INVESTIGATION INTO APOLLO 204 ACCIDENT

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BEFORE THE

SUBCOMMITTEE ON NASA OVERSIGHT

OF THE

COMMITTEE ON SCIENCE AND ASTRONAUTICS

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INVESTIGATION INTO APOLLO 204 ACCIDENT

MONDAY, APRIL 10, 1967

EVENING SESSION

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND ASTRONAUTICS,
SUBCOMMITTEE ON NASA OVERSIGHT,
Washington, D.C.

The subcommittee met at 7 p.m., pursuant to recess in room 2318, Rayburn Building, Washington, D.C., Hon. Olin E. Teague (chairman of the subcommittee) presiding.

Mr. TEAGUE. The subcommittee will come to order.

Mr. WYDLER. Mr. Chairman.

Mr. TEAGUE. Mr. Wydler.

Mr. WYDLER. I would like to understand exactly—and I thought I did but I am not so sure that I do any more—I understand the future plans of the committee are tonight, tomorrow morning, and tomorrow afternoon and tomorrow night. Could you explain those as far as they are known at this time?

Mr. TEAGUE. We have to finish with this board tonight. I will go as long as necessary to satisfy the members of this committee that they have everything from the board they want.

In the morning at 10 o'clock we will hear from Mr. J. L. Atwood, the president and chairman of the board of North American Aviation. He will be accompanied by the vice president and the vice president of space information division, and also Mr. Dale Myers. They will be accompanied by two other quality control people, one from California and the other I believe the chief quality control man from Cape Kennedy.

Tomorrow afternoon we have a bill on the floor that is controversial, that will be read for amendment. I don't think we can meet. We will meet tomorrow night with North American. If we finish with North American, the next morning we will have Dr. Miller, Dr. Debus, Dr. Gilruth, probably Dr. Berry, Gen. Sam Phillips, and anyone else they want to bring that will have the information we might want. We will continue through the day and afternoon and evening with them.

Mr. WYDLER. That is on Wednesday.

Mr. TEAGUE. Yes. After that meeting I would expect our committee to go into executive session and decide on anyone that the committee wants to hear that hasn't been scheduled.

Mr. WYDLER. Are you talking about on Wednesday or Thursday?

Mr. TEAGUE. On Wednesday, for us to know who else we should

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hear from Dr. Mueller's group. Then I have had conversations with the astronauts. I think probably we would ask Col. Frank Borman to come back as an astronaut and probably Deke Slayton and Alan Shepard, and maybe a couple of the others who have been in on this investigation. They are the ones who are going to fly the Apollo spacecraft and I think it would be good for us to hear some of these men.

Then I would expect Dr. Seamans and Mr. Webb to come back as well as Dr. Mueller, for a wrap-up of the whole investigation.

Mr. WYDLER. I have a great deal of difficulty understanding just exactly how I could possibly proceed with the Review Board, as such, just directing my attention to that part of the problem. I went back to my office today and I found there a pile of documents called an appendix which was at least a foot high and which have been referred to constantly in the hearings today—panel 6, report No. D, or something of that nature—as answers to questions. It is going to take me time, certainly, to try to evaluate some of that material. I may try to get a hold of particular parts and get some questions concerning it. But that is not going to take place by the end of this evening under any circumstances because I am here to begin with. I don't know what I am supposed to do on questioning the Board.

Mr. TEAGUE. I can assure you gentlemen that the chairman has the same problem, too. These people have a job ahead of them. It is important that they get through and carry on a space program. I would expect our committee would not make their report for some time. I would think if any member who has some questions, and particularly if there is a panel member you want to hear from, it is not the intent of the chairman to cover up anything or cut off any member. I think it is most important to all of us that we get through with these hearings and let these people get back to work. But certainly if any member of this committee who thinks of questions later that they would like to have answered, we can contact any member of the panel or NASA or North American, or anybody. I would hope that our committee might run down to Cape Kennedy and see the two capsules that are laid down there. I was hoping that the gentleman from New York would go. The chairman has been urging me to do it.

Mr. ROUDEBUSH. Would it be possible for the individual members to ask additional witnesses?

Mr. TEAGUE. It will be possible for individual members to ask any witness and the committee will decide whether we want to hear them or don't want to hear them.

Mr. WYDLER. Thank you.

Mr. ROUDEBUSH. Thank you.

Mr. TEAGUE. The chairman reminds me this is the Oversight Committee and not the full committee. Of course that is true. There was something I didn't say this morning, and I should have. I have been asked a number of times whether our committee's activities were limited. I would like to say in no way, form, or fashion has the chairman imposed any limitation on this subcommittee.

Mr. MILLER. Just get to the truth.

Mr. TEAGUE. Colonel Borman, we would be glad to hear from you.

Colonel BORMAN. I would like to put on the record some information that was requested of me this afternoon.

Mr. TEAGUE. It will be placed in the record.

Colonel BORMAN. Mr. Gurney asked for a breakdown of test expe-

rience at 16.5 pounds per square inch. During the altitude chamber test, there were 2.7 hours unmanned and 3.5 hours manned, for a total of 6.2 hours, at 16.5 pounds per square inch absolute. We had another total of 34 hours unmanned at 6.2 pounds per square inch absolute and 22 hours manned at 5.5 pounds per square inch absolute. This gives you a total of 62.2 hours for this particular spacecraft with a 100 percent oxygen environment.

Does that answer your question?

Mr. GURNEY. Yes.

Mr. DAVIS. Mr. Chairman.

Mr. TEAGUE. Mr. Davis.

Mr. DAVIS. Were the load factors the same on the 28 volt direct current and the 115 volt alternating current tests as were in effect during the actual fire?

Colonel BORMAN. Essentially, yes; for all practical purposes they were.

Mr. DOWNING. Colonel, there has been some discussion that there was a preliminary test eliminated, and this test was the 100 percent oxygen, 16 pounds per square inch unmanned, just prior to the time the astronauts boarded it for the manned test. Was there an elimination of an unmanned 16 pounds per square inch 100 percent oxygen test?

Colonel BORMAN. Not to my knowledge. Mr. Williams is the best man to answer that.

Mr. WILLIAMS. No, there wasn't.

Mr. TEAGUE. Colonel Borman has stated that he would like questions as he goes along, and then when he is finished the Board will be before us to ask any questions you may care to.

Colonel BORMAN. Sir, I didn't volunteer for questions. I would like to put that on the record.

Mr. TEAGUE. You came mighty close to it, though.

STATEMENT OF COL. FRANK BORMAN, U.S. AIR FORCE, ASTRONAUT

Colonel BORMAN. I think perhaps, sir, before we go into the findings and determinations, it might be well to recap just briefly the area that the Board has settled on as the probable source of ignition. If I may have the first slide.

(SLIDES REFERRED TO IN THIS STATEMENT ARE PRINTED IN VOLUME II—PART 2)

Can you dim the lights, please?

This is a picture of spacecraft 012, the one that burned, taken on the 30th of December last year. You see here the wire that we pointed out before going over the stainless steel urine dump line. This is the area where we believe the arc occurred, this general area, that ignited the combustionable located nearby and caused the tragedy.

If I may have the next slide, I will show you exactly the same area after the fire. You will notice the cables, they were carrying bus A and bus B d.c. 28 volts, have been completely destroyed. The intensity of the fire has already been pointed out. Here you see the molten aluminum and the aluminum drippings on the floor. This is the area which the Board considered to be the probable source of ignition.

Thank you.

Mr. WYDLER. Mr. Chairman.

Mr. TEAGUE. Mr. Wydler.

Mr. WYDLER. Were those urine lines in use at the time?

Colonel BORMAN. No, they were disconnected; we never used those lines during ground tests.

Mr. DAVIS. May I ask this question? From the most probable source of combustion, what would be the lowest point of ignition or from point of combustion for combustible material from the highest source?

Colonel BORMAN. It is all nylon material that did meet the specifications as they existed at the time.

Mr. DAVIS. Did you reach a conclusion how high the temperature may have risen?

Colonel BORMAN. Do you mean that ignited it?

Mr. DAVIS. Yes.

Colonel BORMAN. The best person that can answer is Dr. Van Dolah.

Dr. VAN DOLAH. Temperature is not the appropriate term. Rather, it is an energy term. The arcs have sufficient energy to ignite nylon in this oxygen atmosphere.

Mr. DAVIS. The temperature falls off very rapidly with distance, does it not?

Dr. VAN DOLAH. It does except where bits of molten metal from the arc are projected by the energy of the arc. These can be projected some distance while retaining their high temperature.

Mr. DAVIS. I assume, from reading some of your recommendations that by removing the so-called combustible material from a possible source of arcing you might render this module safe with an oxygen atmosphere. Have you considered you might separate flammable materials as a solution to the problem?

Dr. VAN DOLAH. They would have to be rather far removed from potential arcing sources in order to be safe. The other thing that can be done is to reduce in quantity the amount of material in any one location so that if a fire was started it would be a very small fire and would not tend to spread to other combustibles.

Colonel BORMAN. May I have the next slide?

The first finding: (a) There was a momentary power failure at 23:30–55 Greenwich mean time. This was discussed by Dr. Faget. (b) There was evidence of several arcs found in the postfire investigation. We found an explanation for all except the one I mentioned. (c) No single ignition source of the fire was conclusively identified, although, as I mentioned earlier, we have a most probable source.

From these findings the Board determined the most probable initiator was an electrical arc in the sector between the minus Y and plus Z spacecraft axes. The exact location best fitting the total available information is near the floor in the lower forward section of the left-hand equipment bay where environmental control system (ECS) instrumentation power wiring leads into the area between the environmental control unit (ECU) and the oxygen panel. No evidence was discovered that suggested sabotage.

Next finding: (a) The command module contained many types and classes of combustible material in areas contiguous to possible ignition sources.

The test was conducted with a 16.7 pounds per square inch absolute, 100-percent oxygen atmosphere.

Determination: The test conditions were extremely hazardous. The recommendation——

Mr. TEAGUE. Would you answer a question right there?

Colonel BORMAN. Yes.

Mr. TEAGUE. Before this happened, what kind of condition did you think existed?

Colonel BORMAN. I don't believe that any of us recognized that the test conditions for this test were hazardous. I myself in Gemini 7 flew for 2 weeks in a 100 percent O_2 environment. We tested on the ground with 14.7 pounds per square inch absolute O_2, we purged with 20.7 pounds per square inch absolute O_2. In no way did I consider the test condition hazardous.

Mr. HECHLER. Have there been any discussions ever about previous fires in other experiments by the military services?

