This is an interview with Colonel John G. Albert, 6555th Test Wing at Cape Kennedy, May 26, 1967. Do you remember anything about the selection of the Titan II as the Gemini launch vehicle?

Albert: Just a little. I was not involved in the Gemini launch vehicle at that time. However ---

Grimwood: Where did you come from?

Albert: I was involved in the early stage with the target vehicle. I was at Space Systems Division before I came down here and previously had Atlas-Agena launch vehicles for Ranger and Mariner.

Grimwood: Did you get enough attention from all sources on the target vehicle? From NASA Headquarters? From your own people? Space Systems Division? It seemed like everybody had a feeling ---

Albert: The target vehicle was, to some extent - I think you're trying to say - an orphan. We got involved in the very early phases and I think that we had a pretty good team of people. However, I will say that the summer of '63, which was just the time when we were going into the formative stages and firming up on the design and firming up on the contract, I left, Captain ~~Alleca~~ (?) who was working on it last, several people left right at that same time which was ---

Grimwood: Then you were there in the problem time when they were trying to get "what is this mission?"

Albert: This is right. There was some -- I don't -- that didn't bother me too much. No. I think that got over---

Grimwood: It seemed to bother Lockheed.

Albert: I think that got over-played. I think they over-played it a little bit. To tell you the truth, I think Lockheed had enough, and I think Lockheed people didn't face up to what their responsibility really was. The mission wasn't difficult. In fact, I know what has been done, now that the program's over, and the understanding that they had as to what it had to do six years ago was about the same. Now you can nitpick things down to a gnat's eyelash and fight the problem and ---

Grimwood: They were complaining that they never could get this rendezvous mission defined.

Albert: Oh, well. They've got to have a little flexibility here, too. They were to put a vehicle in orbit and something else was going to

come up and mate with it and they were going to have to have a means of commanding it and controlling it. I'm going beyond what I should here but -- Lockheed had a lot of experience with command and control on the Air Force satellite programs.

Grimwood: I was surprised at General Funk. He was pretty hard on them. He's working for them now.

Ertel: His office is about half the size of this one.

Albert: Is that right?

Grimwood: Yes, no carpets either. He said that they had very poor soldering techniques and they were way behind the state of the art, in fact.

Albert: I guess I do not go along with Lockheed that the definition of the mission was a major problem. This is something you always have to worry about; it evolves. But as far as what they basically - what that vehicle basically had to do, they knew enough about it to get on with the job. Along that same vein, as I said, the summer that I left, or the spring that I left, we intended to negotiate the contract and we had gotten cost estimates and we had a work statement in the contract, and everything - a work statement is never perfect, this one wasn't perfect either - but they came in with a cost figure that was just out of this world. So instead of negotiating the contract, before we left, which we had planned to do, we sent the thing back and said it was non-responsive, to re-do it. So that's the time that I got out of the target vehicle business. So my last act was sending their cost proposal and contract back and stating that this was completely different than all of their original planning and all of our earlier negotiations indicated it would be.

Grimwood: I talked with Major Harness who I'm sure you ---

Albert: Yes, she was fairly new out there with me before I left.

Grimwood: She was complaining pretty heavily that they never did consider a man-rating program for the Agena. The Air Force kind-of wanted it and NASA wouldn't particularly buy it.

Albert: How do you define man-rating? This is another thing. It's not the fact that they - well, let me say what I think man-rating is. Man-rating is taking each component and analyzing it and seeing what

you can do to enhance its reliability. It's, in doing that you'll augment your qualification testing program. It is a philosophy that's imbued in all the people that work on this, the fact that they have an individual responsibility, and finally, then, it's real tight controls and checks and double checks through the launch period down here. But there's nothing magic about man-rating. The Agena did not have to carry men up into orbit and there was adequate time to know the condition of the Agena, the health of the Agena, when it was in orbit. As the man was docking with it, he had instruments right on the docking adapter that he could see to make sure that there weren't abnormal tank pressures, and one thing and another. Plus the fact that the Agena had - what? 200 launches or so. 200 flights of that thing beforehand. And the Air Force had carried out a reliability program. A man-rated program is nothing but a reliability program.

Grimwood: It had had 29 straight successes.

Albert: So - true - man-rated program, per se, was not conducted. However, they were not taking a brand-new piece of hardware up there that had never been used before. This is something that had to be weighed and I think it was properly weighed. How much money would you spend in analyzing every little component? And I don't think it was necessary since it was not going to carry a man aloft such as the Titan was.

Ertel: Then when they finally got them up there they worked real well.

Albert: But they should have. It was a vehicle a lot of work had been done on. The Agena was not a new vehicle, by any means. Now, a lot of people would say , well, there were a lot of new things on this Agena. That's true.

Grimwood: That was multi-restart.

