4A~~ and ~~two~~ 2 channels 8A, 28 Vdc, ~~8A~~ power to operate experiments within the combustion chamber.

1.1.1.4 CIR heat rejection.

The CIR shall have the capability to reject a maximum of 6,000 W of power.

1.1.1.5 PI avionics cooling air.

The CIR shall provide a minimum of 450 W air cooling to PI avionics.

1.1.1.6 Thermal cooling water.

The CIR, with applicable PI hardware, shall be capable of providing thermal water cooling with a minimum inlet temperature of 16.1°C (61.0°F) and ~~an~~ a maximum outlet temperature ~~not to exceed~~ of 48.9°C (120°F).

1.1.1.6.1 Thermal water cooling inside combustion chamber.

The CIR, with applicable PI hardware, shall be capable of providing thermal water cooling to the interior of the combustion chamber at a minimum of 500 W capacity with a minimum inlet temperature of 16°C (60.8°F) and ~~an~~ a maximum outlet temperature ~~not to exceed~~ of 49°C (120°F).

1.1.1.7 Durability.

- a. The CIR shall be designed to have a minimum operational life of ~~ten~~ 10 years after full deployment of the FCF, including regular scheduled and unscheduled maintenance activities.
- b. The CIR shall be designed to be capable of an extended life to ~~fifteen~~ 15 years after full deployment, including regular scheduled and unscheduled maintenance activities and major component replacement.

1.1.1.8 Transportation and safety requirements.

This ~~section~~-~~paragraph~~ is covered in ~~sections~~-~~paragraph~~ 3.2.7 and ~~section~~ 5.0.

1.1.1.9 Interfaces.

The CIR, with applicable PI hardware, shall interface with the ISS and CIR internal assemblies in accordance with paragraph 3.1.5.

1.1.1.9.1 Ground Support Equipment (GSE) interfaces.

- a. The CIR shall interface to the Kennedy Space Center (KSC) GSE Rack Insertion Device in accordance with SSP 41017 Part 1, paragraphs 3.2.1.1.2 ~~Static Envelope, and~~ 3.2.1.4.3 ~~Interface Loads~~, and SSP 41017 Part 2, paragraphs 3.3.2 ~~Upper Attachment Interfaces~~ and 3.3.3 ~~Ground Handling Attachment Interfaces~~.
- b. The CIR shall interface to Rack Shipping Containers in accordance with the Teledyne Brown Engineering (TBE) as-built drawing 220G07500.
- c. The CIR shall interface to Rack Handling Adapters (RHA) in accordance with the following TBE as-built drawings: 220G07455 ~~Upper Structure~~, 220G07470 ~~MSFC Lower Structure~~, and 220G07475 ~~KSC Lower Structure~~.
- d. The CIR shall be limited to ground transportation accelerations of 80% of flight accelerations defined by SSP 41017 Part 1, paragraph 3.2.1.4.2.

1.1.1.9.2 MPLM interfaces.

- a. The CIR shall interface to the MPLM structural attach points in accordance with SSP 41017 Part 2, paragraph 3.1.1.
- b. The CIR shall maintain positive margins of safety for MPLM depress rates of 890 Pa/~~second~~ (7.75 psi/min~~ute~~) and repress rates of 800 Pa/~~second~~ (6.96 psi/min~~ute~~).
- c. The CIR shall be limited to producing interface attach point loads less than or equal to those identified by SSP 41017 Part 1, paragraph 3.2.1.4.3, based upon an acceleration environment as defined in SSP 41017 Part 1, paragraph 3.2.1.4.2.

1.1.1.9.3 COF interfaces.

The CIR shall be capable of interfacing with the COF for structural, fluids, and electrical connections, but shall not be required to meet any of the performance requirements and physical requirements unless otherwise specified in SSP 57000.

1.1.2 Reliability.

Not ~~Applicable~~applicable.

1.1.3 Maintainability.

The CIR shall not exceed TBD on-orbit mean maintenance crew hours per year (MMCH/Y) ~~on-orbit~~ for scheduled and unscheduled maintenance activities including inspections, preventative and corrective maintenance, restorations, and replacement of assemblies and components.

1.1.3.1 CIR maintenance access.

The CIR shall ~~be designed to~~ allow for the replacement of ~~Orbital Replacement Units~~ (ORU's) and failed components, and the performance of other internal maintenance activities without rotating the CIR from its installed position within the US Lab. (See Appendix H ~~to for~~ exceptions to this requirement.)

1.1.3.2 Maintenance item temporary restraint and stowage.

CIR maintenance items shall ~~be designed to~~ allow for temporary restraint and/or stowage during maintenance activities.

1.1.3.3 Tool usage for maintenance.

The CIR shall be designed to be maintained using the ISS tools as defined in SSP 57020.

1.1.3.4 Lockwiring and staking.

All CIR maintenance items shall not be lockwired or staked during installation.

1.1.3.5 Redundant paths.

The CIR, with applicable PI hardware, shall ~~be designed to~~ provide for alternate or redundant functional paths of all electrical and electronic harnesses that cannot be replaced on-orbit.

1.1.3.6 CIR reconfiguration for out-of tolerance conditions.

The CIR, with applicable PI hardware, shall ~~be designed to~~ allow visual and tactile access to all avionics hardware for at least one hour during troubleshooting operations without detrimental effects to the crew, the ISS, or CIR hardware ~~for at least one hour during trouble shooting operations~~.

Page: 52

[\[SA1\] It seemed like words were missing here. I'm not sure if my suggestion changes the sentence's meaning.](#)

Page: 53

[\[SA2\] I'm just putting these in the same order listed in the previous requirement: A then Vdc.](#)

Page: 55

[\[SA3\] I'm not sure this heading accurately reflects the content of the paragraph \(change 4.2.4.6 also\).](#)