Colonel BORMAN. Yes, sir. In Gemini 7 we removed our space suits for the first time in American flight. This is when fire in flight becomes a real concern because our primary means of protection is to vent the cabin in vacuum and extinguish the fire. When you are not in a space suit this becomes impractical if you are interested in longevity. We looked very seriously to controlling in-flight fires. We are very aware of the fires that occurred at Johnsville Naval Air Station and also at Brooks Air Force Base. We came to the conclusion that the best available fire extinguisher that we had on board was our water pistol and these were the plans that we used. This was not done lightly. There was a report of considerable length and considerable detail that we looked into before we flew.

Mr. HECHLER. Thank you.

Colonel BORMAN. The Board recommends, based on the previous determination, that the amount and location of combustible materials in the command module be severely restricted and controlled. We not only must reduce the amount, but we have to make sure that the amount that we must have is strategically located.

Next slide——

Mr. GURNEY. Question.

Mr. TEAGUE. Mr. Gurney.

Mr. GURNEY. Have these combustibles been the subject of discussion at all in your program prior to this time, whether there were too many and whether they were a hazard?

Colonel BORMAN. Yes, sir. This spacecraft had several items removed during the inspection at Downey. There was a regulation that no combustible should be within 12 inches of a possible ignition source.

Mr. GURNEY. A combustible item was a matter of concern among the astronauts, would that be fair?

Colonel BORMAN. No; because none of us really placed any stock or gave any serious concern to a fire in a spacecraft. This is the real crux of the problem.

The third finding: (a) The rapid spread of fire caused an increase in pressure and temperature which resulted in rupture of the command module and creation of a toxic atmosphere. Death of the crew was from asphyxia due to inhalation of toxic gases due to fire. A contributory cause of death was thermal burns. (b) Nonuniform distribution of carboxyhemoglobin was found by autopsy.

Mr. TEAGUE. What does the last mean?

Colonel BORMAN. Sir, the last finding (b), and I must tell you that this is what has been explained to me, essentially means that portions of the blood that have been exposed or combined with carbon monoxide

in the lungs were not completely distributed throughout the body; so that the blood that was essentially without oxygen did not have time to be distributed throughout the body before cardiac arrest occurred.

Mr. DOWNING. These astronauts had helmets on at the time of the fire and the suits were supplied with oxygen.

Colonel BORMAN. Yes, sir.

Mr. DAVIS. Was there enough residual oxygen in the suits to keep them going?

Colonel BORMAN. We scrub the oxygen to remove the carbon dioxide. As long as the suit loop was intact they were getting pure oxygen. But when it broke through, they were breathing toxic gases.

Mr. RUMSFELD. To go back to your comment that none of the astronauts gave concern to fires in the capsule. You, naturally, and the other astronauts are concerned with what is known to be a serious and dangerous aspect of flying, the potential of fire. Do you mean in this particular situation you and the astronauts didn't feel that there was any unusual danger of fire or anything unique that caused you to pursue it?

Colonel BORMAN. Yes, sir. For in-flight fire, we were concerned, and we had investigated the means of best handling an in-flight fire. Under the particular test conditions with which we were dealing, there was no undue concern over the hazards.

Mr. RUMSFELD. Then your comment is restricted to the test conditions?

Colonel BORMAN. Yes, sir.

Mr. ROUSH. Colonel Borman, you stated you did not consider the test conditions extremely hazardous. I would like to ask if any responsible person connected with NASA, any prime contractor involved in this particular testing or involved in the supplying of equipment for the particular test, or if any of the astronauts had, prior to this fire, ever raised the question or indicated that they were concerned about these test conditions being extremely hazardous and dangerous to the astronauts?

Colonel BORMAN. To the best of my knowledge the answer is "No." The crew that was killed certainly wasn't concerned because in the final analysis the crew has the undeniable right not to enter any spacecraft that they feel would be hazardous. Although there are sometimes romantic and silk-scarf attitudes attributed to this type of business, in the final analysis we are professionals and will accept risks but not undue risks.

Mr. ROUSH. Thank you.

Mr. KARTH. Referring to your relatively low concern for fire hazards while on the ground, isn't it true that you actually have less concern for the fire hazard while you are in flight because of the lowering of pressure while you are in flight?

Colonel BORMAN. Yes, sir.

Mr. KARTH. You should be less concerned in flight.

Colonel BORMAN. The potential of fire is less at lower pressure but when you are 180 miles away from terra firma and a fire station it becomes more significant than it is on a launch pad.

Mr. KARTH. Unless you are locked in, Colonel.

Colonel BORMAN. That is correct.

The autopsy data leads to the medical opinion that unconsciousness occurred rapidly and that death followed soon thereafter.

The fourth finding: Due to internal pressure, the command module inner hatch could not be opened prior to rupture of the command module.

Next slide. Determination: The crew was never capable of effecting emergency egress because of the pressurization before rupture and their loss of consciousness soon after rupture.

Recommendation: The time required for egress of the crew be reduced and the operations necessary for egress be simplified.

Mr. ROUDEBUSH. Colonel, I wanted to ask you there, in regard to emergency egress. Hadn't any of the astronauts ever expressed concern about the lengthy time to operate the hatch in the Apollo command module?

Colonel BORMAN. No, I practiced it myself. The crew that was in there had practiced. Perhaps you haven't had time to read the 3,000 pages, but there was an emergency egress practice planned at the completion of this test. We had planned for rapid egress. We did not identify, as I pointed out, the crux—in my opinion, the main problem. We did not identify the potential of the spacecraft fire as being a real hazard. Consequently, the egress procedures were primarily concerned with the potential hazard from the booster or the hypergolic fuels that existed in the service module. For the identified hazards, the time required to get out of the spacecraft except in the event of a spacecraft fire was, in my opinion, adequate with that hatch.

Mr. WYDLER. The hatch that now exists on the spacecraft would take 90 seconds to open from inside and to get out, is that right?

Colonel BORMAN. Approximately. It depends upon the training of the crew.

Mr. WYDLER. What would be the emergency in which they would utilize that hatch?

Colonel BORMAN. If you had an impending emergency in the booster, for instance a pressure rise that you couldn't explain or a hold of some unforeseen nature that might be deemed an emergency, you would leave under those circumstances.

Mr. WYDLER. If there actually was any type of explosion or fire that was started in the boosters, that won't be adequate for that.

Colonel BORMAN. You wouldn't wait until it started. We have instrumentation and we can identify trends.

Mr. WYDLER. When the new hatch is designed, how long will it take the three astronauts in the capsule to get out physically?

Colonel BORMAN. I am not sure exactly what the design will call for. They are talking on the order of 2 to 3 seconds to open the hatch. I am hopeful that we don't end up with a hatch that opens too easily. This is another concern when you are operating in orbit. The last thing that you are interested in is a hatch that might accidentally open.

Mr. WYDLER. How long does it take for the three astronauts to get out if the hatch were to open in 5 seconds?

Colonel BORMAN. I would imagine it is on the order of 17 or 18 seconds.

Mr. WYDLER. How long was it before the astronauts in this case were killed?

Colonel BORMAN. Again we can't determine it within that close a time schedule.

Mr. WYDLER. I am just trying to point out that this improvement

in the hatch may not accomplish anything when you are all through with it. The 17 or 18 seconds may not be sufficient for any purpose.

Colonel BORMAN. If they had had a hatch that opened outward and opened in 2 seconds there is no question in my mind that they would have escaped. There was a considerable amount of time from the time the fire was identified or recognized by the crew until it became really a massive burning and, of course, the opening of the hatch would have eliminated the rupture and the attendant swirling inside. It is my firm opinion that the crew would have escaped with a hatch that opened in 2 seconds.

Mr. FULTON. Mr. Chairman.

Mr. TEAGUE. Mr. Fulton.

Mr. FULTON. What kind of emergencies were you talking about when you made this escape emergency plan of 90 seconds?

Colonel BORMAN. You must realize that for the last 30 minutes, the last 30 minutes before launch, you have a very swift means of escape by using the escape tower.

Mr. FULTON. You are talking of launch and we are talking of test.

Colonel BORMAN. All right, sir.

Mr. FULTON. So, under test conditions, there are then emergencies that might happen. What are those?

Colonel BORMAN. Under the test conditions that existed at Cape Kennedy for this particular test, I could identify no hazard, none of us could. That was the problem. We did not have fuel in the booster. We did not have hypergolics in the service module. There was no live pyrotechnics. The escape motor was safetied.

Mr. FULTON. Was it ever called to your attention that there might be a short circuit or an arcing that would ignite materials in a pure oxygen atmosphere?

Colonel BORMAN. We were aware of this but we did not consider this a hazard under the ground test conditions that existed.

Mr. FULTON. Was there any procedure in case the occupants of the capsule were incapacitated that somebody outside could take emergency procedures to get them out?

Colonel BORMAN. Yes, sir; but since this test was not classified hazardous the team was not on duty.

Mr. FULTON. Why didn't they use ordinary atmosphere when they spent so many hours on it? We have had testimony that the difference between pure oxygen or any other two- or three-gas atmospheres like ordinary air, would make little difference on the test. Why wasn't a nondangerous atmosphere used?

Colonel BORMAN. I think we will discuss that a little later on if you will wait for another finding.

Mr. TEAGUE. Mr. Waggonner.

Mr. WAGGONNER. This might not necessarily be a question for you but can you tell me whether or not at any time during the design of this spacecraft NASA or some advisory source or some contractor supplying NASA ever recommended a hatch other than the one which was actually in service on this particular spacecraft?

Colonel BORMAN. Yes, sir. We did have recommendations and a new hatch design was in the process at the time of the accident. But the main concern of the new hatch was not for rapid egress on the ground but rather for a more compatible hatch for extra vehicular activities in orbit.

Mr. WAGGONNER. One that would make egress a little bit easier on station.

Colonel BORMAN. On station.

Mr. WAGGONNER. Nobody suggested or laid claim to the fact that this hatch would require 90 seconds to open against change pressures and open under certain conditions would be unsatisfactory. Is that a true statement?

Colonel BORMAN. Yes, sir; I was on the crew safety committee for 3 years. We tried to identify every hazard we could. This is one we never concerned ourselves with. I am sure there is somewhere on the record a proposal for a quicker opening hatch; for rapid egress on the ground. I personally am not aware of it. In all the time that I served on the crew safety committee I cannot recall that this was questioned.

Mr. MILLER. Mr. Chairman.

Mr. TEAGUE. Mr. Miller.

Mr. MILLER Colonel, if you had been a member of the crew, would you have hesitated on that day to get into the vehicle that then existed?

Colonel BORMAN. No, sir.

Mr. MILLER. Thank you.