Albert: Restart engine. This was a significant change. However, it was only a change in the start system. The engine bell, the combustion chambers, many, many of the components were identical. It was just using this replenishing sphere to restart, rather than the start cartridges, and a lot of testing was done on this. Now the question - I guess this is a valid question - is, was enough testing done on this start system? Since there was a problem in it. So, obviously, you have to say, "No, we probably could have done more." And this test program they conducted at Tullahoma after the failure obviously did

some good.

Grimwood: That was what I was going to bring up. They had tested it, but not in the conditions that they really had available to test it.

Albert: We're getting away from where my responsibility started and ended, but I did want to point out - Let me go back to your original question. I got started in the Gemini program right at its beginning. I attended, well before I came down here, many meetings at Houston with Jim Chamberlin and everything. I remember when Chuck Mathews came into the program. We had a big meeting at Lockheed, to introduce him to what was going on. My role then was with the Atlas-Agena portion. I did get involved with the early discussions and the early definitions and, obviously, they weren't as firm then as they are now, now that it's all over.

Grimwood: Were you at the meeting where they were kind-of pushing for one unmanned launch?

Albert: Yes. And I was a strong advocate of that. As a matter of fact ---

Grimwood: Williams was for that and Mathews was against it.

Albert: That's right. And I made a special trip down to Houston before I left to discuss this in detail with Chuck. I did advocate it and was in favor of it.

Grimwood: He complained about complicating the design. You haven't got a manned vehicle here so you're not really worried about weight; why not make the design simpler. That was his point.

Albert: Make the design simpler? No matter how simple you make it, considering the controls you were going to do with this vehicle and the restarts, you could have come up with a pretty decent program of orbital maneuvers with that vehicle, if they could have fit properly into the time phasing of it. The time phasing, then, probably was such that had you put that in, your command control center probably was not ready - there's a lot of pieces to the puzzle that have to fit together. This was a desirable thing. Then Chuck, of course, had to make the decision - did it fit in the big picture. And obviously he thought that it didn't.

Grimwood: He wanted confidence, though.

Albert: Well, yes. I still think that, considering the restart and what you had to do and what you had to know about the Agena on the ground, to have had a launch, not in conjunction with the manned program - because it was,now getting back to my own business here, the two times that it happened, this was a big letdown in the blockhouse of Complex 19. It was a tremendous letdown to the astronauts when here we counted down and got down to T minus 40 minutes, or thereabouts, and finally absolutely confirmed we didn't have a target and therefore had to scrub. This was very costly to all the activities of the range, it was very costly to the recovery forces that were deployed, and a big emotional letdown, from our point of view, obviously. I'm sure you've talked to Tom Stafford about that. He'll go through this same thing. How you - whether or not a separate Agena test would have precluded this --- probably not. As a matter of fact, even the first Agena failure I feel might have been one of a kind. And had any of the other vehicles been used, it might not have happened.

Grimwood: But, on the other hand, we had a launch vehicle problem at that time, so it might have been rather fortuitous.

Albert: That's right. The chain of events comes up to something that you can't always ---

Grimwood: Sometimes it seems to work for the best.

Albert: We got an awful slow start. This used to make me so mad in the press when they'd play it up and they'd say, "The Gemini program finally had a successful launch two years late," or something like that. Now you read the paper, and, hell, the MOL program hasn't hardly gotten off the ground and already they can't mention it without saying it's three years late, or something. I guess I graduated from college many years late, too. But once Gemini got started, then it really came off and the years '65 and '66 were tremendous. I think this is marvelous if you can get your problems solved and then come up with a rapid rate of launch. I think that's one of the contributions to the success - the fact that we did establish a tempo of about every 60 days. The people knew that tempo was going on and there weren't the big letdowns, the big delays; the team stayed together. There was a strong motivating factor that stayed relatively constant, which was important. So I'm a firm advocate of keeping a pretty constant rate of launch. And 60 days is a good one, I think.

Grimwood: We'll hit on that some more. When you came to the Cape, then, in the fall of '63 ---

Albert: Summer of '63.

Grimwood: Summer of '63, you had missed a good deal of the GLV and Titan II POGO problem there, had you not?

Albert: Yes. Well, ---

Grimwood: Things were kind-of solved.

Albert: They were - no, they weren't. Not entirely. Let me say this before - although I was on the Agena portion in the Ranger and Mariner and everything, before that, I - my office was right in the same hall with Bob Brundin in Mercury. So our Atlases were very similar so I felt that I had done a lot of briefings with Mercury, and then Dick Dineen's office was also just a couple of doors away. And, normally, when we had - I remember we had to brief people up in DDR&E, the Gemini planning board - I generally went with Dick and he'd talk about the GLV and I'd talk about the target vehicle. And we both worked for Colonel Eichel then - you remember Hank Eichel? And I was involved, not directly, but certainly the POGO problem was something I was very much aware of.

