

**APPENDIX H**  
**BOARD RELEASES AND PRESS STATEMENTS**



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APOLLO NEWS CENTER  
HOUSTON, TEXAS

NEWS RELEASE NO. A13-10  
APRIL 17, 1970  
SUBJECT: APOLLO 13 REVIEW BOARD

The National Aeronautics and Space Administration today established an Apollo 13 Review Board to investigate the circumstances and causes of the accident aboard the spacecraft Odyssey and the subsequent flight and ground actions taken to recover.

This action was taken by NASA's Administrator, Dr. Thomas O. Paine, and Deputy Administrator, Dr. George M. Low, immediately following the successful recovery of the astronauts today "because of the serious nature of the accident to the Apollo 13 spacecraft which jeopardized human life and caused failure of the Apollo 13 lunar mission."

Mr. Edgar Cortright, Director of NASA's Langley Research Center in Hampton, Virginia, was appointed Chairman of the Review Board. Mr. Cortright served for many years as NASA's Deputy Associate Administrator for Space Science and Applications, and in 1967-68 was Deputy Associate Administrator for Manned Space Flight.

The other members of the Board will be senior individuals from NASA and other government agencies with special competence in flight safety matters, the Apollo systems, or the various technical disciplines related to the investigation, but not having direct responsibilities relating to Apollo 13. Top consultants from government, industry, and the academic community will also be available to the Board as required. NASA's Aerospace Safety Advisory Panel, a statutory panel responsible to the Administrator, will review both the procedures and findings of the Review Board and make an independent report to the Administrator.

The Apollo 13 Review Board will establish its own procedures as provided by standing NASA instructions for the investigation of mission failures. The timing of its report will be determined after the Board has met and made an assessment of the length of investigation required. The Board will make periodic progress reports directly to the Administrator and Deputy Administrator. Timely progress reports will also be made to Congress and the public.

NASA's Office of Manned Space Flight will make available to the Review Board all pertinent records and data and will provide technical support to the Board as requested. The Office of Manned Space Flight,

as a part of its regular responsibilities, will develop parallel recommendations on corrective measures to be taken prior to the Apollo 14 mission.

Decisions on the Apollo 14 mission will depend on the findings and recommendations of the Apollo 13 Review Board, the Aerospace Safety Advisory Panel, and the Office of Manned Space Flight.

APOLLO NEWS CENTER  
HOUSTON, TEXAS

NEWS RELEASE NO. A13-10

APRIL 18, 1970

SUBJECT: UP-DATE TO STATUS OF APOLLO 13 REVIEW BOARD

The Chairman of the Apollo 13 Review Board, Mr. Edgar Cortright, Director of NASA's Langley Research Center, expects to discuss with Dr. Paine and Dr. Low on Monday the appointment of additional members of the Board established to review the accident to the Apollo 13 spacecraft. The Board will meet as soon as possible — very soon, Mr. Cortright said — to set up its procedures and begin its investigations.

APOLLO 13 INVESTIGATION BOARD REPORT NO. 1  
APRIL 21, 1970

DUFF: Ladies and Gentlemen, this is a briefing by Mr. Edgar M. Cortright, the chairman of the Apollo 13 Review Board. Mr. Cortright.

CORTRIGHT: I thought that it would be beneficial if we got together for a few minutes today to give you some idea of how this Review Board will be conducted, and to announce the members of the Board. The membership has just been selected by Dr. Paine. Basically, as you know, from the material you've received already, and to paraphrase my detailed instructions, the function of the Board is to perform an independent assessment of what happened, why it happened, and what to do about it. To do this, we have selected a group of senior officials from both within the agency and without the agency. These gentlemen will meet here with me during the next few weeks in intensive sessions, which will probably run days, nights, and weekends, without letup, in order to get an early determination. The group will be supported by an additional group of experts, and we will select these gentlemen within the next 2 or 3 days. In addition, we'll draw on the work that the project is now carrying out under the direction of the project manager to determine on their own what happened. Now, the members of the Board are as follows: Mr. Robert Allnutt, who is assistant to the administrator in NASA Headquarters; Mr. Neil Armstrong, astronaut, from the Manned Spacecraft Center; Dr. John Clark, Director of the Goddard Space Flight Center; Brigadier General Walter Hedrick, Jr., Director of Space, Deputy Chief of Staff for R&D office, Headquarters, USAF, Washington; Mr. Vince Johnson, Deputy Associate Administrator for Engineering, in the Office of Space Science and Applications, NASA Headquarters; Mr. Milton Klein, Manager of the AEC-NASA Space Nuclear Propulsion Office; and Dr. Hans Mark, Director of the Ames Research Center.

QUERY: How do you spell that last?

CORTRIGHT: Mark. M-a-r-k. In addition, the counsel, legal counsel, for the Board, will be Mr. George Malley, who is Chief Counsel for the Langley Research Center. Mr. Charles Mathews, Deputy Associate Administrator, Office of Manned Space Flight, will be named to work with the Board to help provide the technical support we'll need to get our job done. In addition, there will be three officially named observers to the



Board. Mr. William Anders, former astronaut, now Executive Secretary, National Aeronautics and Space Council; Dr. Charles D. Harrington, Chairman, NASA Aerospace Safety Advisory Panel, and also President and General Manager of Douglas United Nuclear Incorporated; and Mr. Irving Pinkel, Director, Aerospace Safety Research and Data Institute, Lewis Research Center. We'll be assisted in our relationships with the press by Mr. Brian Duff of the Manned Spacecraft Center. And we'll be assisted in our relationships with the Congress, during the course of this investigation, by Mr. Gerald Mossinghoff, Office of Legislative Affairs, NASA Headquarters. It will be our policy during the course of this investigation to keep you informed of what we're doing, and how we're going about our business, insofar as that is practical. One thing I'd like to avoid, however, is speculation. I must avoid that with this type of a Board. So, if sometimes I appear to be not as communicative as you would like, it will only be because I'm not in a position to say something with authority and certainty, at that time; but otherwise we'll do all we can to keep the members of the press fully informed of what we're doing. And, I think that is about all I really planned to say. I make myself available for questions within the ground rules that I just specified, that I'd like to avoid speculation, and further, since the Board has not held its first meeting, I can't very well represent the Board at this point.