Mr. ECKHARDT. I am interested in your reference to the crew safety committee. It would seem to me that most of the persons involved in NASA operations are rather narrow specialists. To a certain extent you astronauts are the generalists of the group, and the problem that was involved here was one perhaps not so much within the specialty of anyone, but rather within the knowledge of a generalist, as you astronauts are. I was wondering if it might not be desirable to have a staff, perhaps not trained in the particular special test of the operation, but the kind of persons who would have the knowledge of inspections, general inspections that would be at your service as sort of an auxiliary safety force.

Colonel BORMAN. We have that, sir.

Mr. ECKHARDT. You do?

Colonel BORMAN. Yes; we have a whole team of people, including representatives of our flight safety people. In preparing for Gemini VII, I had 16 people that reported directly to me and who I used as my eyes, ears, and bird dogs for making sure that the things were going the way I thought they should go.

Mr. ECKHARDT. I am as much interested in finding ways to avoid other accidents which may be far from direct relationship to this accident as finding out what caused this accident. Is there any way that this process that you are describing could be improved in order to accomplish that objective.

Colonel BORMAN. I would hesitate to answer this offhand. I haven't thought about it until you asked the question. Perhaps I could defer and answer this later on for you.

Mr. HECHLER. Mr. Chairman.

Mr. TEAGUE. Mr. Hechler.

Mr. HECHLER. On that point, let me try to see if my characterization of the general attitude is correct. Isn't it true in all of these things that you are saying here and in the rest of the things that you will say, that the general feeling, not only in NASA, but in the Nation and the Congress was one of overconfidence? We had done so well that perhaps we could afford to be just a little bit overconfident in approaching possible dangers. What you really need is a somewhat dif-

ferent attitude all the way up and down the line in Congress and in NASA and the Nation concerning the potential threats, and the way in which we can guard against these threats to the lives of the men that are in the program.

Colonel BORMAN. Sir, I think I can best answer that by saying that I don't know of a person that is more interested or a group of people that are more interested in performing the mission well than the crew that is assigned to the flight. There is no resting on the oars. There is no laxness. There is no feeling that we have done so well before that we can slow up. Each crew attempts to make their particular flight the perfect flight, so to speak. I was assigned to the spacecraft behind 204, and I observed the 204 crew many hours at Downey and frequently at the Cape, and I can assure you there was no laxity, there was no feeling that this was "a piece of cake" as we say in the Air Force.

They did their utmost to assure that this flight would be a success.

Mr. HECHLER. Don't you think that attitude may be improved a little bit in the future?

Colonel BORMAN. It has never been evidenced to me anywhere in NASA management. I might say that I have never seen a decision where crew safety was sacrificed for anything; money or schedule. If there was ever an issue of crew safety that was identified that was the predominant concern. Unfortuately we did not recognize this particular hazard.

Mr. TEAGUE. Can you identify those items that have been changed from Block I to Block II?

Colonel BORMAN. To the best of my ability. I think we would have to have Dr. Mueller tell us what is going to be done.

Mr. TEAGUE. Mr. Cabell.

Mr. CABELL. This follows somewhat the question of Mr. Hechler. During your course of training and your operational experience, at any time have the recommendations of the astronauts for safety, for changes in procedure, ever been ignored by NASA?

Colonel BORMAN. They have never been ignored. They are always considered. I won't say that everything the flight crew proposes is accepted, that is not true. But concerning safety, I have never been associated with any decision where safety was recognized as a factor where the decision was not made to provide safety.

Mr. CABELL. Then to follow what you said, and I think this is somewhat redundant, the answer to that is, if you as a crew and other crew members made recommendations, you got very definite ear to your recommendations.

Colonel BORMAN. Yes, sir.

Mr. CABELL. And if it involved safety of the crew it got more than token interest; is that correct?

Colonel BORMAN. Yes, sir.

Mr. CABELL. Have you felt very strongly about safety recommendations concerning the safety of the crew that were not given credence by NASA as such, by the Administration?

Colonel BORMAN. No, sir.

Mr. CABELL. You feel as a member of the crew, as one of our astronauts, that you have had the complete cooperation of NASA as such in developing your program and in protecting your interest in your safety.

Colonel BORMAN. Yes, sir.

Mr. CABELL. Thank you.

Mr. TEAGUE. Mr. Gurney.

Mr. GURNEY. Colonel, we all recognize, I think I state this correctly, that the use of pure oxygen does present severe fire hazards. I think actually that is the language used in the report and I guess there has been a great deal of discussion between using pure oxygen or some other combination in the cabins of spacecraft and yet it puzzles me when you say that under these specific test conditions you never considered fire as a hazard. Now, what generally do you consider as a fire hazard in this kind of an atmosphere? Then let me say in trying to illustrate, if you were going into a filling station to have a car serviced you wouldn't strike up a match and have a cigarette while the gas was going into the tank. What areas do you identify as rather severe risks in this business of working in a pure oxygen atmosphere?

Colonel BORMAN. I think what you say about going into the gas station and striking a match is true. Mr. Rumsfeld can tell you when he flew in the Navy in jets he was using 100-percent oxygen all the time. There is oxygen right up above your head when striking matches on a commercial airliner. Oxygen per se is not dangerous, only when associated with a fuel and ignition source. Quite frankly we did not think, and this is a failing on my part and on everyone associated with us; we did not recognize the fact that we had the three essentials, an ignition source, extensive fuel and, of course, we knew we had the oxygen.

Mr. TEAGUE. Mr. Fulton.

Mr. FULTON. When complaints were made or suggestions by any of the astronauts as to developments on the capsule or safety, those complaints would be made either to people who were in the manufacturing team for the contractor or to the programing director. My question is on how the complaints could be made. For a number of years now I have introduced a bill to provide an inspector general in NASA to do inspecting as an independent operator reporting only to the Administrator or maybe the top assistants, so that there is no obstacle to getting a final judgment and decisions do not have to go up through people pushing the program.

Now, either in NASA an inspector general is needed or the one in the Air Force should be disbanded and the money saved. Which do you say?

Colonel BORMAN. I am a colonel, but I think I would have to defer to a higher rank to answer that particular question. I think there is national policy involved. I really am not qualified, sir.

Mr. FULTON. Do you think it would help if there were a continuing function that would permit the astronauts to have consultation with an independent group so that they don't make their complaints to the people who are pushing the program, the contractor, nor the administrators of the program on the operating level? Supposing an astronaut sees something unsatisfactory and he tells someone in authority. Suppose they say, "We have discussed that and it is all right, you just go ahead, buddy." Is there really anyone to follow up for him?

Colonel BORMAN. While some astronauts may think they know everything there is to know, it doesn't follow that they do. I have never had any problem making my position known to the proper people. Dr. Gilruth's door was always open. I have never had any problem getting an ear. We weren't always granted what we asked

but never was a safety request turned down. Dr. Mueller and I have discussed some requests many times.

Mr. TEAGUE. Mr. Wydler.

Mr. WYDLER. Colonel, you said before that the particular exercise was termed "nonhazardous." Therefore, did I understand the rescue team was not on duty?

Colonel BORMAN. Yes, sir. They were to come on duty at the completion of the test because they were to run an emergency egress exercise. They were not on duty at any other time.

Mr. WYDLER. They were not on duty while the astronauts were in the capsule?

Colonel BORMAN. That is correct.

Mr. WYDLER. They had not been on duty at any time the astronauts were in the capsule.

Colonel BORMAN. That is correct. They were to come on duty at the completion so they could participate with the astronauts in an exercise which involved getting out of the capsule as rapidly as possible.

Mr. WYDLER. Where were they at the time of the accident?

Colonel BORMAN. They were preceding toward the launch pad.

Mr. WYDLER. Have they ever had the rescue team on duty while the astronauts were in the capsule.

Colonel BORMAN. Not for a nonhazardous test.

Mr. WYDLER. What are the hazardous tests?

Colonel BORMAN. During a launch you have them in a fire-resistant vehicle—in deference to Dr. Van Dolah I find nothing is fireproof. They are ready to go with their equipment and breathing packs. During a launch demonstration they would be on duty. At this time the vehicle is completely loaded and it simulates a launch except you don't fire the booster.

Mr. WYDLER. Who was the closest man at the time of the accident?

Colonel BORMAN. We are getting way away from the recommendations. I would be happy to proceed along this line.

Mr. TEAGUE. There are 11 findings in the book you have had since yesterday. If you look at these findings, you can see what he is going to discuss.

Mr. WYDLER. I will look.

Who was the closest man?

Colonel BORMAN. Two or three technicians who were standing right beside it.

Mr. WYDLER. You did not realize that there was any hazard in this. I wonder if you, anyone in NASA, or connected with NASA, or the contractor, are aware of a report that was done in December of 1965 by Atlantic Research Corp. under contract to the U.S. School of Aerospace Medicine concerning the extreme risk of fire that exists in the exact instance as in this case.

Colonel BORMAN. Yes, sir; we did a complete study ourselves before Gemini VII. McDonnell Aircraft Co. did the study.

Mr. WYDLER. The conclusion of the study was the fact that this was extremely hazardous and probably the greatest hazard was the carbon monoxide itself, that it could cause almost instantaneous death. Were you aware of that?

Colonel BORMAN. Not only are we aware of it, it has been proven. I agree with you.

Mr. WYDLER. I am talking about the time of the accident.

Colonel BORMAN. As I mentioned before, I was certainly aware of the fact that if you had a fire it would be a very hazardous thing and we had overlooked the possibility. I accept my share of the blame. We had overlooked the possibility that we were apt to have a fire.

Mr. WYDLER. All right.

Thank you.

Mr. TEAGUE. Mr. Davis.

Mr. DAVIS. The reason you have over 16 pounds of pressure per square inch in this command module was the fact that that was about 2 pounds more than the outside atmospheric pressure, was it not?

Colonel BORMAN. 16.7 pounds per square inch absolute.

Mr. DAVIS. Which is about 2 pounds more than 4.5, that is about sea level atmospheric pressure.

Leakage would be from the inside.

Colonel BORMAN. That helped seal the hatch.

Mr. DAVIS. The reason was to prevent contamination from the outside atmosphere.

Colonel BORMAN. It was to keep air from leaking in and another reason was to keep the hatch sealed.

Mr. DAVIS. It was far more economical, and simple to use pure oxygen as you elevated the pressure inside.

Colonel BORMAN. Yes; because you introduce many problem areas if you go to a diluent gas or a two-gas system.

Mr. DAVIS. The course which you decided, from all the data you had, from all the premises you had, to form conclusions, was the safest and quickest, and you could find no reason to have misgivings about it.

Colonel BORMAN. Yes, sir.

Those organizations responsible for the planning, conduct and——

Mr. RUMSFELD. Could you identify them?

Colonel BORMAN. They are, under the procedures in force, the contractor who had the responsibility to identify the test as being hazardous.

Mr. RUMSFELD. "Those organizations" means the contractor.