Grimwood: And you were aware of General McCoy's feelings on the weapon system?

Albert: Yes, and I also - but when I got down here, even that summer, there were many differences of opinion. You've probably heard of this meeting that General Schriever had out on the West Coast ---

Grimwood: I've got that in the chronology here - August 15th ---

Albert: Was that August 15th? Ok, well, that was after. I got here in the middle of July, so I was here when that meeting took place. And, even then, having talked to a lot of the "experts," some people did not feel that the standpipe and accumulators would do the job. They thought it was a completely different thing.

Grimwood: It was real amusing the way Schriever termed the deal. He recommended that the problems be cleaned up. He "recommended."

Albert: Here's another one that got completely out of hand, I think.

Down here - when I was down here, even before we'd launched, everybody thought, Oh, boy. How can the Air Force be so callous and not want to solve that problem?" The press got the impression that the Air Force didn't want to solve it, and the fact that it was going to bounce the eyeballs out of the astronauts, and all this. And completely unsafe condition. But there were differences of opinion on that.

Grimwood: Especially after you got down to 3/4 of a g. That's what General McCoy said. "This is good enough." Do you know how that 1/4 of a g came about?

Albert: This standpipe accumulator certainly worked, because that POGO problem was never a problem at all. I, personally, had confidence in it because the one flight in which we had the highest one, we did go back and pretty well convince ourselves that we had not properly - this was when we'd had a scrub and we'd had a recycle and we did not properly charge the oxidizer standpipe and because of that, we did have it. So I'm convinced that those dampers prevented the resonance and did it. But there - I remember - not on the tape here, but Dr. Payne, when I first got down here, he had all the differential equations worked out, and he was convinced that this would not do the job, speaking from a theoretical basis.

Grimwood: General McCoy was justified in his position, because he just had so many more shots to go.

Albert: Sure, and he could care less. This was a factor that was of no significance to him, from a weapons system point of view.

Grimwood: When it was pretty high, he might have had some worries -

Albert: The highest ones were when they put it on just the oxidizer side. I forget the number of the bird - N-17, or one of those. They put it on one side and it went way up. But, to answer your question, I did not get into the solution to the POGO problem.

Grimwood: But you were hearing it all the time?

Albert; Oh, hell, yes, I was hearing it. Gee whiz, of course, this is something else that I think is real interesting. The press are always interested in the unknown and the future. The interest in Gemini then was much higher than it was toward the end of the actual program. The only thing they could think of then was this controversial point, this

POGO. And they loved to play, "NASA says they've got to protect their astronauts; how can the Air Force be so callous not to care about bouncing the astronauts' eyeballs out?"

Grimwood: It was that spring - wasn't it that spring that they first became aware that the Gemini schedule was slipping, and so then they were seizing on anything. That was April, I think, we were up in Dallas at the AIAA. Did you happen to be there at the time? Well, Chamberlin had just been switched out in March, and I mean they were on him like ducks on a June bug.

Albert: Jim read a paper up in Dallas? Well, there was a schedule change about that time. As a matter of fact, at that particular time, the Gemini program was in some degree of trouble as to whether there would even be a Gemini program.

Grimwood: A considerable degree of trouble.

Albert: And I don't know how, or why, but I got to be a pretty good friend of Jim Elms who was down at MSC at the time, and I remember Jim ran through a briefing that he was going to give up at Headquarters, NASA, really justifying Gemini. And at that time he was emphasizing the value of Gemini to Apollo and the number of Apollo components, actually, that could be flown on Gemini, just to build up this strong support to have a Gemini program. At that time, the spring of '63, you're right. The Gemini program was in jeopardy.

Grimwood: It had gone from about .8 to 1.1 and there were indications that it might just go right on.

Albert: Just too high. Let me just add one point. During this same time period, and I'm bringing this point up because I think this was so important. The launch vehicle people, Dineen, and Buzz Hello, in Baltimore and Walt Smith and those people did a marvelous job of taking that total vehicle and analyzing all of the components and making a detailed reliability analysis. And at that time, they determined the critical components, what could be done to these critical components to improve the reliability; what components had to work for maximizing astronaut safety; and, based on what they could do to individual components, then they came up with the scheme of putting in some of these redundant, or secondary, systems. I feel that that work, which was done early in the game, furnished the basis for people like me, that came in later and had to operate down here,to do a good job. The basis was established. The systems were sound; the designs were

sound. Plus the fact that, because they did all this breadboard work, they were able to pretty much freeze design, come up with real firm specifications, and come out of the factory with a bird that we like to call flight-ready out of the factory. And we did, I think, achieve that more than any other program that I've ever been involved with. We did the work in the factory and we didn't defer it to down here. When they came down here - well, we did have a number of mods on the first couple of birds - but, by and large, they came down here without discrepancies. And we flew pretty much the same components that had gone through the total VTF checkout, then our total checkout down here. So by the time we launched we had developed a lot of reliability confidence. And that was all because of the early work that was done. When I talk about the early times, that was in '62 - '63 time period.

