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THE SHUTTLE MAIN ENGINE: A FIRST LOOK

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Introduction

Anyone entering the Space Shuttle Main Engine (SSME) team attends a two week course to become familiar with the design and workings of the engine. This course provides intensive coverage of the individual hardware items and their functions. Some individuals, particularly those involved with software maintenance and development, have felt overwhelmed by this volume of material and their lack of a logical framework in which to place it.

To provide this logical framework, it was decided that a brief self-taught introduction to the overall operation of the SSME should be designed. To aid the people or new team members with an interest in the software, this new course should also explain the structure and functioning of the controller and its software.

This paper presents a description of this presentation.

Development of the Presentation

Initially, this presentation was envisioned as a video tape, with diagrams, film clips, synchronized voice-over and text. Not only was this overly ambitious for the 10 week period, it was discovered that there is an extensive protocol at Marshall Space Flight Center for gaining approval for the production of video tapes. In part, the approval depended on a demonstration of need and cost effectiveness. It was decided, therefore, to utilize one of the computer accessible packages to produce a product accessible wholly by computer. Microsoft's PowerPoint, being available, was used.

To produce the presentation, it was necessary first, to learn the general function of the main engine systems. Then, to organize the presentation of the systems, acquire and prepare the necessary diagrams and assemble the text. This had to be done in spiral mode as the preparation of the presentation inevitably prompted technical questions which required clear answers which then required modification of the presentation.

The learning phase, itself, was spiral and lasted 5 to 6 weeks. Initially, written documentation was studied [1, 2 and 3]. Then various engineers were consulted. The consultations provided better understanding and perspective so that more could be gained from the documentation..

As knowledge was gained, the layout of the presentation was prepared, modified and eventually finalized.

Many of the images used were found in the written documentation. While they could have been scanned in from this documentation, improved quality was obtained in images provided by Rockwell International. The photographic

images were obtained from various Internet sources, including NASA's Spacelink, and from captured video tape images.

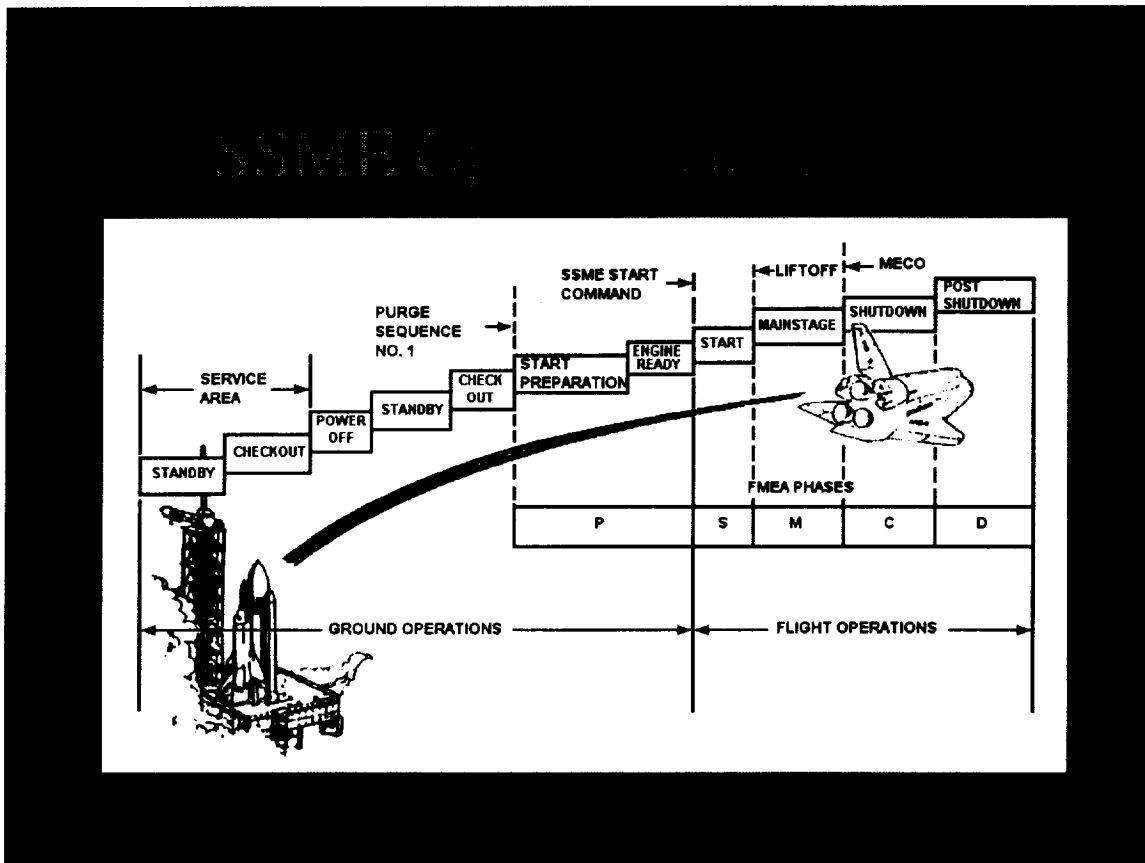


Figure 1. An image that was redrawn at the bit level for a clearer image.

The bit mapped line drawings, see Figure 1, were first cleaned up to sharpen lines and remove speckles. Color was then added to one of those diagrams to show various stages of the fluid flow, see Figures 2 and 3, and to highlight and identify the major parts being discussed. The PowerPoint package provided pleasing background color for the monochromic images.

Text was added to the sequenced images, sometimes as text only slides, to provide explanation of the image being presented. This text is written largely in outline form, but, where necessary, additional discussion is provided, as shown in Figure 3.