Colonel BORMAN. This does not dispel the fact that NASA had the authority and the responsibility to monitor this and identify it, also.

Mr. RUMSFELD. The reason I ask is because it has been said that prior to the time of the accident you didn't regard the operation as involving a substantial hazard. But after your work on this Board you were convinced that there were hazards. It is clear that there is a hazard evaluation gap.

Colonel BORMAN. Not in my mind. I have evaluated it and I have determined it was hazardous.

Mr. RUMSFELD. But there was a gap.

Colonel BORMAN. There was a gap in that we did not recognize it as being hazardous before the test.

Mr. RUMSFELD. Now, we have come to a specific where those organizations responsible failed to identify the hazard.

Colonel BORMAN. Yes, sir.

Mr. RUMSFELD. I am of the opinion that this accident is important, and pursuing it is important. But, from my personal standpoint, I am equally anxious to try to get to the root of the procedures that permitted a gap between the actual hazard and the evaluation and identification of a hazard, and see along with the line of questioning that Mr. Fulton pursued, whether or not an inspector general or an independent safety review board, such as those of the Navy or the Air Force or

the Atomic Energy have, might have been in a position to close that gap.

You said to Chairman Miller that you wouldn't have hesitated to enter that capsule. I suspect that today knowing what you know, that you would hesitate to enter that capsule.

Colonel BORMAN. That is correct. As I mentioned, now I would.

Mr. RUMSFELD. It is my thought that possibly some mechanism could be developed to help to identify other gaps that exist. If one existed, there is a possibility that others may exist. Through the establishment of some mechanism as an inspector general or a safety review board it is possible we might be able to narrow down the number of instances such as this. This is the reason I think it is important to go to the question of what organizations and at exactly what level the problem happened.

Colonel BORMAN. I think this is beyond the scope of my capability to testify.

Mr. RUMSFELD. In civilian airliners there is often an announcement that if the cabin loses pressure an oxygen mask comes down and you are supposed to put out your cigarette. I have never been in a civilian airliner that lost pressure. I suppose the mask just provides oxygen.

Colonel BORMAN. I haven't been in an airliner that lost pressure, but on one we had a hard landing and the masks fell down.

Mr. RUMSFELD. It must have been an ex-Air Force pilot.

Colonel BORMAN. I checked on it and he thought he was practicing a carrier landing.

[Laughter.]

Colonel BORMAN. Sir, if we may go on——

Mr. FULTON. Before you leave that point, you mentioned a possibility that might have occurred. Let me ask your judgment. If you had known then what you realize now you would not only not have entered the capsule under those same conditions but you also would have advised the crew not to enter, isn't that correct?

Colonel BORMAN. That is correct.

Mr. RYAN. Mr. Chairman, may I ask if the question previously asked about the organizations responsible can be more clearly amplified?

Colonel BORMAN. I can probably give it to you.

Mr. RYAN. Was not NASA ultimately responsible for the safety of the crew?

Colonel BORMAN. In my opinion, yes, sir.

Mr. RYAN. Previously, you pinpointed responsibility to the contractor. Wasn't the ultimate and final responsibility on NASA?

Colonel BORMAN. Yes, sir. What I said was that the first step in the indication of the test as being hazardous was, in the procedures in use, incumbent on the contractor. I don't mean to imply that NASA shouldn't have evaluated the test and done this also.

Here is finding 5:

(*a*) No procedures for this type of emergency had been established either for the crew or for the spacecraft pad work team.

(*b*) The emergency equipment located in the "white room" and on the spacecraft work levels was not designed for the smoke condition resulting from a fire of this nature.

(*c*) Emergency fire, rescue, and medical teams were not in attendance.

(*d*) Both the spacecraft work levels and the umbilical tower access

arm contain features such as steps, sliding doors, and sharp turns in the egress paths which hinder emergency operation.

Next slide.

Determinate adequate safety precautions were neither established nor observed for this test.

Next slide.

We recommend: (*a*) Management continually monitor the safety of all test operations and assure the adequacy of emergency procedures.

(*b*) All emergency equipment (breathing apparatus, protective clothing, deluge, systems, access arm, et cetera) be reviewed for adequacy.

(*c*) Personnel training and practice for emergency procedures be given on a regular basis and reviewed prior to the conduct of a hazardous operation.

(*d*) Service structures and umbilical towers be modified to facilitate emergency operations.

Mr. FULTON. Was there in process a reevaluation of the materials within the capsule which might have been flammable? Was NASA in the process of upgrading the safety at the time this occurred, for example, better insulation or better clothes—I am speaking particularly of suits. Wasn't NASA already doing such things?

Colonel BORMAN. To my knowledge, no, sir.

Mr. FULTON. How about the beta cloth?

Colonel BORMAN. That was part of long-range development. I was not aware of any plan to incorporate it.

Mr. TEAGUE. I think Dr. Thompson would like to comment.

Dr. THOMPSON. We have learned that considerable work had been done on beta cloth or Fiberglas, making it suitable for wear, that is, even as underwear.

Colonel BORMAN. That is right.

Dr. THOMPSON. Which is a very demanding requirement. The progress has reached the point where we have been assured by the director involved that there is a very good chance that they can make extensive use of beta cloth at this time.

Mr. FULTON. I was really being an attorney for NASA by saying, weren't they then, even at the time this accident occurred, in the process of upgrading the safety of materials within the capsule, for example, either the suits, the various nylon items, the Teflon, and the Fiberglas? Weren't they even then looking into that angle of safety?

Colonel BORMAN. Yes, sir. This was under development. You asked me were there plans to incorporate them in the suits. My answer was "I was not aware of them." I am not sure it had progressed that far.

Mr. FULTON. At that time hadn't NASA already removed certain items that they considered were dangerous or below safety requirements? Wasn't NASA in the process of experimenting and trying to reach good results for safety in this capsule?

Dr. THOMPSON. Could I add something else?

Teflon has come into use for insulation. We have been shown examples of Teflon clothing material that may be useful. All those things are in the process of development. We are assured they are being very carefully considered for development in the space flight.

Mr. FULTON. Wasn't NASA already doing so?

Dr. THOMPSON. It was underway. We learned about it when we first started this review. That work had been underway for a considerable period of time.

Mr. KARTH. Colonel Borman, in your recommendation (a) where you use the word "management," I assume you mean NASA management at the Cape or a combination of NASA management at the Cape and the prime contractor management?

Colonel BORMAN. NASA management.

Mr. KARTH. If all of those recommendations were instituted, how much time do you think would be added to the program prior to the first launch?

Colonel BORMAN. I don't believe these recommendations would add much time. There are other pacing items, in my opinion—again you are asking me to testify in areas that I admit I am not expert in.

I really can't accurately evaluate the timelag in any of these. Looking at them now I don't believe any would require a great deal of time.

Mr. RYAN. Colonel, on this question of safety you referred to the appendix (d) (7) (57).

Colonel BORMAN. Yes, sir.

Mr. RYAN. That appears to be a memorandum from the chief safety officer to the Apollo Review Board.

Colonel BORMAN. Yes, sir.

Mr. RYAN. It lists pressure testing and operations with hazardous gases. When, before or after the accident, were those specified as being hazardous?

Colonel BORMAN. Pressure testing means pressure-testing tanks.

Mr. RYAN. What are "operations with hazardous gases"?

Colonel BORMAN. Hypergolic fumes, nitrogen, or any of those type gases. Oxygen was never considered a hazardous test gas—is that right, John?

Mr. WILLIAMS. I think that is correct.

Mr. RYAN. Paragraph 5 states, "Apollo procedure submittals had been very delinquent in meeting the 30-day time requirement. The late submittal of procedures has been brought to the attention of North American Spacecraft Operations in various meetings and correspondence. Some procedures have been submitted with as little as 2 days' allowable safety review time."

Is that correspondence and are summaries of those meetings available for us?

Colonel BORMAN. I am sure they are. We do not have them here.

(The information referred to follows:)

Chief, Test and Operations Management Office, KE
Chief, Safety Office, RE
Operations Checkout Procedures for KSC Safety Review

1. Review of NAA S/C 017 OCP status dated September 16, 1966, indicates that the allowable time between OCP publication and test date is only 6 days.

2. KSC Safety has repeatedly requested 30 days for review of procedures, but to date, a workable solution has not been established to assure our receiving the procedures by the required date.

3. The present schedule for S/C 017 OCP publication is not acceptable to KSC Safety. RE-1 must have a minimum of 14 working days to give the procedures proper review.

4. RE requests that your office initiate action to eliminate the aforementioned problem.

JOHN R. ATKINS.

Mr. J. Simmons, SCO-63
Chief, Operations Safety Branch, QAS-23
OCP-PO-K4620, GO_2 Servicing System Test, and OCP-PO-K-4621, GH_2 Servicing System Test

1. Subject procedures were received on the morning of May 2, 1966, with the cover letter stating that the tests were scheduled for May 2 and 4, 1966.

2. It is not normal for this office to approve a flimsy copy of the checkout procedures. We can make comments on flimsy copies, but it appears that most procedures are changed before they are published in the hardback copy.

3. The two subject procedures do not have a NASA Systems Engineer's signature, so we must assume that the NASA Systems Engineers do not approve the procedures.

4. By receiving these procedures with only one day to review them, this office cannot review them properly.

5. These two procedures will not be reviewed nor approved until a NASA Systems Engineer's signature has been affixed.

6. Further flimsy copies of any procedure will not be approved by this office. We will submit comments only to flimsy copies.

7. These two tests do not have KSC Safety approval at this time, and KSC Safety will not condone the running of these tests with GO_2 and GH_2 in the MSO until we have received and reviewed the proper procedure.

JOHN. T. MCGOUGH.

Chief, Safety Division, QAS–2
Manager, Apollo CSM Operations, SCO–8
Transmittal of Apollo S/C 011 Technical Information
Ref: Your memo dated April 26, 1966, same subject

1. Based upon the information contained in the referenced memo, NAA was requested to prepare a package showing documents anticipated submittal date.

2. NAA's response is enclosed. It should be noted that in most cases the scheduled transmittal dates do not comply with the 30-day pre-test safety review requirement. It should be further noted that most of these cases concern documents previously approved for S/C 009 and that the content is virtually identical.

3. Due to the advanced schedule that has been initiated for S/C 011, it is our feeling that the dates presented by the contractor in the enclosure represent the "best possible" and can not be improved.

4. If these dates are not satisfactory then the utilization of filmsy or advance copies for KSC and ETORS safety reviews must be reconsidered.

5. If this is unacceptable, QAS should contact PPR and negotiate the resulting S/V schedule impact.

6. This office will insure delivery of the documents to KSC Safety at the earliest possible date.

GEORGE T. SASSEEN.

MAY 9, 1966.