Grimwood: By the time you came down here, though, in this first mission, the GLV engines had become the pacing item. Of course, the spacecraft looked good on paper for just a structural test, but ---

Albert: But, of course, the spacecraft didn't really get in the game until No. III, really.

Grimwood: It got in the game in No. II pretty heavily, also.

Albert: I beg your pardon. II was the one that the spacecraft - in fact, I remember that problem was considered our toughest mission.

Grimwood: That was the last time that I can find where the GLV was the pacing item.

Albert: It was pacing for a little while after our shutdown on II, if you remember. For a few months, well, it wasn't a few months. It was about a month that we were pacing. But you're right. This is right. We had battles down here before the first vehicle came down. I say, battles - this is what people don't understand. Everybody ---

Grimwood: This is what I want you to lead into. This deal of getting this flightready deal down here and not having quite as much to do at the Cape, having it come down from Baltimore, how did this ASFITS, with this little test --- what it sounds like it leads into the ---

Albert: ASFITS solve problems that saved us tremendous work down here.

Grimwood: Who put the pressure on them to get this type of - who thought of this?

Albert: I don't know who actually thought of it or conceived it. But, obviously, Colonel Dineen and Buzz Hello - that's two individuals - I'd have to give them the credit for spending the money. This cost money. And one thing that I think is significant here, when we talk about that --- because of things like ASFITS, if you just take the time of the program from its inception in dollars, here, they figured out a curve something like this. Because of ASFITS, the early cost did go up high, it peaked up. But because of that, then they fell off faster and leveled off at a lower value than --- But there was great concern about the fact that these costs were above - were going up above ---

Grimwood: And that was caused by ASFITS?

Albert: Well, not entirely, but partly. Because this cost a lot of money and by doing things more thoroughly, and I think that we're all believers now in do your testing work; freeze your designs; firm up what you want to do; make sure your system is solid, sound, and adequate, early in the game. Do everything that's necessary, then, and that'll pay off dividends in the end.

Ertel: Then go into operations.

Albert: Then go into operations with something you know you've got. ASFITS not only took all of the systems early in the game, but whenever we had a component failure down here, we could send it back to ASFITS and they could put it in and they had voluminous data and they could get data comparisons, trend analyses, and it helped us in our failure-analysis/corrective-action program, too. This isn't all ASFITS. I'll tell you another one that got into that was ---

Grimwood: What I was speaking of here - maybe you can take this whole deal - the price of the launch vehicle for the GLV program was just spiraling along the way, and NASA was saying watch this cost, and so the estimate would come in again and instead of it being lower it would be higher.

Albert: Of course, I've got another philosophy on this. When you decide to go into a program like this, you know you're going to spend a lot of money. And from then on, the only thing that really costs is failure. We negotiate these one and two million dollar items to

beat heck, and you have to do it. There's no question about that. You try to work to a budget but comparing something like that with a failure, which is some 20, 40, 50 million dollars, you just can't do it. So - another thing - and this wasn't necessarily tied into this curve, but we did an extensive program down here on what we call our EEI, electrical-electronic interference test program, which again cost more than we thought it would. But here again it was so valuable because we established a baseline and when we had uncertainties, later on, we went back to that baseline and were better able to pinpoint where the problem was, because we had done that before. On vehicle No. XII, actually we went back and reviewed our EEI data, because we had a spurious signal up there one time. So things like that I think are important. We diverted a little bit - a lot of work, of course, was done down here getting the complex in shape and getting all the ground support equipment in for both the vehicle and the spacecraft, and a lot of structural work. And, of course, you had your architect engineer who had done all the designs for erector modifications, the white room structure, the platforms, and everything. But one of the serious things that happened - about two weeks before the vehicle was going to come down here, somebody detected some cracks in the wells of the bridge crane - that crane that's up on the top of the white room - and they caused such a stir that they finally decided that this was unsafe. You just couldn't erect the vehicle with that - but there was a Major Bud White, here, - I don't mean Bud White - Bud Carpenter, who got on that thing and I swear within about two weeks he got a new bridge crane put up there. He had it fabricated locally with bolted construction instead of welded construction. But that's how that problem was solved. It was very interesting at that time.

Grimwood: That was before I (spacecraft one) arrived?

Albert: Before I (spacecraft one) arrived, right.

Grimwood: Very good.

Albert: Oh, gee. That was a real crisis. Before I (one) arrived, it was - of course, Colonel Dineen was working like the dickens to get this vehicle cleaned up out of the factory and bring the proper product down here.

Grimwood: And NASA was pressing. We needed to have a launch.