- DUFF: I'd just say one thing, before we have questions. The biographies of all the members and the documents relating to what Mr. Cortright has just said will be available after this conference is over. Now we'll take questions.
- QUERY: Can I add one point, Brian? I think I forgot to mention that the first meeting of the Board will take place at 8:00 p.m. this evening.
- DUFF: All right Bob, we'll start across the front row.
- QUERY: I realize it's impossible for you to say precisely how long the Board will take to reach the determination, but do you have any estimate at this time? In other words, would it be a matter of perhaps 3 or 4 weeks or do you think it would last through the summer?
- CORTRIGHT: It's my hope that we can reach adequate and effective determination within 3 or 4 weeks. As a matter of fact, that is the number I had in my mind. But we'll have to take as much time as required to do it properly. It could run longer.

SPEAKER Bob.

QUERY: What procedure will you follow for calling perhaps contractor experts and so on? Can you - you said you would talk about them a little bit.

CORTRIGHT: Yes, we identified the need for speciality information that's best developed by a contractor. We'll call on that contractor to provide us information and/or to appear before the Board to testify on this information.

QUERY: Do you have any names or companies already formulated?

CORTRIGHT: No.

QUERY: What is going to be the possibility, Ed, on making your releases? Are you going to do it on a regular basis like once or twice a week, or just whenever you have something to say? How are you going to arrange this?

CORTRIGHT: The releases of the Board will be made only with my approval and through the office of the Public Affairs here at Houston. Now there may, of course, be releases by Dr. Paine or Mr. Low based on information that I can provide them on regular meetings. We'll probably meet once a week. And I would envision the use of bulletins for the press. How much information they would contain would be dependent on how much progress we will make. But at least it would keep you informed on where we are and what activities are facing the Board that week.

QUERY: Do you intend to break the Board down into teams similar to what was done for the 204 Review Board?

CORTRIGHT: That's my current plan. But until the Board meets with me and expresses their individual opinions and negotiate a little bit, I won't know for certain.

DUFF: Here.

QUERY: Ed, when will you have all the telemetry data reduced, do you think, with the Board then in a position to move at full burner?

CORTRIGHT: Well, the telemetry data are being reduced at the moment by a pretty sizable team of engineers, both here and in the contractor's plant. I don't have specifics on that yet, Jules, but I have the impression that they expect some

milestones to be reached before the end of the week, in terms of telemetry data reduction. Of course, that's sort of first time through, perhaps, and we'd have to iterate that to get the last little bit out of it.

QUERY: Was consideration given to appointing Lt. Gen. Sam Phillips to the Board?

SPEAKER: I'm not certain. Dr. Paine selected the Board. I know General Phillips is extremely busy with his present assignment and it probably would be an impossibility.

DUFF: Right here, Mary Bubb.

QUERY: When you finally do pinpoint the cause, sir, how long do you think it will take you to decide whether you have to go into redesign or some modifications? I would presume anyway that you would make recommendations along these lines.

SPEAKER: Well, of course that depends on what the problem is. Generally speaking, you work on potential fixes at the same time you're homing in on the probable cause, so that there need not necessarily be a long period of time between the two, the determination of the problem and what to do about it. On the other hand, there could be under certain circumstances, and my position at the moment is that I can't - I have a totally open mind. I'm trying not to prejudge anything. As the facts unfold, then we'll start forming opinions.

DUFF: Ed.

QUERY: Two questions: I assume that the bulk of the investigation will be conducted here at MSC. Is that correct?

CORTRIGHT: That is correct.

QUERY: And what will the relationship be between your Board's investigation and the investigations already underway by individual contractor teams and by the initial review board that was set up right after the accident? And what is the status of that board, by the way?

CORTRIGHT: Well, I'd rather not comment on the status of the Manned Spacecraft Center Board. That's Dr. Gilruth's board, but I can tell you a little bit about how we plan to work together. In the first place, most of the detailed technical work will have to be done by the men who know that area the

best, and these are the engineers and scientists of the Manned Spacecraft Center and the prime and supporting contractors. We will follow their work and audit their work and make the best possible use of their work that we can. At the same time, we'll maintain sufficient independence so that it will constitute a true independent check on what's done here and an independent assessment of what corrective measures should be taken. Does that answer your question?

QUERY: Mr. Cortright, in your experience have you ever conducted a similar investigation having to do with unmanned spacecraft, trying to find out what happened?

CORTRIGHT: I have not chaired a board of this type, but I've been involved in a number of investigations of various unmanned spacecraft projects, such as Ranger, Surveyor, and Centaur.

QUERY: What was your rate of success in these investigations?

CORTRIGHT: Well, all of the projects that I mentioned succeeded to a rather high degree. The extent to which the review board helped that process is something we'll probably never know.

DUFF: Here in the front row.

QUERY: Will your reports - your periodic reports to Dr. Paine be released to the press?

CORTRIGHT: Probably not.

QUERY: Will we know that there are these reports and will we even know the gist of them, if you're making progress, or stymied, or what?

CORTRIGHT: Well, as I mentioned earlier, we will try to keep the press informed as to what's going on with the Board, but we'll stop short of speculating or prematurely judging the results. That, of course, is quite a constraint in terms of making public what our current opinions are as to what happened, and I think we'll be fairly limited on what we can say until this job is done. Now, my reports to Dr. Paine will be informal progress reports and will contain just the sort of material that it would be improper to release in totality because it's somewhat speculative in nature. I don't think you'd really want that any more than I would.

QUERY: Ed, I'm not quite clear on this point. You may have made it clear and I may have slipped in a cog. Does - is corrective work, such as deemed necessary by various groups here at MSC or the Cape, or wherever else it might be, is corrective work suspended or held in abeyance while the Board meets? For example, if it were found that the liquid oxygen tank, for example, was suffering from stress corrosion or metal fatigue and blew at too low a pressure, and Beech or North American or somebody wanted to go ahead developing new tanks, would that effort go ahead in tandem with the Board's investigation or be held up for the Board's findings?