John F. Kennedy Space Center
National Aeronautics and Space Administration
Kennedy Space Center, Florida
Attention Manager, Apollo CSM Operations (SCO–8)
Contract NAS 9–150, Safety Significant OCP's of Transmittal of

In order that the current status of safety significant documentation submittal for CSM 011 may be more fully understood, enclosures (1) through (5) are submitted for your attention. It should be noted that the only areas where NAA has not met the full 30 day safety review requirements are a limited number of OCP's as can be identified from enclosure (3). The under-support of the 30 day safety review is primarily a result of a facility ORD compression of 14 days and compression of the launch schedule. You are assured that NAA is making a determined effort to recover as much of the 30 day review time as possible and will continue this effort.

It may be to the advantage of the KSC Safety Office to reconsider its position of not reviewing advanced copies of OCP's in respect to those OCP's showing under-support. An advanced review in combination with the complete file of specifications and drawings, currently in possession of KSC Safety Office, plus the knowledge that in most instances the OCP is a rerun of S/C 009 procedures, may reduce review time on the final released OCP to a degree that schedule impacts can be avoided.

The NAA Apollo System safety personnel will be most happy to assist in any way possible to support your safety personnel in their reviews of procedures.

NORTH AMERICAN AVIATION, INC.
J. L. PEARCE,
Director, Apollo CSM Operations, Florida Facility, Space and Information Systems Division.

Status of safety significant OCP's for S/C 011

Item	OCP	Date transmitted to NASA safety	Date scheduled for transmittal to NASA safety	Remarks
1	FO-K-0007 countdown		July 30	
2	FO-K-0033 countdown demonstration.		July 12	7 days for safety review, OCP is very similar to S/C 009 0033 except Cryo is used.
3	0034 CSM altitude chamber test		June 2	7 days for safety review.
4	FO-K-0035 combined systems test	May 4		16 days for safety review OCP is very similar to S/C 005 0035 except test is conducted in altitude chamber.
5	FO-K-0038S/C hypergolic loading		July 21	7 days for safety review, OCP combines OCP's 4082, 4622, 4624, and 4700 as approved for S/C 009.
6	FO-K-1096 water glycol servicing system test, altitude chamber, MSOB.	Apr. 22		Operation completed.
7	FO-K-1210 water glycol servicing system test, cryogenic test facility.	Apr. 14		Do.
8	FO-K-2016 forward compartment buildup.	Apr. 22		Do.
9	FO-K-3045 LES buildup	Apr. 14		Do.
10	FO-K-3060 C/M, S/M, CSM or SLA transportation and handling.	do		Do.
11	FO-M-3071 C/M-B/M mate	do		30 days for safety review.
12	FO-K-3071A C/M-S/M mate	May 6		7 days for safety review. This is an "A" revision to the basic which has had the full 30-day review period.
13	FO-K-3112 LES/DPC to C/M date/demate and thrust vector alinement verification.	Apr. 14		30 days plus for safety review.
14	FO-K-3113 C/M LES weight and balance and thrust vector alinement.	Mar.		Do.
15	FO-K-3116 CSM/SLA mating	Apr. 14		Do.
16	FO-K-3117 S/C transportation to pad and mate.	Apr. 22		Do.
17	FO-K-4058 electro explosive devices receiving inspection, storage and preinstallation checkout.	Apr. 14		Operation completed.
18	FO-K-4065 LES motor receiving, inspection, storage, and handling.	do		Do.
19	FO-K-4066 pitch control motor, receiving inspection, storage and handling.	do		Do.
20	FO-K-4067 jettison motor receiving, inspection, storage, and handling.	do		Do.
21	FO-K-4070 C/M RCS functional and leak test.	Apr.		OCP approved by KSC safety.
22	FO-K-4072 S/M RCS quad leak and functional test.	Apr. 22		Do.
23	FO-K-4074 SPS functional and leak test.	Apr.		Do.
24	FO-K-4079 SLA ordnance installation and removal.	Apr. 14		30 days plus for safety review.
25	FO-K-4082 propulsion pad functional test.		do	7 days for safety review very similar to OCP 4074 as approved by KSC safety also was used on S/C 009, all specifications and drawings have been approved.
26	FO-K-4086 SPS fuel servicing system test, manual control, LC 34.	Apr. 27		16 days for safety review similar to procedure used on S/C 009, all specifications and drawings have been approved.
27	FO-K-4089 SPS ovidizer servicing system test, manual control, LC 34.	May 3		14 days for safety review, similar to procedures used on S/C 009, all specifications and drawings have been approved.
28	FO-K-4231 S/A SIM RCS fuel servicing test, manual control, LC 34.		May 13	7 days for safety review, similar to procedure used on S/C 009, all specifications and drawings have been approved.
29	FO-K-4237 S/M RCS oxidizer servicing system test, manual control LC 34.		May 18	7 days for safety review, similar to OCP used on S/C 009, all specifications and drawings have been approved.
30	FO-K-4243 helium servicing system test, manual control, LC 34.	Apr. 30		10 days for safety review similar to OCP used on S/C 009, all specifications and drawings have been approved.

Status of safety significant OCP's for S/C 011—Continued

Item	OCP	Date transmitted to NASA safety	Date scheduled for transmittal to NASA safety	Remarks
31	FO-K-4249 LO_2 servicing system test, manual control, LC 34.	.....	May 23	8 days for safety review, all specifications and drawings have been approved.
32	FO-K-4252 LH_2 servicing system test, manual control LC 34.	.....	May 31	Do.
33	FO-K-4254 fuel servicing system test, propulsion test complex.	Mar. 1	.....	Operation completed.
34	FO-K-4601 oxidizer servicing system test, propulsion test complex.	March	.....	Do.
35	FO-K-4602 pressurization servicing systems test, propulsion test complex.	March	.....	Do.
36	FO-K-4615 fuel cell and cryo servicing cryogenic test facility.	May 3	.....	OCP approved by KSC safety.
37	FO-K-4616 cryogenic storage system verification, cryogenic test facility.	Apr. 29	.....	Do.
38	FO-K-4617 SC ordnance installation and removal.	.....	July 8	7 days for safety review, similar to OCP used on S/C 009; specifications and drawings have been approved.
39	FO-K-4618 LM_2 servicing system test, manual control, cryogenic test facility.	Apr. 14	.....	Operation completed.
40	FO-K-4619 LO_2 servicing system test, manual control, crygoenic test facility.	...do....	.....	Do.
41	FO-K-4622 SPS tanking/detanking LC 34, section 1, ACE control; section 2, manual control.	.....	July 21	7 days for safety review, same as approved for S/C 009; all specifications and drawings have been approved.
42	FO-K-4624 C/M RCS tanking/detanking LC 34, section 1, ACE control; section 2, manual control.	.....	...do....	Do.
43	FO-K-4700 S/M RCS tanking/detanking LC 34, section 1, ACE control; section 2, manual control.	.....	...do....	Do
44	FO-K-4736 fuel cell cryogenic servicing, LC 34.	.....	July 12	7 days for safety review, OCP is almost identical to OCP 4615 which is approved by KSC safety.
45	FO-K-4738 pyro verification test	.....	May 20	30 days plus for safety review.
46	FO-K-4741 fuel cell servicing, LC-34.	.....	June 9	7 days for safety review, OCP is almost identical to OCP 4615 which is approved by KSC safety.
47	FO-K-8227A S/M RCS quantity gaging system calibration.	Apr. 22	.....	30 days plus for safety review.
48	FO-K-8236 gas chromatograph analysis system and checkout PIA.	.....	May 11	7 days for safety review, complete package; specification drawings and manual has been approved by KSC safety.
49	FO-K-9179A LH_2 transfer unit (S14-026).	Apr. 11	.....	OCP approved by KSC safety.
50	FO-K-9180A LO_2 transfer unit (S14-032).	...do....	.....	Do.
51	FO-K-9187A LO_2 mobile storage unit (S14-065).	...do....	.....	Do.
52	FO-K-9188B LM_2 mobile storage unit (S14-066).	...do....	.....	Do.
53	FO-K-9882 ground equipment loading RCS propellant unit (S14-057) hypergolic test facility and launch complexes.	.....	.....	Safety review not required for S/C 011 per agreement with KSC safety; same as OCP approved for S/C 009.
54	FO-K-9883 ground equipment loading RCS propellant unit (S14-063) hypergolic test facility and launch complexes.	.....	.....	Do.
55	FO-K-9885 loading and unloading SPS propellant unit (S14-059) for propulsion test complex and launch complexes.	Apr. 14	.....	30 days plus for safety review.
56	FC-K-9886 loading and unloading SPS propellant unit (S14-058) for propulsion test complex and launch complexes.	...do....	.....	Do.
57	FO-K-10004 SC installations and removals.	May 3	.....	8 days for safety review very similar to OCP approved for S/C 009.

Subject: Apollo S/C 017 OCP Safety Review

NORTH AMERICAN AVIATION, INC.,
Manned Spacecraft Operations Building,
Kennedy Space Center, Florida.

Attention: Mr. J. L. Pearce

GENTLEMEN: The following listed Apollo S/C 017 OCP's are requested for KSC and Range Safety approval:

OCP No.	*Title*
0005	Integrated Test with Launch Vehicle Simulator
0007	Countdown
0033	Countdown Demonstration
0038	S/C Hypergolic Loading
3112	LES/BPC to C/M Mate/Demate & Thurst Vector Alignment Verification
3116	S/C Transportation to VAB and Mate
4070	C/M RCS Functional and Leak Test
4074	SPS Functional and Leak Test
4617	S/C Ordnance Installation and Removal
4736	Fuel Cell Cryogenic Servicing, LC–39
4747	Propulsion GSE Leak Check
K–5114	Water Glycol Servicing System Test, VAB
K–4720	Helium Servicing System Test, ACE Control, MSS
K–4721	Helium Servicing System Test, Manual Control, MSS
K–4723	SPS Fuel Servicing System Test, Manual Control, MSS
K–4725	C/M RCS Fuel Servicing System Test, Manual Control, MSS
K–4727	SPS Oxidizer Servicing System Test, Manual Control, MSS
K–4729	S/M RCS Fuel Servicing System Test, Manual Control, MSS
K–4731	CSM RCS Oxidizer Servicing System Test, Manual Control, MSS
K–4732	LH_2 Servicing System Test, ACE Control, MSS
K–4733	LH_2 Servicing System Test, Manual Control, MSS
K–4734	LO_2 Servicing System Test, ACE Control, MSS
K–4735	LO_2 Servicing System Test, Manual Control, MSS
K–9187	LO_2 Mobile Storage Unit (S14–065)
K–9188	LH_2 Mobile Storage Unit (S14–066)
K–9885	Loading and Unloading SPS Propellant Unit (S14–059) for Propulsion Test Complex and Launch Complexes
K–9886	Loading and Unloading SPS Propellant Unit (S14–058) for Propulsion Test Complex and Launch Complexes
K–9941	Calibration of Propellant Mass Measuring System Using Oxidizer
K–9942	Calibration of Propellant Mass Measuring System Using Fuel
K–10027	GSE Evacuation and Reinstallation—LC–39, Pad A

The following listed Apollo S/C 017 OCP's are required for KSC Safety information and update:

OCP No.	*Title*
3045	LES Build-up
3071	C/M–S/M Mate
3116	CSM/SLA Mating
4058	Electro Explosive Devices Receiving, Inspection, Storage and Pre-installation Checkout
4072	S/M RCS Functional and Leak Test
4079	SLA Ordnance Installation and Removal
4738	Pyro Verification Test

The North American Aviation, Inc. S/C 017 OCP status dated September 16, 1966, shows six (6) days between OCP publication and test date. This schedule is not acceptable to KSC Safety. For proper review of tests conducted at KSC, KSC Safety will require a minimum of fifteen (15) working days.