Albert: Of course, he was saying that, hell, we weren't ready, if he did send the vehicle. And we were saying, we're ready. Send the

vehicle. But this bridge crane was one of the items. There were several others. We did one thing that I think is not necessarily unique, but it turned out to be very valuable. Early in the game, we set up very rigorous ways in which we were going to do business. And we got a lot of static from it, from Martin Company. I remember people saying "Well, by God, we've launched Vanguards, Titan Is and Titan IIs without all this documentation and pilot safety reviews and everything. This is all extra effort and extra paperwork for nothing." But every person that said that is now a believer, I can guarantee. And it wasn't extra paperwork, it was useful. I'm not ---

Grimwood: Do you remember carrying them down to San Diego for the MA-9 rollout, and they couldn't believe what they saw? Martin and Lockheed and all of them?

Albert: Yes, I think I went down for that one.

Ertel: When they saw it rejected?

Albert: But we did run, on every piece of equipment that was installed here for checking out the vehicle, GSTP - ground support test procedures. And this sort of started our trend in terms of our approving all of these procedures before they were run and a very careful review, and we had many battles because we said the data just isn't good enough. Some of those problems set the trend and, really, I think raised the level of achievement.

Grimwood: Buzz said that when they started off, "We resented all this attention."

Albert: Well, sure, they resented it. Anybody would. This is right. But we did one other thing and that is that, speaking purely from down here, we were all in it together. This bothered me when I first got here. I attended a meeting and, boy, one guy'd stand up from one company and he'd point his finger and say, "Boy, we're great. You're wrong." And somebody else was wrong. Boy, after that meeting, I pulled all of our local people together and said, "We're down here as a team. We either succeed or fall together. I doesn't give me a bit of satisfaction to say, 'Mr. Company A, you're wrong.' " And the same way with my own people. We approve test procedures, and no officer ever came into me and said, "Martin made a mistake." Because he was responsible for what they did and he made a mistake. We had to throw a number of people out for a remark like that. Then we also ran facilities

test procedures. And all the facilities were - nitrogen system, the water systems, electrical power systems, the transomatic switches, the erector control systems, and all that - we ran facilities test procedures. Which again were fully documented and fully reviewed and accepted. So we were right in the middle of all that when the vehicle was about to be accepted. And, of course, Dineen would say, "You haven't completed all your procedures that you need to do." And we'd say, "Well, get the vehicle down here. We're in good shape." It was a little game we played there.

Grimwood: Dineen had a little other pressure on him, too, because at that time and for quite a while there, Ben Hohmann and his group were kind-of injecting this structural integrity question again - a junior-grade MA-1 and MA-2 from the Mercury program. That was bothering him - so those tests were being run -

Albert: I remember - they were very - you're talking particularly in the adapter area there, the interface area.

Grimwood: So he was bothered by that ---

Albert: I was on this Worthman-Rhode committee that investigated ---

Grimwood: You were! We've got quite a bit in there on that.

Albert: I haven't read your last version. The earlier one I wasn't too wild about, but I think you cleaned this up, so they tell me.

Grimwood: Let's see, we got through I. It turned out to be a real good flight. You got the launch vehicle in for II ---

Albert: Let me ask you - we had problems on I. In fact, some people have asked me what were some of the toughest times I had ---

Grimwood: What'd you have - the actuators?

Albert: No, no. I'm talking on I - this was ---

Grimwood: That was a confidence flight.

Albert: But we had several problems with that. Let me just think back on a couple of them. One that we had from many birds was our propellant loading system. We had some propellant loading exercises that gave us terrible problems on I. In fact, I look back and it's

amazing how we ever got through them. But we had problems with the ball valves in our propellant loading system. I remember the first wet mock we ran, gee, we were so many hours behind on that it was terrible. And then we scrubbed our first - I, you remember, had our static firing in it, and I think that was December of '63 that we were scheduled to have our first static firing. And we got into it way late, all because of the propellant loading - we were so late. And then there became a question of the positioning of one of the prevalves and we had to scrub. Then a couple of weeks later we tried again, and this time - this made me so provoked - we had a very abnormal cold spell down here and right in the middle of the count, Aerojet got real concerned about the energy output of their start cartridges, and the fact that if they didn't put out enough energy they could cause a disaster. And the thing that made me so provoked is that people have said, "Well, it's because it was cold that night and we got below the spec, that was really the catalyst that caused us to find out that our data on these start cartridges as a function of temperature was just very poor." So, when I looked at the curve that they were trying to show me, gee, they didn't have a high-level confidence that those start cartridges were strong enough on the best day in the world. But they've always blamed the cold weather. The cold weather was the catalyst that caused them to find out that we just didn't have good enough data. So we had to scrub again. The reason I'm bringing this up is, since these weren't operational, I remember Walt Williams, who was mission director, came down and was real upset. Of course, he had pressures on him to get the Gemini program off the ground and here we couldn't even static fire the darned thing. And he was real upset with me because we had tried to do this twice and weren't ready. Of course, I maintained, by golly, we were ready. We had accomplished all of our preliminary test procedures, that our system was ready. Of course, his argument to me was "you couldn't have been ready or you would have succeeded," which is right. We had a meeting - Colonel Russell was here then next door - and it was quite a rough meeting, as a matter of fact, because here, as we pointed out earlier, the Gemini program was so far behind, in terms of publicity it was getting, so in the public eye, and here, by golly, we'd tried two static firings and couldn't get them off the ground. And, of course, obviously, if you don't succeed, you weren't ready. But I maintained we were ready and it a pretty difficult argument to maintain, since we hadn't succeeded. So I guess it was along in January that we actually - I think we made our static firing, I guess, in December. I think we finally succeeded in getting it