CORTRIGHT: I'm not positive, but I believe the procedure that would be followed would be that a major corrective work which might impact the existing system and result in changes to hardware that's currently assembled would be held in abeyance until the Board's report was in. On the other hand, it is not unreasonable that certain things could go forward in parallel for possible incorporation later in order to save time now.

QUERY: Dr. Cortright, does your franchise possibly extend to the early shutdown of the second stage engine, and second question, is it likely that you would make any recommendations on the deployment of rescue ships in the Atlantic or even possibly the Indian Ocean?

CORTRIGHT: The instruction does not require us to examine the early shutdown on the second stage engine except insofar as the peak g loads might have influenced the anomaly we're looking into. I don't anticipate that we will be considering deployment or any other aspects of rescue ships.

QUERY: Along the same line, it is in your charter to examine the adequacy of the measures taken in Mission Control to see whether there are some improvements that could be made in those or whether that response could be improved in any way. That is still your understanding?

CORTRIGHT: Yes, sir. That is in the charter, the instructions.

DUFF: Thank you very much.

APOLLO 13 INVESTIGATION BOARD REPORT NO. 1  
APRIL 24, 1970

CORTRIGHT: I indicated the other day when we talked that I'd keep you abreast of what we're doing and although I think what I have to say is less than you want to hear, it's a progress report at least. I thought I'd start out by telling you how we've organized to do the job. There was a little indication of that the other day, but this is the structure of the Review Board. This is the Board itself, and I went through those names the other day. Now, in addition, we have four major panels. One is on Mission Events, and this panel is chaired by Frank Smith from NASA Headquarters. In addition, we have asked that Neil Armstrong from the Board have a secondary function of following in depth the activities of this particular panel. The panel will have three members: John Williams from Kennedy Space Center, who will handle preincident events as to the events up to the time of the incident; Tom Ballard, from Langley Research Center, will handle the events of the incident in detail — the short period of time in which the apparent explosion took place; and the postincident events will be handled by Pete Frank, and he is from Houston Manned Spacecraft Center. The second panel is Manufacturing and Test. Schurmeier from the Jet Propulsion Laboratory will handle that, and Jack Clark, the Director of the Goddard Space Flight Center, will be the member of the Board who stays with that panel's activity when he is not meeting with the Board. That panel will also have three members: Ed Baehr from the Lewis Research Center, who will review the fabrication and acceptance testing of the hardware that flew; Karl Heimberg from the Marshall Space Flight Center, who will review the subsystem and system testing of the qualification-type testing; and Brooks Morris from the Jet Propulsion Laboratory, who will look into the reliability and quality assurance aspects of the hardware. The third panel, on Design, will be headed by Mr. Himmel from the Lewis Research Center, and Mr. Johnson of the Board will honcho that activity with him. Now the one member, Dr. Lucas from Marshall, who has been identified to work on failure modes and mechanisms, will also be a design evaluation man and a man to look into related systems, so that if there is a lesson in here to be learned which can be interpreted and applied to other systems it will be his responsibility to understand that. The last panel is on Project Management. Ed Kilgore from Langley Research Center is the Chairman there, and Milt Klein from the Board will work with him. There are three men who will help, a Mr. Ginter from NASA Headquarters,

Mr. Mead from the Ames Research Center, and Mr. Whitten on safety from the Langley Research Center. That group will, in general, look into the management aspects of the procurement of this hardware and its preparation for flight to see if there were any breakdowns in the system we've been using which may have been contributory. Now, although I haven't shown you this chart before, there are some staff boxes that we don't have to spend any real time on. The first one I mentioned the other day — that's a very important box actually. Mr. Mathews is heading up the OMSF Technical Support. That is, he's insuring that the Board gets everything it needs down here. And he's also working on how to interface with the investigation that's going on by the project, and just how do our members of the panel work with their counterparts in the Manned Spacecraft Center and the contractors who are really looking at the same questions. We have a council secretary to handle our records and papers, a Report Editorial Group, I think I mentioned that the other day, to lay out the manner in which we'll report this to Dr. Paine, Public Affairs, and Legislative Affairs, Mr. Mossinghoff. We've had one addition to the observers, Mr. Wilson from the House Committee on Aeronautics and Space, Congressman Miller's Committee.

CORTRIGHT: Now, that is the essence of what I wanted to tell you today. We're getting into the problem in some depth. We've been going through that period when everyone who starts to look at the data immediately invents his own explanation and has to discard it the next day. So, it's sort of a "getting humble" period, and I think we're almost through that, and we're starting to get our hands really dirty and understand what went on. I'm not prepared to issue any statement on that subject today, but I would ask you whether or not — or I might point out, rather, that there was a statement issued in Washington's part of the committee — the testimony of Mr. Petrone before the Congress today, which gave the timeline of significant events or the major events leading up to the incident. Have you all had a chance to get that yet?

SPEAKER: I believe so - -

CORTRIGHT: Well, it may be more current. I'll be glad to quickly read it for you if you'd like. The first event at — this is eastern standard time 10:06, oxygen fans were turned on. At 10:06 and 22 seconds, it was a high current spike in fuel cell number 3. At 10:06 and 36 seconds, there was an oxygen tank number 2 pressure rise. At 38 seconds, there

was an 11.3-volt transient on ac bus number 2, at 41 seconds, a high current spike on fuel cell number 3, and at 58 seconds, an oxygen tank number 2 temperature rise. At 10:07 and 45 seconds, oxygen tank number 2 maximum recorded pressure, and at 10:07, 53 seconds, there were measurable motions of the spacecraft. At 10:07 and 56 seconds, the oxygen tank number 2 pressure went to zero, and shortly thereafter Lovell stated that he had a problem. Additionally, Mr. Petrone made the following statements: "That the event was not a meteorite. The probability was calculated to be too low, for one thing." And also, "The telemetry is good enough and the number of events have enough information in them that it would appear not to be that rare coincidence of a meeting with a meteorite." He goes on to say, "From preliminary examination, it does appear that the observed rapid rise in the oxygen tank number 2 pressure would require an amount of heat much greater than that produced from current flow for the tank fans, heaters, and instrumentation operation. In other words, the electrical system could not alone pump enough heat into that — energy into that tank to raise the temperature of the oxygen as — and the pressure of the oxygen, rather, as much as was observed. This does not rule out electrical power as a source of initiation for some other energy source as yet undetermined. Analysis and tests are being made to determine what such an energy source could be and how it could have been initiated." That's all I have to say.