It is requested that NAA initiate action to assure KSC/SCO that the above listed procedures required for Safety approval be submitted with sufficient time for proper Safety review.

Your cooperation is appreciated.

Sincerely yours,

ERNEST N. SIZEMORE,
Chief, Planning and Technical Support Office.

Date: September 30, 1966
Requirements & Analysis Branch, KG–1
Chief, Operations Safety Branch, RE–1
Apollo S/C 017 OCP Request for KSC Safety Review

1. Please submit the attached list (Encl. #1) of Operations Checkout Procedures to KSC Safety for review and approval. Encl. #2 contains a list of OCPs which RE–1 requires for update.

2. Review of NAA S/C 017 OCP Status dated September 16, 1966, indicates that the allowable time between OCP publication and test date is only 6 days. KSC Safety has repeatedly asked for 30 days for review of procedures, but a workable solution has not been established to get these procedures to us by the required date.

3. The present schedule for S/C 017 OCP publication is not acceptable to KSC Safety. RE–1 must have a minimum of 14 working days to give the procedures proper review. Request your office initiate action to get these procedures to RE–1 with sufficient time allowed for proper Safety review.

JOHN T. MCGOUGH.

OCPs FOR KSC SAFETY REVIEW AND APPROVAL

OCP No.	*OCP title*
0005	Integrated Test with Launch Vehicle Simulator
0007	Countdown
0033	Countdown Demonstration
0038	S/C Hypergolic Loading
3112	LES/BPC To C/M Mate/Demate and Thrust Vector Alignment Verification
3116	S/C Transportation to VAB and Mate
4070	C/M RSC Functional and Leak Test
4074	SPS Functional and Leak Test
4617	S/C Ordnance Installation and Removal
4736	Fuel Cell Cryogenic Servicing, LC–39
4747	Propulsion GSE Leak Check
K–5114	Water Glycol Servicing System Test, VAB
K–4720	Helium Servicing System Test, ACE Control, MSS
K–4721	Helium Servicing System Test, Manual Control, MSS
K–4723	SPS Fuel Servicing System Test, Manual Control, MSS
K–4725	C/M RCS Fuel Servicing System Test, Manual Control, MSS
K–4727	SPS Oxidizer Servicing System Test, Manual Control, MSS
K–4729	S/M RCS Fuel Servicing System Test, Manual Control, MSS
K–4731	CSM RCS Oxidizer Servicing System Test, Manual Control, MSS
K–4732	LH_2 Servicing System Test, ACE Control, MSS
K–4733	LH_2 Servicing System Test, Manual Control, MSS
K–4734	LO_2 Servicing System Test, ACE Control, MSS
K–4735	LO_2 Servicing System Test, Manual Control, MSS
K–9187	LO_2 Mobile Storage Unit (S14–065)
K–9188	LH_2 Mobile Storage Unit (S14–066)
K–9885	Loading and Unloading SPS Propellant Unit (S14–059) for Propulsion Test Complex and Launch Complexes
K–9886	Loading and Unloading SPS Propellant Unit (S14–058) for Propulsion Test Complex and Launch Complexes
K–9941	Calibration of Propellant Mas s Measuring System Using Oxidizer
K–9942	Calibration of Propellant Mass Measuring System Using Fuel
K–10027	GSE Evacuation and Reinstallation LC–39, Pad A

OCPs RE–1 REQUIRES FOR UPDATE

OCP No.	*OCP title*
3045	LES Buildup
3071	C/M–S/M Mate
3116	CSM/SLA Mating
4058	Electro Explosive Devices Receiving, Inspection, Storage and Pre-Installation Checkout
4072	S/M RCS Functional and Leak Test
4079	SLA Ordnance Installation Removal
4738	Pyro Verification Test

Mr. RYAN. Can you describe what efforts were made by the Safety Review Board to require the contractor to submit their plans within 30 days?

Colonel BORMAN. I can say that there were no plans required for this particular test. There was nothing amiss as far as the Safety Review Board goes, because there was no requirement for a safety review of this test.

Mr. RYAN. What does it refer to?

Colonel BORMAN. A hazardous test.

Mr. RYAN. Which hazardous tests were not submitted on time?

Colonel BORMAN. I would have to check.

Mr. RYAN. The Review Board is saying that there had been a failure and that this has been repeatedly brought to the attention of North American.

Colonel BORMAN. That is right.

Mr. RYAN. I would think this would be of interest to the committee. What hazardous tests were not properly submitted to the Review Board?

Colonel BORMAN. We will have to get that information.

Mr. WYDLER. Looking at those four recommendations that you have listed on the screen, what changes would they require in any present NASA authority or North American procedures?

Colonel BORMAN. Pad crew personnel had not been given instruction in emergency opening of the hatches. It would have to be changed; it would have to be implemented.

Mr. WYDLER. If we asked NASA if they were doing those things the day before the accident, they would have said they were doing them all. There isn't anything they wouldn't have admitted they were not doing. They would say they were doing all that, if we asked them, the day before the accident; wouldn't they?

Colonel BORMAN. Yes, sir. It implies more than what they were doing. We want management to monitor and review all tests, not merely just the ones that have been designated as "hazardous."

If you had asked NASA if they were doing it for a hazardous test they would have said "Yes," and they would have answered you truthfully. The difference between a hazardous test and a nonhazardous one resulted in a considerable difference in the approach to the test.

Mr. GURNEY. This finding and these recommendations are certainly worthwhile. As a matter of fact, they probably would not have made any difference in this accident; would they?

Colonel BORMAN. Except for the first one.

Mr. GURNEY. You couldn't avoid this accident with all these in effect, isn't that right?

Colonel BORMAN. Yes, sir.

Mr. RYAN. Before we leave this question, perhaps Dr. Thompson would like to comment on this memorandum. Perhaps he might provide an example of the kind of procedure which was not submitted in advance and about which there was considerable correspondence. See page (d) (7) (57). What is the reference to? "The late submittal procedures have repeatedly been brought to the attention of North American."

Dr. THOMPSON. In (d) (13–10) there is paragraph 7, investigation of methods presently used to identify hazards in document emergency procedures. It is appendix D, panels 12 through 17. It is page 13–10.

"Investigation of methods presently used to identify hazards and document emergency procedures." This matter is discussed in considerable detail in that paragraph.

Mr. RYAN. Can you describe a hazardous test about which the safety office complained because it was not submitted on time?

Dr. THOMPSON. I am not familiar with the specific case referred to; I cannot describe it to you.

Mr. RYAN. Did your Review Board question the author of this No. 5?

Dr. THOMPSON. The panel determined that and tells you about that; the panel wrote this report. They are the ones that spent time in looking into those matters in detail.

Mr. RYAN. Is there anyone present in the room who can answer this question?

Dr. THOMPSON. Not at this time.

Mr. RYAN. Who could?

Colonel BORMAN. The gentleman who wrote that memorandum.

Dr. THOMPSON. Frank, you are not familiar with it.

Colonel BORMAN. I am familiar with the fact that we talked to the man. The only thing we know as far as specific tests were in that memorandum. They did not involve manned flights.

Mr. WILLIAMS. I can give you an example. I don't know if it is in specific correspondence, or so forth. But a test will come up where we will have to pressure a tank. We will know about it 2 days in advance. It is a new requirement. I cannot give specific memoranda he is talking about, but most probably it involves the hypergolic or cryogenic loading on complex 34. We can get you that information.

Mr. RYAN. It would be helpful to have that for the record. It certainly leaves the impression of a major negligence on a number of occasions.

Colonel BORMAN. There was some concern about the people who conducted this investigation being NASA people. The person who signed that document is in the NASA safety office. One of the dangers of asking people to investigate themselves is that they sometimes become overzealous when people who are supposed to respond to them do not do so in the manner that they think is appropriate.

Mr. TEAGUE. We would appreciate having that information furnished for the record.

(The information referred to follows:)

OCTOBER 5, 1966.

Chief, Test and Operations Management Office, KE.
Chief Safety Office, RE.
Operations checkout procedures for KSC safety review.

1. Review of NAA S/C 017 OCP status dated September 16, 1966, indicates that the allowable time between OCP publication and test date is only 6 days.

2. KSC Safety has repeatedly requested 30 days for review of procedures, but to date, a workable solution has not been established to assure our receiving the procedures by the required date.

3. The present schedule for S/C 017 OCP publication is not acceptable to KSC Safety. RE–1 must have a minimum of 14 working days to give the procedures proper review.

4. RE requests that your office initiate action to eliminate the aforementioned problem.

JOHN R. ATKINS.

MAY 2, 1966.

Mr. J. Simmons, SCO–63.
Chief, Operations Safety Branch, QAS–23.
OCP–FO–K–4620, GO_2 Servicing System Test, and OCP–FO–K–4621, GH_2 Servicing System Test.

1. Subject procedures were received on the morning of May 2, 1966, with the cover letter stating that the tests were scheduled for May 2 and 4, 1966.
2. It is not normal for this office to approve a flimsy copy of the checkout procedures. We can make comments on flimsy copies, but it appears that most procedures are changed before they are published in the hardback copy.
3. The two subject procedures do not have a NASA Systems Engineer's signature, so we must assume that the NASA Systems Engineers do not approve the procedures.
4. By receiving these procedures with only one day to review them, this office cannot review them properly.
5. These two procedures will not be reviewed nor approved until a NASA Systems Engineer's signature has been affixed.
6. Further flimsy copies of any procedures will not be approved by this office. We will submit comments only to flimsy copies.
7. These two tests do not have KSC Safety approval at this time, and KSC Safety will not condone the running of these tests with GO_2 and GH_2 in the MSO until we have received and reviewed the proper procedure.