off close to Christmas. We managed to always muck up Christmases in Gemini. So when I think of I, I think of all of our problems with the static firing and then, of course, the launch. It got off very successfully.

Ertel: I hit Walt with that, too. He was talking about ready versus not ready, your right versus wrong. At the press conference right after I, as soon as they knew it was in orbit they had a press conference at the Cape, and somebody asked Walt what the hell happened to the 1.69 second we were late. "Where was the hold?" He said, "It wasn't a hold. Somebody started that damn clock wrong." Do you remember that? I didn't know whether you were out there or not. So two weeks ago, when we were out at Aerospace, I asked Walt. "What ever happened to that little over a second that you lost on GT-I?" "God damn, Ivan, somebody started the clock wrong." I said, "That's the same thing you said five years ago." He said, "Well, at least I'm consistent."

Albert: Well, you know, this is sort of a funny thing. Even on our rendezvous missions, which were very precise, we didn't have the capability of starting or picking up our sequencer to the hundredth or thousandth of a second. We just didn't have that capability and - you're right. People say "Well, how come you couldn't launch right on the minute?" Well, of course, the range gives you Zulu point bump, bump, bump, bump. We never tried to do that. We didn't have the capability. So there was always bound to be - a tenth of a second was just inherent in man's ability to start the sequencer. I don't remember the full story - this is certainly possible. Very possible, in fact.

Ertel: I mean the same thing Walt's getting on you about is the same thing that he's out by a length later, you know.

Albert: It was an interesting discussion because, first, you can't say you're ready unless you succeed. Anytime a football team loses, obviously they weren't ready for the game.

Grimwood: They had a management panel meeting in late '63, I don't remember exactly the date now, but they started making a push to man-launch in 1964, by the end of '64. In the meantime, they changed their test philosophy at the Cape. What's going to be done where, especially on the spacecraft. And they bundled up about 250 people and sent them to McDonnell. The launch vehicle comes in in April and stays, and stays, and stays. Of course, it was down to August

before you started having a little trouble with it. What were you doing all this confounded period you're more or less waiting and they're fiddling around with schedules?

Albert: At that point in time, we still had plenty to do.

Grimwood: Wasn't there something about tandem actuators along in here somewhere?

Albert: Tandem actuators were one of the latest things on a vehicle to become qualified. There were ---

Grimwood: Didn't one mission bring out something about this?

Albert: Our first launch attempt on II brought it out. But the tandem actuators - as a matter of fact, this is an interesting thing. If I'm philosophizing too much ---

Grimwood: No. That's what we need - your point.

Albert: Let me know. I don't mean to just use up all your tape here.

Grimwood: We've got another side.

Albert: I know you've got to go back. You want meat, not junk. But it's interesting that the one - if anybody asked me, even now, or before the program got - what was the biggest major item that was a complete redesign of the vehicle, I'd say the tandem actuators. Now there were other switches and things like that - but that was the biggest item that was not flight tested on Titan II.

Grimwood: What about going through this actuator bit - how it was, why it didn't work, and what you did.

Albert: Let me get - let's get to that point first. We're not quite there, chronology-wise. But that was the one thing that had been redesigned and that's the one thing that we found a design deficiency in. When you talk about - you asked me one other question and that was what we did during that time period. This was real early in the program. We had a lot of equipment on the complex that needed to be refined. We had to refine our test procedures to a great extent. And, strangely enough, we had a lot of modifications to make on that vehicle. So vehicle II came down there. It wasn't flight ready out of the factory, as we said, because ECPs had been developed. So we had - at that time,

we were running an awful lot of mods - many too many, as a matter of fact, --

Grimwood: Hull said that poor old thing was tested to death.

Albert: When I get to II you'll see - we're on II now - but we did do a lot of mods down here. As a matter of fact, at one time we had some 800 hardware stickers open on vehicle No. II. But, I guess the first thing that happened, and I don't recall the exact date, we had - the spacecraft had arrived then, the vehicle ---

Grimwood: The spacecraft came down September 21.

