Brissenden

SPACE FLIGHT SIMULATION

At this stop I would like to discuss space flight simulation. But, first, what is a simulator? A simulator is a facility which brings the essential features of a real-world situation or problem into the laboratory so that we can study it under controlled conditions.

There are several types of simulators. One type is what we call "environmental simulators." These study hardware problems. They are characterized by the fact that they try to duplicate the physical characteristi of our problems, such as vibration, pressure and temperature. Examples of these simulators are vacuum tanks or this new facility which you will see on your tour. Another type is what we call "manned flight simulators" and these are designed to study the human problems of how to manage and control our aircraft and space vehicles. In these simulators we try to duplicate those features of the environment which affect man's senses. By this I mean the things a pilot will feel or see such as the interior of his cockpit, his instruments, what he sees out the window, his accelerations and things like that.

Some flight simulators duplicate a vehicle or mission down to the smallest detail. This can be done generally only after the program has been almost fully developed. These sophisticated simulators are used for training. And we prefer to call them that—trainers. We like to reserve the term simulators for what we have here—basic research tools.

Every airplane mission or space mission is the sum of a great number of separate phases, each with its unique problems. For this reason simulators come in all shapes and sizes, from the smallest such as this simple chair and x-y plotter, which the pilot is using to fly a reentry trajectory, to this rudimentary centrifuge which is used to study how man might feel in a rotating space station.

Simulators can also be very complex such as this control center simulator where a number of people are involved and a large complex of computing equipment is necessary or, in something as equally complex—this supersonic transport simulator. Here we show the cockpit and you will be able to see the simulator later in your tour today.

The X-15 used more than 30 different simulators of one kind or another and in space flight we will probably use even more because of the exotic features of this new environment. What are some of these new features that we have to design into our space flight simulators? Well, one feature might be the blackness of space were the pilots or astronauts see nothing but the stars in the background and they will have to detect and steer towards a small blinking light in order for Gemini to dock with the Agena or to resupply a space station. I might mention that a duplicate of the blinking light we used in Gordon Cooper's Mercury experiment is flashing in the exhibit to your right. Another feature might be the emptiness of space where the astronauts will have nothing familiar around them to help them judge distance or closing speed when they dock. Or it might be the high accelerations of launch or reentry. Or the low acceleration on the moon where a vehicle or man has to tilt six times as far to move sideways at the same rate he does on earth.

Why are space flight simulators so necessary? In exploring the unknown only man can observe the unpredictable or react intelligently to the unexpected.

Not only do we need man in space as an explorer and observer but we should also need his capabilities in the management and control of our missions in order to improve our reliability and chances of success. This use of man has been well-demonstrated in the X-15 and Mercury programs. We need these simulators to study man's capabilities, to define them; and then, using this information, to learn how to design our space systems so that the man becomes an integral part of the mission. We have to study man not only under normal conditions but under every emergency condition that we can anticipate.

Now, I would like to describe some of our newer space flight simulators that you will see on your tour today at Langley. To do this I would like 8a to take you on an imaginary trip to the moon. As we come within about 200 miles of the moon we will use LOLA (Lunar Orbit Landing and Approach Simulator). We will sit in this cockpit, look out the windows and see before us the lunar surface just as the astronauts would see it as they approach the moon. We will control the spacecraft. These control motions will go through computers and drive cameras which are looking at these relief maps. There are four relief maps of larger and larger scale and these cameras will look at these maps, one after the other, pick up the visual scene and transmit it into the projection sphere. We will study with this facility the problems of achieving a parking orbit, the problems of how to initiate and control the powered descent to the surface, or, if something happens, how to abort and return safely. You will see LOLA under construction at one of the other facilities on your tour.

