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VERIFICATION OF LM AGS RENDEZVOUS NAVIGATION USING AUTOMATIC DATA FOR APOLLO 15

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Mathematical Physics Branch

MISSION PLANNING AND ANALYSIS DIVISION



MANNED SPACECRAFT CENTER
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PROJECT APOLLO

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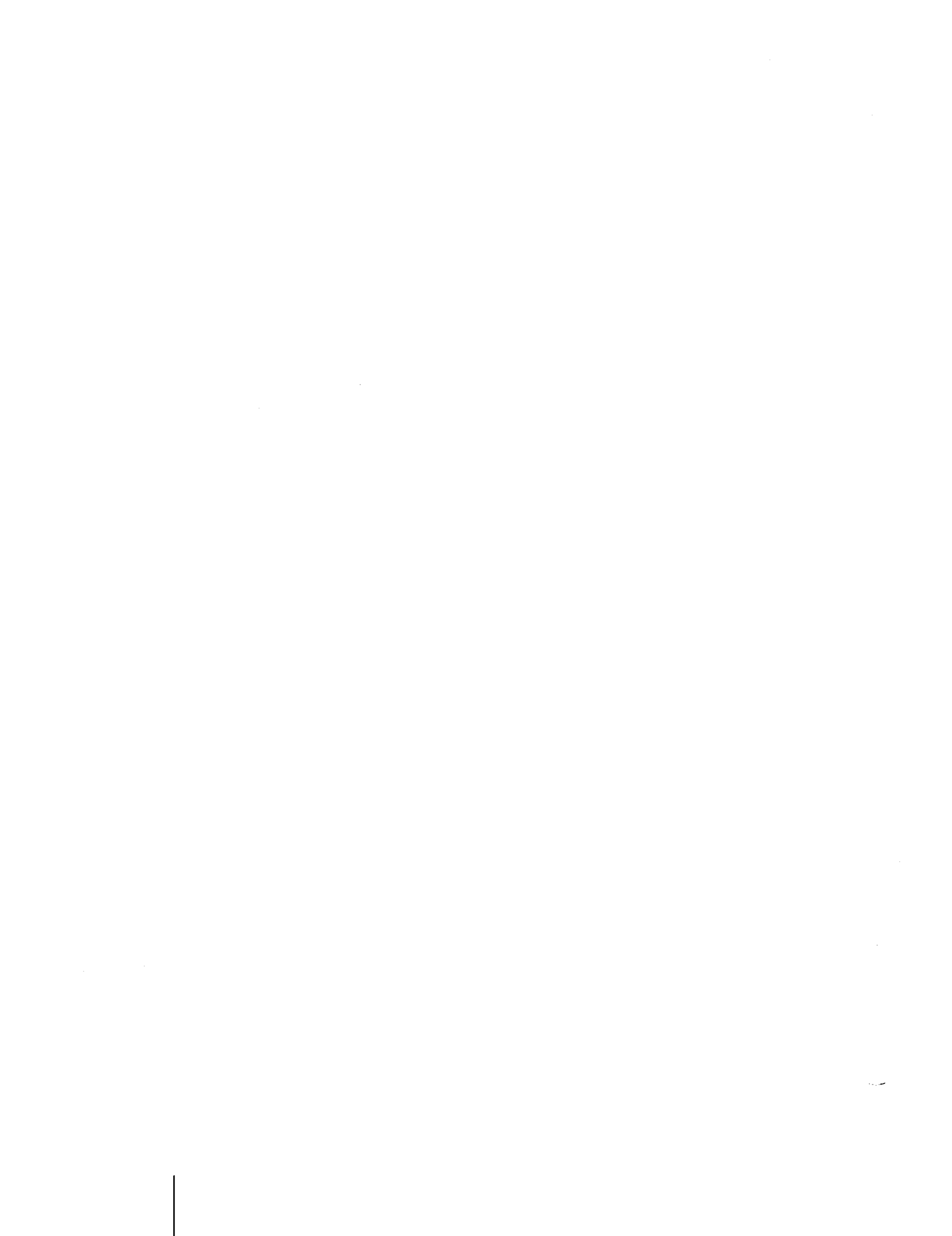
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June 30, 1971

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VERIFICATION OF LM AGS RENDEZVOUS NAVIGATION

USING AUTOMATIC DATA FOR APOLLO 15

By Arland L. Actkinson

SUMMARY

It has been verified that the abort guidance system (AGS) FP-8 navigation radar filter using automatic observation processing has been correctly programed in the onboard ROPES for Apollo 15.

INTRODUCTION

The abort guidance system, a computer system on board the lunar module (LM), is designed to support a rendezvous of the LM with the command and service module (CSM) in the event of the failure of the primary guidance, navigation, and control system (PGNCS). This internal note shows how the navigation filter of the onboard computer using automatic data was demonstrated to have been programed correctly.

ANALYSIS

The AGS is a system designed to support rendezvous in the event of the failure of the PGNCS. Both systems are on board the LM. Since the AGS was created for emergency use, its design is much simpler than that of other guidance and navigation systems, and, with the exception of alinements, no hardwire connection exists between the PGNCS and the AGS.

The AGS flight program 8 (FP-8) navigation filter is derived and explained in reference 1. Briefly, in automatic observation processing, range and range rate observations are taken from the PGNCS downlist, and angle data are taken from the downlist and from the AGS platform. At 16-second intervals, the AGS updates the error covariance matrix, which contains the estimate of the error in position and velocity. Observations are incorporated at the end of the 2-second interval in which they are made. The AGS filter is a Kalman filter, although a variety of simplifications have been required as a result of computer space limitations.

The LM AGS Interpretive Computer Simulation/Flight Simulation (ICS/FS) described in reference 2 is a bit-by-bit simulation of the entire AGS. Using the actual onboard ROPES, the ICS/FS performance is the performance of the onboard AGS computer. Another simulation, AGSIM, described in references 3, 4, and 5, was used to examine the ICS/FS performance. By comparing the results of this engineering simulator with the results of the ICS/FS program, it is possible to determine if the onboard program is programed properly.

RESULTS

By the plan described previously, an ICS/FS simulation of a portion of the Apollo 15 rendezvous was duplicated using the AGSIM program (ref. 6). Two range observations, each followed by two range rate observations, were incorporated. The differences between the ICS/FS estimate of the state and the AGSIM estimate of the state in feet and feet per second are the following.

Mark	Position, ft			Velocity, fps		
	ΔX	ΔY	ΔZ	$\Delta \dot{X}$	$\Delta \dot{Y}$	$\Delta \dot{Z}$
1 (Range)	-444.3	56.1	-734.3	-0.135	-0.008	-0.205
2 (Range Rate)	-410.3	83.8	-732.0	0.349	0.028	-0.651
3 (Range Rate)	-619.9	-24.9	-847.7	0.328	-0.086	-0.895
6 (Range Rate)	-409.9	100.5	-856.7	1.056	0.112	0.264

On the basis of the comparisons, the radar filter of the AGS, FP-8, is considered verified for automatic observation processing.

CONCLUSION

It has been verified that the abort guidance system (AGS) FP-8 navigation radar filter using automatic observation processing has been correctly programed in the onboard ROPES for Apollo 15.

REFERENCES

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