Albert: It didn't get here until September?

Grimwood: The launch vehicle got down here in April. That's the reason I mentioned the five months ---

Albert: When did we have the lightning incident?

Grimwood: That was August 17.

Albert: That was before the spacecraft got here then. So we - by then we were going through our - we'd gotten the mods completed and we'd made whatever changes we thought were necessary on the complex, and, as a matter of fact, I think this was the day before or the day after our launch vehicle combined systems test. At that point, also, in talking about time, there was a lot of training of people. We - that was a busy time, I guess I'd better point out. I don't guess we were so healthy that we could say we were sitting around waiting for that spacecraft. Doing our own mods and getting our own house in order and getting our own procedures and way of doing business established - that was a pretty busy time and I think we had a number of component replacements and things like this, too. But at any rate that lightning incident was probably one of the biggest blows that ever happened to us. And, frankly, we still don't understand it. This always plagued me through the rest of the program. If it had happened again, and somebody had said, "Well, by God. Why didn't you do something about it?" I guess all I had was documents from the experts that nobody was able to come up with anything real positive you could do about it. So frankly we - our lightning protection at the complex was found to have been adequate by the state of the art. All the experts, after analyzing our problem, weren't able to come up with anything more helpful.. We put in some more sensors

and things like this that perhaps could have told us the magnitude of charge that was around there. But nothing could have prevented it. We didn't put in any more deep rods or fields or anything like that.

Grimwood: Now, you've had this bird that's been around a long time that you've worked with, probably more or less become a friend, even though the lightning came about, and after the lightning came about, here's NASA wanting to scrap it. This is where you really go to battle.

Albert: This is where you really went to battle. I remember this one I got heavily involved in personally.

Grimwood: What strikes me is you did it real fast, too, because 28 days later you were sitting down at a briefing on September 15, and telling them exactly what you had found, what needed to be done, what had been done. So that must have been a hectic meeting.

Albert: It was. That was a tough period. I just don't know how to even attack it. It was an all-up spacecraft and it was a very important mission and a very difficult mission.

Grimwood: September 4.

Albert: September 4 was - the strike was when, did you say? August 17.

Ertel: That was 17 days later - 18 days later.

Albert: I'm trying to recall - ok, now. What happened down here was - boy, this was a real hectic morning. All the wheels of the program - Chuck Mathews and everybody - was down here and we had a briefing scheduled for - to go over this lightning incident. And Chuck, at that time, hadn't made his decision although we'd heard a rumor that the MSC position was to - not to fly this thing.

Grimwood: Simpkinson said that they were against flying it.

Albert: Oh, they were against flying it. No question about that, but, although I knew about it, they hadn't come right out and said that that was their position when this damn hurricane came along. So here we had all these people down here and we were going to give them a briefing - or I was - on what we had decided. That fact that we had

identified all the solid state devices that had been affected - zapped, as we say - all the components that we were going to change out in our flight control systems and instrumentation systems, our diode packages, and everything. The fact that we had come up with a plan for a data book and we were going to compare the work that had been done here again, and ASFITS, and testing at Baltimore on this vehicle, and our previous ----

Grimwood: That data book hadn't been kept before?

Albert: No. The data book --- the data book that we --- we made a special data book up for this incident. The data had been kept, but we made a system - we came up with a bunch of overlays and everything, so - it was a big, thick book ---

Grimwood: You shook me when you said data book.

Albert: To show trends. In other words, this was kept in a different fashion ---

Grimwood: ---than the launch vehicle people did, your contractor.

Albert: Yes. In Baltimore. What we came up with then was we took their data, our previous data on the vehicle before the lightning incident, and then the data on each one of our tests thereafter, and put it on overlays to show that it stayed well within all the tolerances and there was no degradation. We built that book up, down here, to convince everybody by using all the data that was available. We changed that type of data book and made it a little more efficient later on and did use a similar technique throughout the program. But that was the first time I ever saw such a comprehensive comparison. We made that up down here. And its purpose, obviously, was to say that this vehicle, now that we've changed these components, is plain - just exactly the same as a new one - and there was no degradation in any of the systems. But then the people were down here when that hurricane came. These hurricanes are such a pain in the neck that you don't believe the weather men, but that particular night I remember going down to the midnight briefing by the weather people and they said it was going to be well out 90 miles east of here by that next morning. So here all the people were in town, and I got busy down at the complex. These people did go out to the Cape and they got in a meeting and here we weren't there to defend ourselves and a lot of the people thought - well, since we weren't there we got sold down the river, see. And that's