Oxidizer Flow Cont'd

- A last branch
 - supplies LOX (11%) to the preburner oxidizer boost pump located at the bottom of the HPOTP.

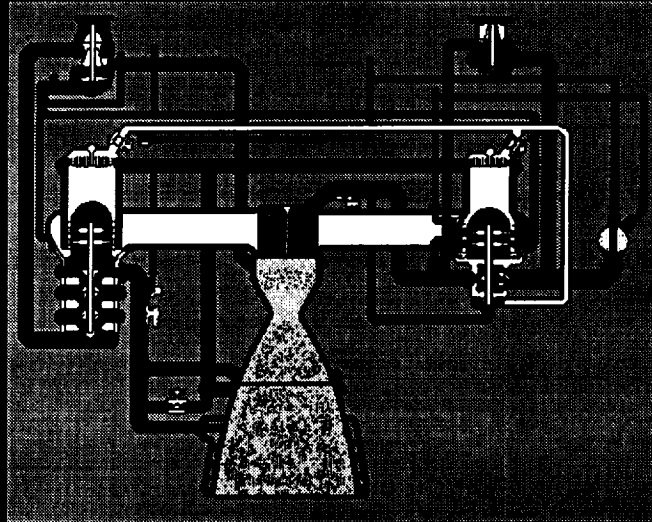


Figure 2. Shows flow of oxygen to the boost pump located at the bottom of the high pressure oxidizer turbopump.

Conclusion

The finished presentation comprises 118 computer screens or slides. Typically, while self-paced, it takes about 3 hours to view.

Extensions

It would be useful to add comments to a number of the slides, both as note pages and as audio. There is also a need for more extensive and detailed discussion of the software, which would in effect turn the presentation into a course which introduces the software.

The presentation could also be converted for inclusion as a section of the NASA homepage on the World Wide Web.

The presentation also demonstrates that a fully animated video tape showing the flow would be more meaningful.

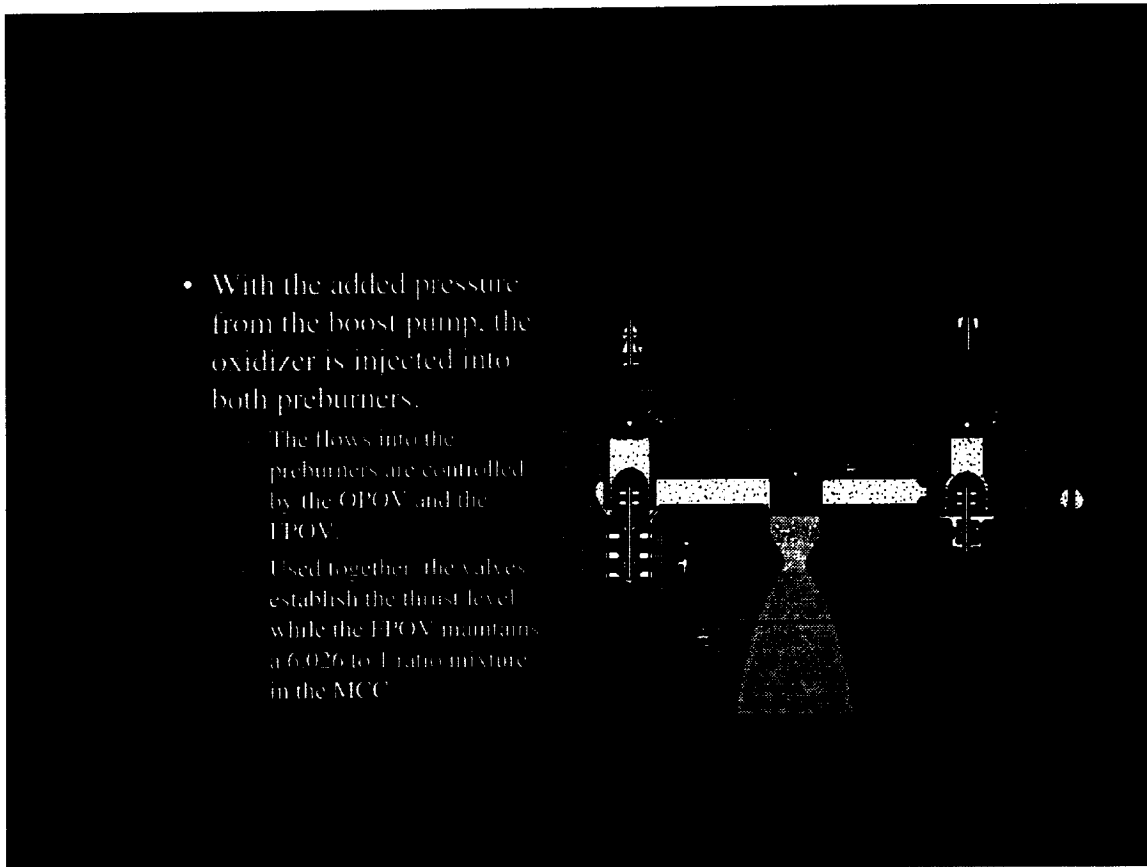


Figure 3. Shows the oxygen flow into the preburners.

Acknowledgements

Thanks to Charles Nola who presented me with this topic, Dave Wilson who spent time explaining the workings of the engine, Amy Hardy of Intergraph who helped me scan images and edit them, and the people at Rocketdyne in the HSL who helped with the details on the Controller software.

References

1. Space Shuttle Main Engine Block II Controller Software Design, Rockwell International Corporation, CP406R0022D Part II, February, 1994.
2. Space Transportation System Technical Manual, SSME Description and Operation, Rockwell International Corporation, E41000, RS-8559-1-1-1, August, 1991.
3. Consultations with engineers at MSFC on the software and hardware.