QUERY: I'd like to ask you a question about what Dr. Paine said this morning. He referred to it as a relatively simple component in the number 2 oxygen tank, and he seemed to think the problem could be taken care of right away. Could you comment on that? What is this relatively simple component?

CORTRIGHT: Well, here's what he said: "The oxygen thermos flask believed to be involved is a relatively simple component, and corrective action should not prove to be a major task." I think he was referring to the entire tank and its contained equipment as being simple. And I think what he — I'll speculate here — that he means it's simple compared with the rest of the system, and even if they had to do major things to that tank, that it probably could be done in time not to impact the schedule. But, I don't think he was precluding the possibility of some fairly major changes in that tank. But, the tank itself, you know, is a reasonable-sized device to have to cope with.



QUERY: Then you see possibly some major changes that will have to be done in the tank for Apollo 14.

CORTRIGHT: I wouldn't rule that out.

QUERY: Cortright, have you seen any indication at all which would give you a clue or a vague hint as to what possibly could have gone wrong? Anything at all to lead you into a general direction?

CORTRIGHT: Well, the obvious. If you're looking for energy in a tank like this, you have to say, "Well, what energy is there to start with?" And, you do have kinetic energy, you have moving parts, namely, the fan and the motor that drives it. And, you have electrical energy. You do know that there were glitches in the electrical system which would lead you to think there might be some electrical problem in the tank. And, it's not very mysterious, really. You can get short circuits with electrical equipment, and they usually are accompanied by glitches. So, that's certainly one possibility that would have to be considered.

QUERY: You didn't mention fires. Was there any danger of fires?

CORTRIGHT: Again, the major energy source, potentially in the tank, would be combustion, and if combustion took place, it's not certain exactly what it would be like with super-critical oxygen at those pressures and temperatures and the small amount of combustible material in there. We don't quite know what it would be like if it happened, but it could happen conceivably, and that could have been the energy source.

QUERY: Mr. Cortright, is there anything that you have eliminated as — besides the meteorite — as not being the cause?

CORTRIGHT: Now, we're not really going at it that way, yet. Now the Board has started by concentrating on that area that the experts here had determined as the probable source of trouble. And, we've spent most of our time trying to get to understand everything about that oxygen tank; how it interfaces with the rest of the equipment in the system; what energy sources are there in that tank and how might they be triggered; what type of chemical reactions could take place in the tank; would they look like combustion or not, and how might they be initiated? So, we are not really yet concentrating on ruling things out. We're trying to rule things in right now.

QUERY: Mr. Cortright, do I interpret that to mean that Mr. Petrone's statement today was his own; it was not based on anything the Board of Review had said? It was based on the MSC investigation? And, let me ask you further to follow Paul Recer's question, have you ruled out a meteorite?

CORTRIGHT: We haven't considered it about yet, but I'm inclined to say "Yes." The odds would be extremely small that it could be that. As far as Petrone's statements are concerned, I'd say they are his own, and the way we're handling this sort of thing; statements of fact, insofar as they can be determined to be fact, are made by the Project. And, we draw on those same facts to help us in our investigation. So, in other words, if you have detailed questions about how vague were the current spikes and exactly when they occurred, the Project is releasing all that information as fast as it can pin it down. And, the interpretive part of it, apparently, they are releasing some of that too. I'm trying not to do too much of that now.

QUERY: Have you ordered any tests such as the effect of the electrical arc within this tank or some to that effect? Any tests using - -

CORTRIGHT: Tests are already under way by the Houston team. They are trying to determine in what way an electrical problem might have been a source of ignition, for example.

QUERY: To follow that question, have you ordered or requested that Houston investigators or any others go further in their investigations in any direction than they have been going and are you generally satisfied with those investigations?

CORTRIGHT: Well, I've been generally satisfied. We have made a suggestion or two which would constitute slight expansions to what was already being done, but generally, we've been satisfied.

QUERY: You listed some possible or potential causes that are being investigated. I wonder if you could run through a complete, you know, 1, 2, 3, of the possibilities that will come into consideration without weighing them in any relative value.

CORTRIGHT: I'd rather you get that from the Project.

QUERY: You plan to meet as — in panels and perhaps one or two executive sessions a day.

CORTRIGHT: We do that. Generally speaking, we meet with Jim McDivitt and his people at 8 o'clock in the morning, to start the day off. And we get a summary of what they accomplished the day before. Then we have special technical briefings as we need them in the morning and otherwise operate as panels and subpanels during the balance of the day. We also monitor the technical meeting that takes place every evening at 6 o'clock, Mr. Arabian's meeting.

DUFF: It would make my life a little easier if you'd say what you plan to do over the weekend. If you don't, I don't have to.

CORTRIGHT: Well, if you know, I wish you'd tell me. We will work over the weekend, but at the moment, most of our days aren't planned very far in advance. We're still playing it by ear as we go along.

QUERY: Sir, I've been told that there's a report at Cape Kennedy that one source of the problem is thought to have been a motor driving fan which failed. That it's the motor driving the fan that failed. Is this true, or do you know?

CORTRIGHT: Well, that — the fan motor and the fan does constitute the kinetic energy you have and also constitutes a major electrical element, one which does use a fair amount of current. Yes, that's under close examination.

QUERY: Did it fail?

CORTRIGHT: No. I didn't say that. I'm sorry. I guess I misunderstood your question. It could have failed. It could have been the source of the problem. It's one of the potential sources.

QUERY: Do I understand correctly that there's no doubt whatsoever that the problem occurred within the tank?

CORTRIGHT: No. It's highly likely. According to the project here, the project office, that the problem occurred within the tank. And frankly, the evidence we've seen so far, also points in that direction. We haven't come up with anything different.

QUERY: Will telemetry tell you whether this fan motor failed?

CORTRIGHT: Telemetry may. There was a loss of some telemetry, as I guess you know, something like 1-1/2 seconds, and it may be possible to get a little more data out of that lost telemetry, which would help determine that problem.