As we come close to the surface—within a few hundred feet—the astronauts may continue their landing, say, for example, into a large crater, or, if it turns out that they don't like that, they may stop and land short, or they may start a descent such as this and decide then they have to move and they will flare to a new position. In this kind of maneuvers, we will, of course, use our background experience of helicopter and VTOL research, but we also have to study these maneuvers under the unusual conditions that we will experience on the moon. For this we use the Lunar Landing Research Facility which is shown on this chart. Here we have a model and you will see the real thing later. The actual facility is 400 feet long, 250 feet high. The unique feature of the facility is the way in which it simulates lunar gravity. The way it does this is by sensing the weight of the vehicle and then pulling on the vehicle with this cable with 5/6ths of that weight, leaving 1/6th left over which is the weight of the vehicle on the moon. This 1/6th weight has to be counteracted by the rockets that are on the vehicle. At the same time, this overhead crane senses the motions of the vehicle and follows the vehicle around so that the cable always applies a simple vertical force. With this facility we will study some of these various techniques of landing on the moon.

The research vehicle that we use is shown here. It looks somewhat like a lunar lander but, of course, we will not have a helicopter canopy on the lunar lander because of the environmental situation. We put this on here simply because it gives us flexibility. We can mask off various parts of it to simulate various window arrangements. The rockets on this system—to control attitudes or motions—are also adjustable to various configurations so that we can study different vehicle dynamics. This flexibility is characteristic of all of our simulators so that they are not necessarily designed for one specific problem but can be adapted to a variety of problems.

Another approach to study of lunar landing uses a flight research vehicle, and you may see this described in the Flight Research Center exhibit on the other side of the hangar.

After we have landed we then, of course, must get out of our space vehicle and maneuver, walk around on the moon. You will see a demonstration of our Lunar Walking Simulator. I would just like to explain very briefly how this works. It's a very simple principle. We suspend a man by a harness so that he is essentially lying down. He has no force on his feet, so if you look in this direction he is under Zero-g. However, if we start pushing him away from the vertical, we eventually reach a point where the force on his feet is 1/6th-g, or the force that he would feel on the moon. Then by letting him walk back and forth or jump on this inclined platform we can study what would happen on the moon. We can study how to carry loads, how to climb, and how to operate in a pressure suit which is necessary in the vacuum on the moon.

After we have done this, we will get back into our spaceship and we will take off, and in the case of the Apollo mission we will rendezvous with the Apollo which remained in orbit. Take-off and rendezvous problems we study in this inflatable planetarium which are large words to describe a surplus DEW-line radar dome. This is a chart showing the same facility and you get some idea of the kind of equipment we use. We have cockpits, optical sights, star projectors, horizon projectors, and the like, and all these pieces of equipment are driven through a computer, which is behind this board over in that corner. After this talk is over you will have an opportunity to look through that door and see the equipment we are now using to study some of the current Gemini problems. Finally, we will dock. And the docking problems are studied by the Rendezvous Docking Simulator. This is a model of it. The actual simulator is behind you, hanging from the ceiling of the Hangar. We will show you this in operation at the end of this talk.

With this simulator we study how the astronauts can control their spacecraft in yaw, pitch, roll, fore and aft motions, sideward motions, up and down motions, control these very precisely—particularly at the instant of contact.

At the present time, of course, with these facilities we are strongly supporting the Gemini and Apollo programs. For example, with the Rendezvous Docking Simulator we have studied all sorts of jet failures and we have developed techniques that allow the astronauts to complete the docking operation rather than abort. We have also devised lighting schemes and visual aids, which have made it possible to dock on the darkside of the earth with as much success as we are able to do on the sunlit side of the earth.

In addition to the current programs we are also using these simulators to provide the basic background information necessary for future missions. Some of these are what we call extra-vehicular locomotion—where an astronaut gets out of his vehicle and maneuvers around in space to inspect and repair his spacecraft. We are studying space station docking, and we are studying Mars landings and launch. On Mars, of course, we have a little atmosphere (equal to about 50,000 feet on earth) so the problems are different from both earth and moon landing.

This completes my talk. In a few seconds you will see a short demonstration of the Rendezvous Docking Simulator. On a closed-circuit TV monitor you will see what the pilot sees.

After the demonstration, you will have time to look into the planetarium and see the equipment.