JOHN T. MCGOUGH.

MAY 18, 1966.

Chief, Safety Division, QAS–2.
Manager, Apollo CSM Operations, SCO–8.
Transmittal of Apollo S/C 011 Technical Information.
Reference: Your memo dated April 26, 1966, same subject.

1. Based upon the information contained in the referenced memo, NAA was requested to prepare a package showing documents anticipated submittal date.
2. NAA's response is enclosed. It should be noted that in most cases the scheduled transmittal dates do not comply with the 30-day pre-test safety review requirement. It should be further noted that most of these cases concern documents previously approved for S/C 009 and that the content is virtually identical.
3. Due to the advanced schedule that has been initiated for S/C 011, it is our feeling that the dates presented by the contractor in the enclosure represent the "best possible" and can not be improved.
4. If these dates are not satisfactory then the utilization of flimsey or advance copies for KSC and ETORS safety reviews must be reconsidered.
5. If this is unacceptable, QAS should contact PPR and negotiate the resulting S/V schedule impact.
6. This office will insure delivery of the documents to KSC Safety at the earliest possible date.

GEORGE T. SASSEEN.

MAY 9, 1966.

John F. Kennedy Space Center,
National Aeronautics and Space Administration,
Kennedy Space Center, Fla.
(Attention Manager, Apollo CSM Operations (SCO–8)).

CONTRACT NAS 9–150, SAFETY SIGNIFICANT OCP'S, STATUS OF TRANSMITTAL OF

In order that the current status of safety significant documentation submittal for CSM 011 may be more fully understood, enclosures (1) through (5) are submitted for your attention. It should be noted that the only areas where NAA has not met the full 30 day safety review requirements are a limited number of OCP's as can be identified from enclosure (3). The under-support of the 30 day safety review is primarily a result of a facility ORD compression of 14 days and compression of the launch schedule. You are assured that MAA is making a

determined effort to recover as much of the 30 day review time as possible and will continue this effort.

It may be to the advantage of the KSC Safety Office to reconsider its position of not reviewing advanced copies of the OCP's in respect to those OCP's showing under-support. An advanced review in combination with the complete file of specifications and drawings, currently in possession of KSC Safety Office, plus the knowledge that in most instances the OCP is a rerun of S/C 009 procedures, may reduce review time on the final released OCP to a degree that schedule impacts can be avoided.

The NAA Apollo Systems Safety personnel will be most happy to assist in any way possible to support your safety personnel in their reviews of procedures.

J. L. PEARCE, NORTH AMERICAN AVIATION, INC.,
Director, Apollo CSM Operations, Florida Facility, Space and Information Systems Divisions.

Status of safety significant OCP's for S/C 011

Item and OCP	Date transmitted to NASA safety	Date scheduled for transmittal to NASA safety	Remarks
1. FO-K-0007 countdown		July 30	
2. FO-K-0033 countdown demonstration		July 12	7 days for safety review, OCP is very similar to S/C 005 0033 except Cryo is used.
3. 0034 CSM altitude chamber test		June 2	7 days for safety review.
4. FO-K-0035 combined systems test	May 4		16 days for safety review. OCP is very similar to S/C 005 0035 except test is conducted in alt. chbr.
5. FO-K-0038S/C hypergolic loading		July 21	7 days for safety review; OCP combines OCP's 4082, 4622, 4624, and 4700 as approved for S/C 009.
6. FO-K-1056 water glycol servicing system test, altitude chamber, B808	Apr. 22		Operation completed.
7. FO-K-1210 water glycol servicing system test, cryogenic test facility	Apr. 14		Do.
8. FO-K-2016 forward compartment buildup	Apr. 22		Do.
9. FO-K-3045 LES buildup	Apr. 14		Do.
10. FO-K-3065 C/M, S/M, CSM, or SLA transportation and handling	do		Do.
11. FO-K-3071 C/M—S/M Mate	do		30 days for safety review.
12. FO-K-3071A C/M—S/M Mate	May 6		7 days for safety review. This is an "A" revision to the basic which has had the full 30-day review period.
13. FO-K-3112 LBS/BPD to C/M date/demate and thrust vector alinement verification.	Apr. 14		30 days plus for safety review.
14. FO-K-3113 C/M LES weight and balance and thrust vector alinement	(1)		Do.
15. FO-K-3116 CSM/SLA Mating	Apr. 14		Do.
16. FO-K-3117 S/C transportation to pad and mate	Apr. 22		Do.
17. FO-K-4058 electro explosive devices receiving inspection, storage, and pre-installation checkout.	Apr. 14		Operation completed.
18. FO-K-4065 LES motor receiving, inspection, storage, and handling	Apr. 14		Do.
19. FO-K-4066 pitch control motor, receiving, inspection, storage, and handling	do		Do.
20. FO-K-4067 jettison motor receiving, inspection, storage, and handling	do		Do.
21. FO-K-4070 C/M RCS functional and leak test	(2)		OCP approved by KSC safety.
22. FO-K-4072 S/M RCS quad leak and functional test	Apr. 22		Do.
23. FO-K-4074 SPS functional and leak test	(2)		Do.
24. FO-K-4079 SLA ordnance installation and removal	Apr. 14		30 days plus for safety review.
25. FO-K-4082 propulsion pad functional test		July 21	7 days for safety review very similar to OCP 4074 as approved by KSC safety also was used on S/C 009. all specifications and drawings have been approved.
26. FO-K-4086 SPS fuel servicing system test, manual control, LC 34	Apr. 27		16 days for safety review similar to procedure used on S/C 009, all specifications and drawings have been approved.
27. FO-K-4089 SPS oxidizer servicing system test, manual control, LC 34	May 3		14 days for safety review, similar to procedures used on S/C 009. all specifications and drawings have been approved.

28. FO-K-4231-S/A SIM RCS fuel servicing test, manual control, LC 34	----------	May 13	7 days for safety review, similar to procedure used on S/C 009, all specifications and drawings have been approved.
29. FO-K-4237 S/M RCS oxidizer servicing system test, manual control, LC 34	----------	May 18	7 days for safety review, similar to OCP used on S/C 009, all specifications and drawings have been approved.
30. FO-K-4243 helium servicing system test, manual control, LC 34	Apr. 30	----------	10 days for safety review similar to OCP used on S/C 009, all specifications and drawings have been approved.
31. FO-K-4249 LO_2 servicing system test, manual control. LC 34	----------	May 23	8 days for safety review, all specifications and drawings have been approved.
32. FO-K-4252 LH_2 servicing system test, manual control, LC 34	----------	May 31	Do.
33. FO-K-4254 fuel servicing system test, propulsion test complex	(1)	----------	Operation completed.
34. FO-K-4601 oxidizer servicing system test, propulsion test complex	(1)	----------	Do.
35. FO-K-4602 pressurization servicing systems test, propulsion test complex	(1)	----------	Do.
36. FO-K-4615 fuel cell and cryo servicing, cryogenic test facility	May 3	----------	OCP approved by KSC Safety.
37. FO-K-4616 cryogenic storage system verification, cryogenic test facility	Apr. 29	----------	Do.
38. FO-K-4617 SC ordnance installation and removal	----------	July 8	7 days for safety review, similar to OCP used on S/C 009; specifications and drawings have been approved.
39. FO-K-4618 LM_2 servicing system test, manual control, cryogenic test facility.	Apr. 14	----------	Operation completed.
40. FO-K-4619 LO_2 servicing system test, manual control, cryogenic test facility	---do----	----------	Do.
41. FO-K-4622 SPS tanking/detanking LC34: sec. 1, ACE control; sec. 2, manual control.	----------	July 21	7 days for safety review, same as approved for S/C 009; all specifications and drawings have been approved.
42. FO-K-4624 C/M RCS tanking/detanking LC 34: sec. 1, ACE control; sec. 2, manual control.	----------	---do----	Do.
43. FO-K-4700 S/M RCS tanking/detanking LC 34: sec. 1, ACE control, sec. 2, manual control.	----------	---do----	Do.
44. FO-K-4736 fuel cell cryogenic servicing, LC 34	----------	July 12	7 days for safety review, OCP is almost identical to OCP 4615 which is approved by KSC Safety.
45. FO-K-4738 pyro verification test	----------	May 20	30 days plus for safety review.
46. FO-K-4741 fuel cell servicing, LC 34	----------	June 9	7 days for safety review, OCP is almost identical to OCP 4615 which is approved by KSC Safety.
47. FO-K-8227A S/M RCS quantity gaging system calibration	Apr. 22	----------	30 days plus for safety review.
48. FO-K-8236 gas chromatograph analysis system and checkout PIA	----------	May 11	7 days for safety review, complete package; specifications, drawings, and manual has been approved by KSC Safety.
49. FO-K-9179A LH_2 transfer unit (S14-026)	Apr. 11	----------	OCP approved by KSC Safety.
50. FO-K-9180A LO_2 transfer unit (S14-032)	---do----	----------	Do.
51. FO-K-9187A LO_2 mobile storage unit (S14-065)	---do----	----------	Do.
52. FO-K-9188C LM_2 mobile storage unit (S14-066)	---do----	----------	Do.
53. FO-K-9882 ground equipment loading RCS propellant unit (S14-057) hypergolic test facility and launch complexes.	----------	----------	Safety review not required for S/C 011 per agreement with KSC Safety; same as OCP approved for S/C 009.
54. FO-K-9883 ground equipment loading RCS propellant unit (S14-063) hypergolic test facility and launch complexes.	----------	----------	Do.
55. FO-K-9885 loading and unloading SPS propellant unit (S14-099) for propulsion test complex and launch complexes.	Apr. 14	----------	30 days plus for safety review.
56. FO-K-9886 loading and unloading SPC propellant unit (S14-058) for propulsion test complex and launch complexes.	---do----	----------	Do.
57. FO-K-10004 SC installations and removals	May 3	----------	8 days for safety review very similar to OCP approved for S/C 009.

[1] March. [2] April.

Subject: Apollo S/C 017 OCP Safety Review.

NORTH AMERICAN AVIATION, INC.,
Manned Spacecraft Operations Building,
Kennedy Space Center, Fla.
(Attention Mr. J. L. Pearce).