QUERY: And do you still think that you can conclude this in 3 or 4 weeks?

CORTRIGHT: I think it's possible. It looks tight.

QUERY: Well, in order to do that, wouldn't you have to know where you're going?

CORTRIGHT: Yes. And that's why I said we haven't yet. Of course, we've only been here a couple of days — a few days, but we haven't yet seen any anomalies in the mission that point elsewhere. Everything points to this tank. So we're concentrating on understanding every possible failure mechanism of the tank.

QUERY: Are you as optimistic as Mr. Paine was this morning? He seemed to be rather optimistic that everything would be cinched up pretty fast and Apollo would be back on schedule very soon. Are you that optimistic?

CORTRIGHT: I think it should be possible to fix this tank up. Yes. But I — you know, when I look at a tank like that, I think, well, there's a good job here to be done, probably, and it will take some effort. But it's not as big an effort as these people have handled many times before.

QUERY: Talking about something as basic as a fan motor, all the other tanks have fan motors, don't they? Or are there - -

CORTRIGHT: There are other fans and other systems I believe, yes, that will have to be looked at.

QUERY: Does your data indicate there was a fire on board definitely and if so, what size fire?

CORTRIGHT: No. That conclusion has not been reached. All it indicates is that there was some source of energy in the tank large enough to raise the pressure above that possible with just plain electrical omni heating.

QUERY: Would you, in reference to that, that list you have there, indicate the 1-1/2 second data dropout?

CORTRIGHT: Well, the dropout occurred just at the time of the incident. In other words, when the apparent bang took place that's when they lost the data.

QUERY: How's that indicated on that list?

CORTRIGHT: I guess it isn't.

QUERY: Do you have a time for it?

CORTRIGHT: You can get that from the Project Office.

QUERY: Combustion in a tank would infer the presence of a contaminant, would it not?

CORTRIGHT: Not necessarily. Combustion can be different things, of course. Oxidation — rusting is combustion, you know, in a sense. So what we want to understand is if there was combustion, what was it that was oxidizing and how was it going about. It wouldn't have to be a contaminant. There are other things in the tank that could react with oxygen and metals and insulation, both.

QUERY: Dr. Cortright, when you say within the tank, you mean inside the sphere now. You're not talking about equipment associated with the tank or near it. You were talking inside the sphere of the tank.

CORTRIGHT: That's correct.

QUERY: I understand there's paper matting insulation between the two walls. Is this being left out as the possible source of combustion?

CORTRIGHT: Yes. I don't know whether it's paper or not. There's superinsulation in there. At the moment, the Board is concentrating and looking at the inside of the inner sphere, both the insulation on the wires and the possibility of contaminants and some of the metals themselves.

QUERY: You also plan to look between the two walls?

CORTRIGHT: We'll have to look at all that.

QUERY: — metal could react with the oxygen could you characterize that? The nature of the reaction that the metal prepared — you're not speaking about combustion in there are you?

CORTRIGHT: Yes. Aluminum can burn, and liquid oxygen under the right conditions.

QUERY: Blaze sort of thing?

CORTRIGHT: I don't know too much about that yet. I'd just as soon not try to answer that question. As you know, aluminum can burn in air.

QUERY: Is the Project Office or industry, or anyone else simulating any failure modes and if so, what are they?

CORTRIGHT: The Project Office and North American are both attempting to generate failure modes which could explain all the anomalies in the telemetry. And I refer you to the Project Office for the details of that.

QUERY: In reference to the picture that was released, could you tell very much from that picture what had happened?

CORTRIGHT: Not at first glance. But there are image enhancement experts working on the pictures now to try and get more out of them. In other words, it was difficult to tell much about the number 2 oxygen tank.

QUERY: Is there anything you detected in the photos that would indicate a fire? Any charring or that sort of thing?

CORTRIGHT: No, not to me but there was some staining as you recall that was announced by the astronauts themselves. A brown stain on the outside and I don't know what that means. That's being looked at.

QUERY: Would liquid oxygen itself leave a brown stain?

CORTRIGHT: I haven't any idea.

DUFF: Thank you very much.

APOLLO 13 PRESS CONFERENCE WITH DR. GEORGE LOW  
MAY 1, 1970

DUFF: Press conference this afternoon with Mr. George Low, Deputy Administrator of NASA.

LOW: Good afternoon. I have just spent the day since early this morning receiving my first status report from the Apollo 13 Review Board. I received briefings this morning from Mr. Cortright, who is Chairman of the Board, several members of his panels, and also from Mr. Scott Simpkinson and Col. McDivitt and Don Arabian who are conducting the Apollo Program Office investigation here at the Manned Spacecraft Center. There is a major effort on the way, as all of you know, to determine the cause and the possible fixes for the Apollo 13 accident. I don't have an exact number, but I would estimate that between two and three hundred people are working on the problems associated with this event. We do have excellent telemetry data, and a great deal of information from the spacecraft about the sequence of events that occurred on April 13, about 55 hours into the flight of Apollo 13. And as we said before, the major source of information is the telemetry data. We also have photographs of the service module taken after the service module was jettisoned just before reentry. And as of today at least, the information given by these photographs is still inconclusive. Specifically, there is still no firm decision based on the photographs as to whether the oxygen tank number 2 was still in the service module at the time it was jettisoned or not. Review work is on the way in enhancing the photographs, getting the maximum possible information out of them, but it is certainly not clear that we will ever get that answer from the photos themselves. In addition to the telemetry and the photograph, there's also on the way now a very significant effort of tests and analyses. And it will take a combination of all of the data from telemetry, from all of the testing of all of the analytical work, and perhaps information from photographs to determine the most probable cause or causes for the event that took place on April 13. But from what I've heard today, and from what I've been told previously, I'm fairly confident, quite confident that we will be able to bound the problem, that we will be able to determine its limits, and that we will find corrective action that will encompass all possibilities. Both the Board and the project people told me today that the most probable sequence of events on Apollo 13 was as