Now, if you will please stand up, and turn around, we will start the demonstration.

(Running commentary)

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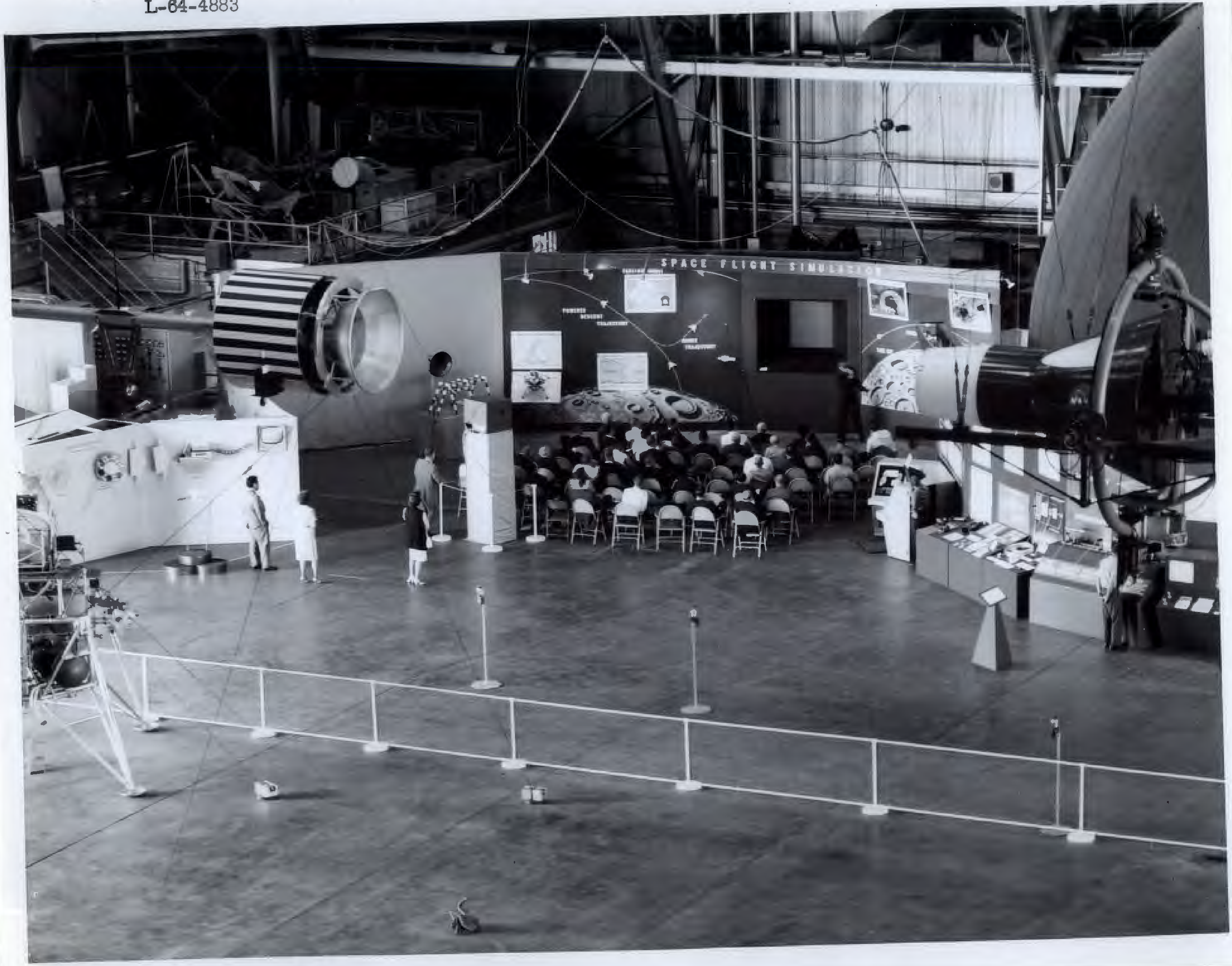
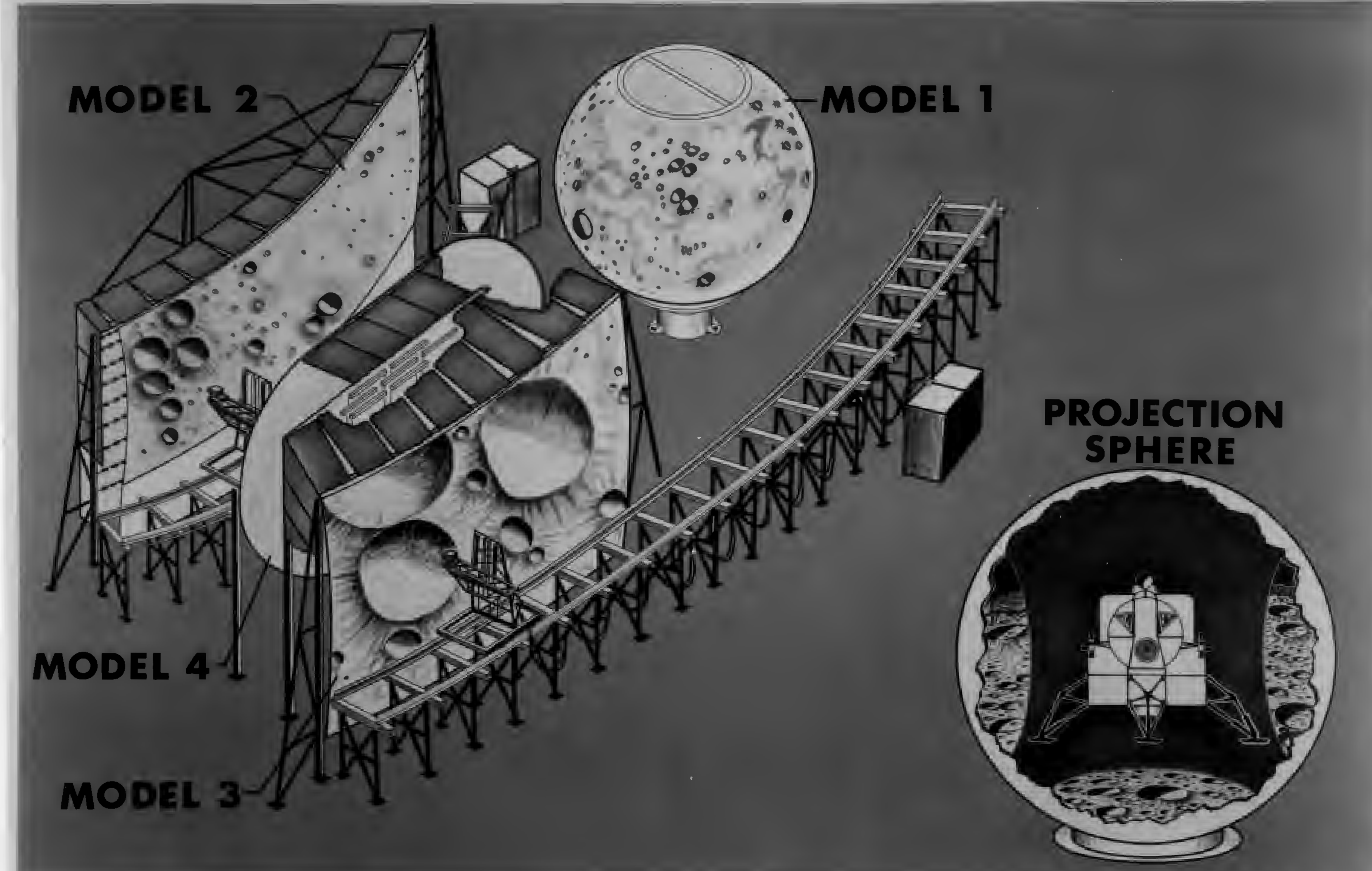