GENTLEMEN: The following listed Apollo S/C 017 OCP's are requested for KSC and Range Safety approval:

OCP No. and Title:

0005 Integrated Test with Launch Vehicle Simulator.
0007 Countdown.
0033 Countdown Demonstration.
0038 S/C Hypergolic Loading.
3112 LES/BPC to C/M Mate/Demate & Thrust Vector Alignment Verification.
3116 S/C Transportation to VAB and Mate.
4070 C/M RCS Functional and Leak Test.
4074 SPS Functional and Leak Test.
4617 S/C Ordnance Installation and Removal.
4736 Fuel Cell Cryogenic Servicing, LC–39.
4747 Propulsion GSE Leak Check.
K–5114 Water Glycol Servicing System Test, VAB.
K–4720 Helium Servicing System Test, ACE Control, MSS.
K–4721 Helium Servicing System Test, Manual Control, MSS.
K–4723 SPS Fuel Servicing System Test, Manual Control, MSS.
K–4725 C/M RCS Fuel Servicing System Test, Manual Control, MSS.
K–4727 SPS Oxidizer Servicing System Test, Manual Control, MSS.
K–4729 S/M RCS Fuel Servicing System Test, Manual Control, MSS.
K–4731 CSM RCS Oxidizer Servicing System Test, Manual Control, MSS.
K–4732 LH_2 Servicing System Test, ACE Control, MSS.
K–4733 LH_2 Servicing System Test, Manual Control, MSS.
K–4734 LO_2 Servicing System Test, ACE Control, MSS.
K–4735 LO_2 Servicing System Test, Manual Control, MSS.
K–9187 LO_2 Mobile Storage Unit (S14–065).
K–9188 LH_2 Mobile Storage Unit (S14–066).
K–9885 Loading and Unloading SPS Propellant Unit (S14–059) for Propulsion Test Complex and Launch Complexes.
K–9886 Loading and Unloading SPS Propellant Unit (S14–058) for Propulsion Test Complex and Launch Complexes.
K–9941 Calibration of Propellant Mass Measuring System Using Oxidizer.
K–9942 Calibration of Propellant Mass Measuring System Using Fuel.
K–10027 GSE Evacuation and Reinstallation—LC–39, Pad A.

The following listed Apollo S/C 017 OCP's are required for KSC Safety information and update:

OCP No. and Title:

3045 LES Build-up.
3071 C/M–S/M Mate.
3116 CSM/SLA Mating.
4058 Electro Explosive Devices Receiving, Inspection, Storage and Preinstallation Checkout.
4072 S/M RCS Functional and Leak Test.
4079 SLA Ordnance Installation and Removal.
4738 Pyro Verification Test.

The North American Aviation, Inc. S/C 017 OCP status dated September 16, 1966, shows six (6) days between OCP publication and test date. This schedule is not acceptable to KSC Safety. For proper review of tests conducted at KSC, KSC Safety will require a minimum of fifteen (15) working days.

It is requested that NAA initiate action to assure KSC/SCO that the above listed procedures required for Safety approval be submitted with sufficient time for proper Safety review.

Your cooperation is appreciated.

Sincerely yours,

ERNEST N. SIZEMORE,
Chief, Planning and Technical Support Office.

MEMORANDUM

SEPTEMBER 30, 1966.

Requirements and Analysis Branch, KG–1.
Chief, Operations Safety Branch, RE–1.
Apollo S/C 017 OCP request for KSC safety review.

1. Please submit the attached list (Encl. #1) of Operations Checkout Procedures to KSC Safety for review and approval. Encl. #2 contains a list of OCPs which RE–1 requires for update.

2. Review of NAA S/C 017 OCP Status dated September 16, 1966, indicates that the allowable time between OCP publication and test date is only 6 days. KSC Safety has repeatedly asked for 30 days for review of procedures, but a workable solution has not been established to get these procedures to us by the required date.

3. The present schedule for S/C 017 OCP publication is not acceptable to KSC Safety. RE–1 must have a minimum of 14 working days to give the procedures proper review. Request your office initiative action to get these procedures to RE–1 with sufficient time allowed for proper Safety review.

JOHN T. MCGOUGH.

OCB'S FOR KSC SAFETY REVIEW AND APPROVAL

OCP No. and title:

0005 Integrated Test with Launch Vehicle Simulator.
0007 Countdown.
0033 Countdown Demonstration.
0038 S/C Hypergolic Loading.
3112 LES/BPC To C/M Mate/Demate and Thrust Vector Alignment Verification.
3116 S/C Transportation to VAB and Mate.
4070 C/M RCS Functional and Leak Test.
4074 SPS Functional and Leak Test.
4617 S/C Ordnance Installation and Removal.
4736 Fuel Cell Cryogenic Servicing, LC–39.
4747 Propulsion GSE Leak Check.
K–5114 Water Glycol Servicing System Test, VAB.
K–4720 Helium Servicing System Test, ACE Control, MSS.
K–4721 Helium Servicing System Test, Manual Control, MSS.
K–4723 SPS Fuel Servicing System Test, Manual Control, MSS.
K–4725 C/M RCS Fuel Servicing System Test, Manual Control, MSS.
K–4727 SPS Oxidizer Servicing System Test, Manual Control, MSS.
K–4729 S/M RCS Fuel Servicing System Test, Manual Control MSS.
K–4731 CSM RCS Oxidizer Servicing System Test, Manual Control, MSS.
K–4732 LH_2 Servicing System Test, ACE Control, MSS.
K–4733 LH_2 Servicing System Test, Manual Control, MSS.
K–4734 LO_2 Servicing System Test, ACE Control, MSS.
K–4735 LO_2 Servicing System Test, Manual Control, MSS.
K–9187 LO_2 Mobile Storage Unit (S14–065).
K–9188 LH_2 Mobile Storage Unit (S14–066).
K–9885 Loading and Unloading SPS Propellant Unit (S14–059) for Propulsion Test Complex and Launch Complexes.
K–9886 Loading and Unloading SPS Propellant Unit (S14–058) for Propulsion Test Complex and Launch Complexes.
K–9941 Calibration of Propellant Mass Measuring System Using Oxidizer.
K–9942 Calibration of Propellant Mass Measuring System Using Fuel.
K–10027 GSE Evacuation and Reinstallation LC–39, Pad A.

OCPS RE–1 REQUIRES FOR UPDATE

OCP No. and title:

3045 LES Buildup.
3071 C/M–S/M Mate.
3116 CSM/SLA Mating.
4058 Electro Explosive Devices Receiving, Inspection, Storage and Pre-Installation Checkout.
4072 S/M RCS Functional and Leak Test.
4079 SLA Ordnance Installation and Removal.
4738 Pyro Verification Test.

Mr. GURNEY. One other question, Colonel, on these safety procedures. Did the Board come up with any recommendation or consider the position of whether in the testing procedures you could detect an electrical mishap or a source of energy increase which would contribute to a fire? I think we touched on this a little bit before. What I am really talking about are those lines we looked at earlier this afternoon that obviously rang a bell if you could recognize them. Are there any recommendations about changing the testing procedures so that this condition might have been recognized or could be recognized in the future?

Colonel BORMAN. Dr. Faget covered that. Any such instrumentation would be prohibitive.

Mr. GURNEY. That was the feeling of the Board in general?

Colonel BORMAN. I believe so. He is the director of engineering development.

Excuse me. I think that is right.

6. Finding:

Frequent interruptions and failures had been experienced in the overall communication system during the operations preceding the accident.

The Board did not feel this contributed to the accident.

We are talking about the ground communication system.

Mr. FULTON. Was that because of loose connections or faulty reception?

Colonel BORMAN. This is a design problem. We changed from a four-wire system in the spacecraft to a two-wire system with vox relays on the ground and the relays were not tuned up properly.

Mr. FULTON. Have the astronauts complained about these failures previously? It would seem to me that communication on any test would be of vital importance.

Colonel BORMAN. We determined the overall communication system was unsatisfactory.

Mr. FULTON. Had they complained about it?

Colonel BORMAN. Not to my knowledge. Several other people in NASA complained about it, but I am not sure that this particular crew did.

Mr. FULTON. Who would they be?

Colonel BORMAN. Mr. Craft had some very strong feelings about the inadequacy of the communication system.

Mr. FULTON. Does not this lead to the safety of the astronauts?

Colonel BORMAN. Yes.

Recommendation, ground communications system be improved to assure reliable communications between all test elements as soon as possible and before the next manned flight.

A detailed design review be conducted on the entire spacecraft communication system.

Mr. DOWNING. It was reported that the astronauts complained of a sour odor in the cabin.

Colonel BORMAN. Yes, sir.

Mr. DOWNING. What was it?

Colonel BORMAN. There was no determination of any gases that could have led to a combustible mixture. We have the analysis sheet. It was what we could expect for normal oxygen.

Mr. DOWNING. What were they complaining about?

Colonel BORMAN. They were complaining about a sour milk odor. We did not identify the specific substance that would have caused that.

Mr. DOWNING. The people who were responsible for checking out odors, were they available?

Colonel BORMAN. Yes, sir.

Mr. DOWNING. Did they have an instrument with them?

Colonel BORMAN. The test was delayed while the sample was taken. The analysis of this sample was negative.

Mr. DOWNING. Thank you.

Colonel BORMAN. Next slide.

Finding: (a) Revisions to the operational checkout procedure for the test were issued at 5:30 p.m., eastern standard time, January 26, 1967—209 pages—and 10 a.m., eastern standard time, January 27, 1967—4 pages.

(b) Differences existed between the ground test procedures and the in-flight check lists.

Mr. FULTON. Whose job was it, in the line of authority in administration, to correlate the ground test procedures and the in-flight check list? If differences exist whose job was it to correlate them?

Colonel BORMAN. It would require coordination between the flight crew operations division of Houston and the test organization at Kennedy.

Mr. FULTON. Was that caused by the difference in location or a difference in time, or was it difference of opinion?

Colonel BORMAN. The difference was primarily caused in that the flight checklists were designed for flight. This test was not a launch and consequently some of the switch positions were not the same as they would be during a flight. This finding is brought in only to point out the fact that we must make sure that the two are compatible and that we are using the same checklist for the particular test.

Mr. FULTON. What is the real point of your paragraph (a)?

Colonel BORMAN. In the determinations and recommendations.

Mr. FULTON. But point out what paragraph a means.

Colonel BORMAN. It means that a test procedure had been issued some time before the test was to be run, someone showed up the night before with 209 pages of changes to the test.

Mr. FULTON. Who is that someone?

Colonel BORMAN. John Williams can best answer that.

Mr. WILLIAMS. It would be the test organization.

Mr. FULTON. Where?

Mr. WILLIAMS. Down at Kennedy.

Mr. FULTON. Who are they under?

Mr. WILLIAMS. Under NASA.

Mr. FULTON. Are they part NASA and part contractor?

Mr. WILLIAMS. That is correct.

Mr. DAVIS. I have a question about the previous slide.

On your communications was that all on 28-volt direct current?

Colonel BORMAN. Again, you have exceeded my particular capability to answer. I will have to defer to someone who knows the details of the communicative system. Is there anyone on the Board who knows?

Mr. DAVIS. I want to know if all communications were conducted over 28 volts direct current?