follows. First, a short circuit occurred in oxygen tank number 2. This short circuit most probably caused combustion within the tank. This in turn caused the pressure and a temperature within the tank to increase. The tank then ruptured. This rupture of the tank caused the pressure in the compartment in which the tank is located to increase which then caused the panel, the big covering panel in the service module, to blow off. And if at any one fact then that I had not known before today is that the blowoff of the panel most probably was when the panel flew off and then hit the high gain antenna which temporarily knocked it out for a matter of a second or two and this led to the loss of data for that very short period of time just about the time that the panel did fly off. We also discussed today the preflight events that might be of importance in connection with the Apollo 13 accident. These included the facts that the motors, the fan-motors, the fans inside of the tank were changed early in the manufacture at the vendor's plant; later on the tank, itself, was removed and reinstalled; moved from one spacecraft and installed in spacecraft 109 and during the removal from spacecraft, I believe it was 106, it was jarred or dropped an inch or two, and this may or may not have had an influence on the well-being of the tank. Finally, during the loading and unloading of the tank during the countdown demonstration tests at the Cape, there was an anomaly which made it very difficult to get the oxygen out of the tank. This was several weeks before the flight and a new procedure, not previously tried, was used in this detanking. These three factors are also being looked at by the Board and by the Review Team to see whether there's any possible connection between those and the accident, itself. The Board, today, estimated that they will make their final report to Dr. Paine and myself about the first of June. This is a very brief summary of our discussions today. I also spent time this afternoon then with Dale Myers and Rocco Petrone and Jim McDivitt and discussed possible alternatives of design changes that might be made to the spacecraft without in any way prejudging what the conclusions of the report would be. But no decisions in any such changes have been made at this time. Be glad to answer any questions you might have.

DUFF: We'll start with Art Hill and then go back.

QUERY: George, how certain can you be that a short circuit was responsible for initiating this series of events?



LOW: As I said, Art, the conclusion by the Board and the Review Team was that this was the most probable initiative of the events. I don't think that anybody, as of today, can be positive that this was the — that this will be the final answer, but, as you know, there were a number of electrical glitches, high currents, low voltages, just preceding the rest of the events and the investigation today was focusing in that direction.

DUFF: Ed DeLong.

QUERY: In what component would you estimate that that short circuit happened and when you say combustion in the tank, does anyone yet have any idea of what combustion in a high pressure LOX tank is?

LOW: First question, what component — what component did it happen on. Short circuit could only be in the wiring leading to the fans, to the temperature sensor, to the quantity gage or to the heaters. Now the preliminary conclusions today are that the heaters were not powered at the time, so they're eliminated. And the current to the quantity sensor and to the temperature fills were so low that they are unlikely components. So the most likely source would be the current to the fans.

QUERY: Before you go further, you say wiring leading to the fans. Would that include wiring in the fan motors themselves?

LOW: It could certainly include that, yes.

QUERY: What component reacted or where was — where did the combustion take place?

LOW: Again, the people have looked at what might burn in this oxygen environment, and it would have to be the insulation on the wiring or the wires themselves or some of the aluminum components.

DUFF: Paul, you had one.

QUERY: Have you all simulated this failure with the tank rupturing, and if so, does it cause shrapnel that would damage other components in the same bay?

LOW: The complete simulation — there has been no complete simulation of the tank rupturing or of the entire events in the full-scale tank, and it is certainly not clear today whether the tank would rupture or whether it would spring a leak or whether it would open a small hole only. I was told today that all possible tests are still being examined and that no firm test plan has yet been developed. Again this will depend in part on the analyses and part in the small scale tests and part of it is also the — of looking at the data before the people here will come up with a plan for an overall test program.

QUERY: Dr. Low, you indicated that during the countdown demonstration tests at the Cape that there was what you said was an anomaly which caused difficulty in detanking the O<sub>2</sub> tanks. The other two factors were physical factors like a fan changed or dropped. This is a procedural change. Would you explain how that could possibly be a contributory factor to the series of events?

LOW: Only in that it may — well, first of all it may have — going back to this prelaunch event now, the — at the time that it was difficult to detank the oxygen, an analysis was made and it was concluded that there could have been a buildup of tolerances between various types in the stand-pipe and the vent line that could have led to this difficulty in detanking. In looking back over the records, one can then ask the question could the detanking difficulties be an indicator of something else being wrong inside that tank, and we don't know today that it was. Also, could the specific procedures in the detanking have caused something else to be damaged? For example, during the detanking the gaseous oxygen was pumped into the tank and released again, and the heaters were turned off and on. These procedures are now being examined in detail by the Review Teams and by the Board to see if any of it could have had an effect on the tank itself.

QUERY: George, at what point in the history of the tanks were the fans changed and why were they changed and was it both fans we're talking about or just one or what?

LOW: At what point in history were they changed? Before the tank was delivered to North American, I believe, so while they were still at Beech. They were changed, I believe, because there was a reading of voltage or current or something that was not completely within specifications, so they were removed and a new set of fans was installed.

QUERY: So the fans that were in the tank that the explosion occurred in were new fans?

LOW: As far as I know, that's right. They are not the original fans that were removed at the vendors.

QUERY: The old fans weren't fixed and then put back in, or anything like that?

LOW: I don't believe they were.

QUERY: Sixty-six are we not - -

LOW: I don't know the date, but I would imagine it was at least that early.

DUFF: We could help perhaps afterward by going back and finding some of these. Do you have a question?

QUERY: Two or three here. One, do you have any idea what combustion would be — I mean, would it be flame, what would the physical process of combustion be under those high pressure or low temperature liquid oxygen conditions? Two, yesterday we received from, I gather Jim McDivitt's group, although it came out through the Public Affairs Office and was not tagged specifically as to who it came out through, very firm assurances that, although the shelf had been dropped an inch, this did not contribute to the problem and you seem less certain of that. Could you explain that a little bit, and has there been any speculation at all about what might cause a short circuit and what do you mean when you say short circuit; do you mean two wires crossing, do you mean something stalling the motor and overheating it, what's included there?