LUNAR ORBIT LANDING APPROACH



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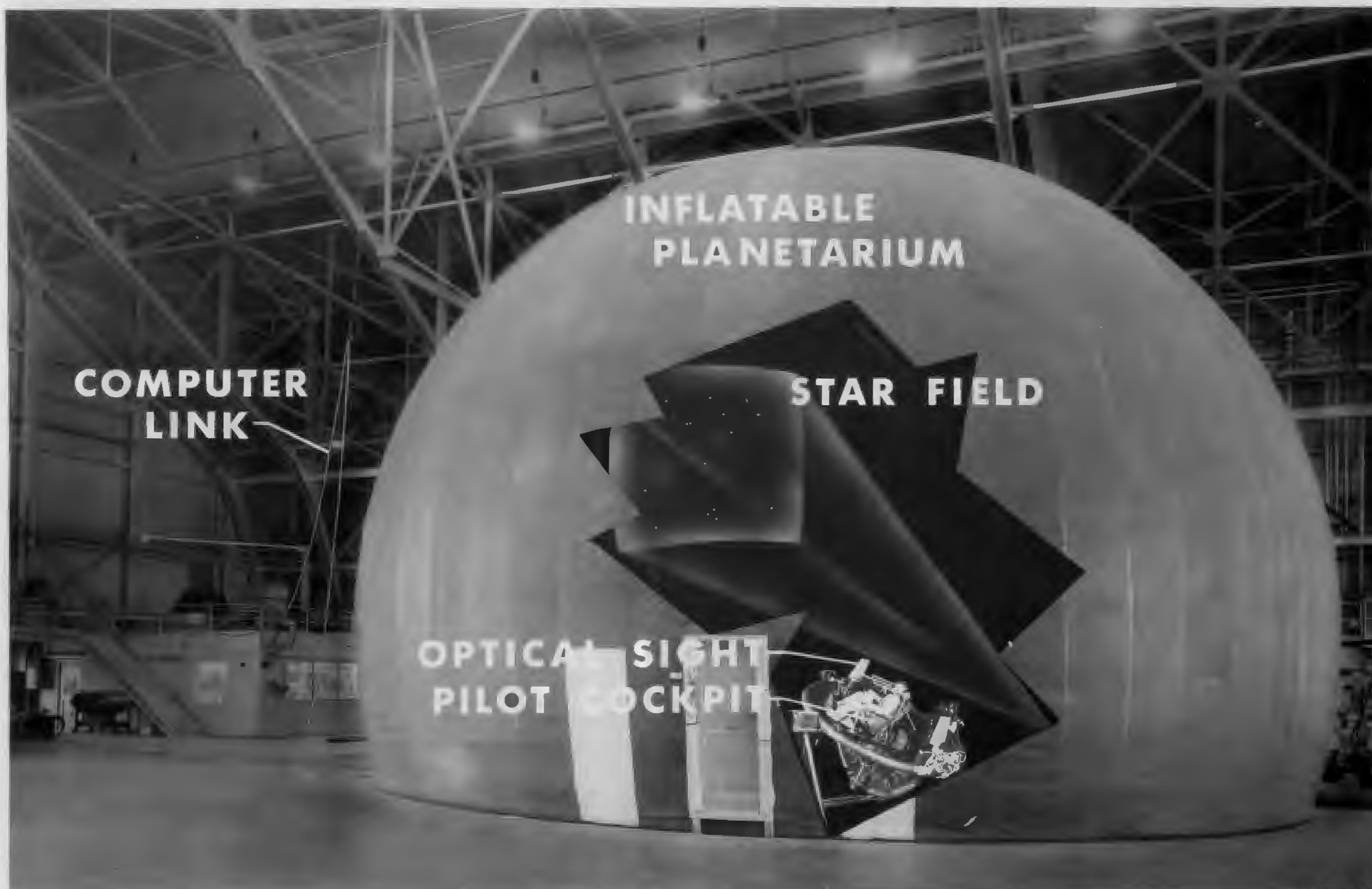
LUNAR ABORT



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