LOW: To the first question, do you remember it? Okay, what is combustion like in that environment, its supercritical oxygen at minus 150 degrees and 900 pounds pressure. I really don't know. We had an interesting discussion about this at lunch time, whether — I asked whether we had ever seen or been able to take pictures of something reacting violently in that environment. And I was told no, we had not yet, at least the people here had not seen this, and we are going to look at the possibility of putting a window or a port into a test model so that one can take films of this. So combustion really means a violent reaction, release of energy of so many Btu's which are needed then to increase the pressure and the temperature. I don't think

anybody today can really answer that question in any more detail. The second question concerned the — I try to point out here the three things that we discussed that were anomalous in the preflight situation. The fan change and the removal of the oxygen shelf, and the 2-inch drop that was involved there, and third, the detanking. And I brought these out only because they are unknowns today; I mentioned also that at the time that the shelf was removed and was dropped a couple of inches there was a normal discrepancy procedure followed; in other words, it was examined and was looked at, it was analyzed and the conclusion reached at that time was that certainly the tank was all right to reinstall, where it would not have been done. What the people are now beginning to do is take a look at this again, to reanalyze what might have happened at that time, to see whether higher loads could have been imposed on it than was known at that time, to see whether anything else could have happened that was overlooked at that time. And I mention it only in that light. And if — do I have them all?

QUERY: What do you mean by a short circuit?

LOW: A short circuit means an abnormal flow of current which could be caused by insulation missing off the wire, or the wire touching the ground or it could be almost anything.

QUERY: Does that include the fan motor stalling?

LOW: My recollection from previous knowledge I have had is that the fan motor even in the complete stalled condition will not generate enough heat to cause any kind of a problem.

DUFF: We will get Jim because we haven't gotten to him yet, then we are going to Washington for a few questions, then we will come back.

QUERY: Will any or all of the fixes that you have discussed delay the launch of 14?

LOW: I don't know. I think the important thing here is to fix what went wrong. I should have mentioned, of course, that everybody here is also looking at all the many other possibilities in many other areas where similar or related events might occur. So we are going to take whatever time is necessary to make right what went wrong, and until I get the complete Board report, and this may not even be on June 1st, this was the estimate today, if they need more time, they

will get more time to do their job, and until the job is done both by the people here at MSC and by the Board, we won't really know whether or not we will delay Apollo 14.

DUFF: We are ready for questions from Washington now.

SPEAKER: Okay, please wait for the mike now. Don.

QUERY: George, could you tell us when and where the tank jarring occurred?

LOW: Where and when the tank jarring occurred; it occurred at the North American Rockwell Factory in Downey. And it therefore occurred before the spacecraft was delivered. We will have to get to the exact date; I don't have it. I am told November 68.

QUERY: George, could you tell us -- you were speaking of separating the oxygen tanks takes some equipment change to do that. Are you also thinking -- 1 to 3 months in this whole thing?

LOW: I missed the middle part of the question. Could you repeat it please?

LOW: Could you repeat the question, please. I did not get it.

QUERY: George, are you thinking of separating the oxygen tanks some physical way, not putting them into a different bay, but maybe armor plating them? Are you also thinking of removing the fans and the heaters and any other source of electricity, and if you are thinking of this, wouldn't this mean a delay of anywhere from 1 to 3 months in Apollo 14?

LOW: First question concerned the separation of armor plating of the tanks. This is being looked at also, but it is as of today not proposed as a solution. The removal of fans, specifically the removal of fans, and the changing of the wiring to the heaters instead of removing them or even the possibility of removing them is being examined by Jim McDivitt and his people. Again, no decision has been reached. As far as time is concerned, I cannot give you an answer. I know that there was a time when we launched Apollo flights on 2-month centers and made some very major dramatic changes in those fairly short periods of time. As I said before, we will take whatever time is necessary to fix it.

DUFF: All right. I am told that October is the correct date.

QUERY: Dr. Low, while you were talking about the change and relocating them and so on, you discussed something in general about what design modifications you talked to Jim McDivitt and also what area is it you're looking into where you could through a single event lose your safety redundancy other than the - -

LOW: I can answer the first question. The design changes today are the only design changes. They have not yet moved out on any hardware changes. The design changes that are being looked at include the removal of the fans, the changing of the heater wiring, or the heater location so that all of the wiring into the heaters can be enclosed in a metal sheath going to the outside of the tank. The relocation of the quantity probe or the redesign of the quantity probe to remove the aluminum in it, and at the same time make it possible to assemble the heater and probe device without needing flexible wiring leading to them. And the removal of all nonmetallic materials from inside the tank, and the removal of aluminum and anything else that may react with oxygen. Now, again let me emphasize that these are changes that were being discussed and not yet being perused at North American. At the same time as looking at these and other changes and until all these get together, no decision has been made on any changes.

QUERY: - - some of the possible errors where you could lose your redundancy.

LOW: This we did not discuss today.

QUERY: Did you say McDivitt has some people looking into those other possible areas?

LOW: Yes.

QUERY - - yesterday that after they're manufactured the oxygen tanks were rejected two times before hastily being accepted on the third inspection as the deadline approached. Would you comment on that?

LOW: This is the first time that I've heard this. We'll certainly look into it and get you an answer. I have no information on this.

QUERY: Well, I'm kind of confused on this fan. When you changed out these fans, did you put back new ones of the same model or were they different models, different in design than the fans that had flown on all the previous Apollos?

LOW: The fans in Apollo 13, to the best of my knowledge, were the same fans that we had flown in previous Apollos. The fans that were removed from the tank back at the vendor's plant apparently did not quite meet specifications when they were tested in the tank. They were rejected, removed, and other fans of the same kind were reinstalled.

QUERY: Okay. Did this happen in any previous Apollo flights, that you had to remove the fans?

LOW: If it did, it was not discussed today.

QUERY: Dr. Low, again along with Paul's question, could you compare these anomalies with anomalies of similar nature of other Apollo flights? Have you had things of this nature happen on other flights that you might be able to compare with the anomalies on 13?

LOW: It's hard to form a comparison. We had, of course, some anomalies in every Apollo flight. None of them was as critical, none of them could potentially lead to as catastrophic a result as the anomalies on Apollo 13 could have led to. Going back in history, of course, we had Apollo 6 where we lost 3 engines on the Saturn V launch vehicle on the way out and had a very — had the POGO problem on the first stage and also had a very major damage to the service module LM adapter. Apollo 7, I don't remember the list. We did lose, during the flight of Apollo 7, momentarily all ac power as you'll recall. Apollo 8, we had very few, although the list of details was quite long still. Apollo 9, you're making me go back in memory here, but we had some kinds of problems in every flight, up to and including the computer alarms on Apollo 11 and the lightning strike on Apollo 12, but none of them, as I mentioned before, were potentially as catastrophic as these might have been on Apollo 13.

QUERY: Well, I was basically thinking that — not of the overall flight but on the LOX tank itself. If you could compare all of the Apollo LOX tank situations, what would 13 look like? Would it look like really a bad tank and if you'd have compared them all would you have gone with it?

LOW: I can't answer that question. It is not at all unusual to have countdown problems or countdown demonstration problems and — because this is why you conduct a countdown demonstration in the countdown. I remember in Apollo 9 we had a very significant problem the entire night before launch on the supercritical helium tank where we did not know whether we had a blockage in the tank or not, and we decided at that time that we were satisfied that we understood the problem as we did on Apollo 13 on the oxygen tank, and went ahead with the launch. That's a related problem in that they were both cryogenics that we had a problem with and only in that sense. I don't think you should consider any single countdown problem or a single countdown demonstration problem or a single check-out problem at the Cape to be unusual. We've changed engines, we've changed fuel cells, we've done all of these things and that's why you conduct tests at the Cape. It's only today in retrospect, now that we've had the accident, we're looking at the procedures again, that we're looking particularly at the procedures in connection with that tank to see whether that could have had an effect on what happened later in the flight.

QUERY: If you're moving the fans from the tank, what mechanism would be used to stir that oxygen? The second thing, what is your opinion now of the possibility of flying another Apollo flight this year?

LOW: The first question is a technical one and even that does not have a complete answer, Jim. Based on information by Jim McDivitt and his people to date, it is possible that we can conduct the flight without stirring the cryogenics with the fan. This is based on looking at all the information from all of the Apollo flights to date and looking at the times and the fairly long times that we've gone on some of these flights without turning on the fans, it appears to be possible to eliminate the fans entirely without replacing them with anything else. This is not yet a firm conclusion. What is the probability of an Apollo 14 flight this year? I can't give you an answer.

QUERY: You talked about the possible design changes in the hardware. How about design changes in the flight, itself, the trajectory and the use of this hardware. Specifically, there has been a suggestion that you might possibly carry the ascent stage back as a possible lifeboat. Is there any consideration being given to design changes in this area?



LOW: That was not discussed today and has not been discussed with me at all, so I really can't answer that. I don't know whether or not it is being considered and if it is being considered, whether it has a positive outlook or not.

QUERY: Dr. Low, based on the thinking of your investigative Board that it can have a final report ready for you and Dr. Paine by June 1st. Does this mean that you have arrested a prime suspect and now you're just going to give the guilty party a fair trial the rest of the month, or have you got some other —

LOW: That's a good way of putting it. No, I told you all that I know. However, the people here are quite confident, that given another week or two of proceeding with the analysis, of doing some of the tests that are underway, that they will have enough information to bound the problem to decide on the design fixes. Now, it may be, as I said before, that they will not be finished by the first of June or it may be that they will give a report on the first of June and we'll ask them to reconvene in July or August or some other time to again look at what has been going on within the Program, and to make sure that all the loose ends, if any, will clean up.

QUERY: Among the possibilities of solving this problem, have you considered any that are not directly related to the structure itself, such as carrying another set of bottles or dividing them into two small bottles, or carrying a reserve supply somewhere else so that a flight would not be impeded?

LOW: Yes. I listed, a moment ago, those avenues that the project people here are looking at most seriously, today. They, then, have a whole list of other things that they are also looking at which include, perhaps all of them that — all of the ones that you have mentioned.

LOW: Have it one at a time, Ed.

QUERY: Okay. You reminded me when you mentioned the POGO problem and the engine failure that we did have an engine-out on this flight and that I have heard some project people say that if there is a delay in 14 that the fixes for that engine-out may be more responsible for it than any modes to the spacecraft. What is the status of that engine situation and how accurate is that assessment of the possibility of delay?

LOW: Ed, I know that people at Marshall are working very hard on that. I have not been briefed on it, and I have not reviewed it, and I honestly don't know.

DUFF: Thank you all very much.

APOLLO 13 REVIEW BOARD CONFERENCE  
JUNE 2, 1970

CORTRIGHT: Good afternoon. The purpose of this particular conference is to bring you up to date on where the Apollo 13 Review Board stands, tell you a little bit about why we've delayed our report and a little bit about what our prospects are of making the current date. Now, in particular, I want to tell you something about the tests that are going on. I will refer to a few notes here in which I hope I didn't leave anything out. First of all, let me say that the general status of the review is that it's nearing completion. I'm generally satisfied with the results that have been turned up in the investigation to date. I think the understanding of the accident is good. We've delayed the report, as I mentioned in a bulletin which came out within the last few days, because there are critical tests being carried out which will help pin down some of the details of what took place. The Board has not been satisfied until recently that these details were pinned down. There are still a few key points to clear up.

Now, the tests that are being carried out are being carried out all over the country. For example, here at Manned Spacecraft Center, there are a number going on. They are also being conducted at Ames Research Center, Langley Research Center, Marshall Space Flight Center, Kennedy Space Center, and at North American Rockwell, Beech, Boeing, and a few other places. One of the key tests is — one series of tests relates to this special detanking procedure, which you heard about before, and the checkout proceedings at the Cape prior to launch. Now the tests so far have found the faulty thermal switches, or the failed thermal switches, which were mentioned the other day. They've also demonstrated that if these thermal switches had failed as we now are relatively certain was the case, that the temperatures that would have been reached in the heater tube assembly could have exceeded 1000° F in some spots, although not everywhere. There were tests conducted here at the Manned Spacecraft Center that showed that when the heater assembly, the heater tube assembly, reached temperatures like that it baked the Teflon-coated wires and destroyed the insulation. And a little bit later I'll show you some samples of this insulation and what happens to it when it's baked in an oxygen environment. Now the clincher is going to be conducted at Beech Aircraft Corporation this week wherein an actual flight tank will be cycled back through