why the NASA people got so enthusiastic about changing the vehicle. As it turned out, because of our warning, we only got the second stage down. It was the most miserable thing you've ever seen. And so we left the first stage up. So that was another factor in Mathews' saying, well, that first stage not only got zapped by the lightning but it also got saturated with all this salt water. I remember - but, hell, there wasn't any salt water in that rain. That was a good fresh water washdown that it had. As it turned out the wind didn't get excessive beyond the structural capabilities of the vehicle there. So then the impetus - as I say we came to this 4 September briefing. We had our data and we told the condition we were in when it occurred and reviewed the condition after and how we analyzed everything and all the hypotheses we could possibly think of that could have caused this to get into the system, and whether it was induction through the gantry, or what. We still don't know. There's as many theories as people have studied lightning. But, at any rate, we did convince them to keep the vehicle up. And, I'll be a son of a gun, it wasn't two weeks later that we had another hurricane and had to pull the whole vehicle down again. This time we took the whole vehicle down. Then there was a little delay because we waited three or four extra days to put it back up because there was another hurricane brewing out there. So I'll tell you, you talk about vehicle II, you're talking about the - the problem - modifications, it's amazing how we ever launched I with all the problems we had with II, here. Getting our ways of doing business, our procedures, and everything in shape. The spacecraft, and then the two hurricanes, and the lightning incident. As you know, we convinced them that this was still a good vehicle and that we should go ahead with it.

Ertel: How much support did you have from Aerospace and other people on helping convince them? Or was there any ---

Grimwood: Aerospace indicates at this meeting that they were for it. Everybody recognized ---

Albert: Aerospace, I am sure, was for it. However, when you asked me that - I don't remember them being very vocal about it. I got a feeling that had MSC stuck in saying we shouldn't fly this vehicle, Aerospace would not have fought it very hard, because nobody at Aerospace got up real strongly and - not as strong as Dineen and Buzz Hello and I did. We were very, very positive about it. I don't remember Aerospace - I think Aerospace said yes, they concurred, but it wasn't a real strong position on our account.

Grimwood: But when you attempted to launch in December did you get some of these I told you sos?

Albert: No, sir, we did not. And then, of course, we've gone through the length of time the vehicle was down here, all the problems - and then we go to our launch countdown and had to shut down. And this shutdown is a real serious incident. We had run some simulations with the crew and with the people and knew that it could happen and knew that you had to check your tank pressures and what could become risky and dangerous, so people were - performed very well when it occurred. However, now we did find - we went out - we knew we'd lost a primary hydraulic pressure - that's what actually transpired.

Grimwood: When a shutdown happens this way, in those minutes after when you get out, you might say, to safe everything - go a little bit into this type of operation. You've got to work with the spacecraft people, too, because you've got a live vehicle up there, also.

Albert: That's right. Of course, the spacecraft is, from about T minus 15 minutes, is pretty static. They've got all the ordnance installed and everything. But they run very - after they've run their thrusters, that's about the last major thing that they do. So they ---

Grimwood: They have shot those pyros down to the valves.

Albert: That's right. Those valves are open. What are they - claxton valves - I forget the name of them.

Grimwood: They just call the darn things the poppets.

Albert: Yeah, but those valves are open. I think that's the only part - that's one of their big concerns - how they safe and close those valves and then they had to change them out. But you know that this is automatic shutdown. We have what we call - our sequencer monitor functions during the latter part of the count and could give us an automatic hold if progress weren't right. After engine ignition, there were seven things that we monitor during the three seconds of engine thrust buildup before the firing of the launch nuts. And anytime something is not right, then that would cause the thrust chamber valves to close and obviously shut down. Let me just state what some of the - you may have this list -

We would have a shutdown if we did not have proper power to the flight control system, a 28-volt signal to the flight control system. We would have a shutdown if we did not have buildup of proper thrust on the ladder at the proper time. We would get a shutdown if we, if our autogeneous system, our system of pressurizing the tanks as a bleed-off from our propulsion system - if that tank pressurization system was not working right. We would have a shutdown if we did not have a proper secondary hydraulic pressure - you know we have a primary and secondary hydraulic system. And we'd have a shutdown if our programmer was not set at zero. This actually was what caused our shutdown on VI. And we'd also have a shutdown if we had had a switchover to secondary system. Those are the only ones I can think of now. That's pretty good, more than I thought I could. This is what happened there. The subtle point here is we do not have a shutdown on primary hydraulic pressure. This is why this one always got a little complicated and every - Pres never understood this. But what happened here is - we had a leak in primary hydraulic system. It went down below the threshold which sent a signal to switch us over to secondary. So this put us in the secondary system, and being in the secondary system was a shutdown. So that's what shut us down. Your question was -- after that, your main thing is, obviously, safety and your two main things here are stopping any spill of propellants, by shutting off the proper valves - and, normally, unless you've got a tank leakage, your thrust chamber valves will stop any big flow. However, in this particular case, we did get a little rupture in one of the regenerative cooling tubes in the engine and those tubes are all full of propellant, so that continued to leak. Then, of course, you've - that's your first thing. Then, your next thing is you've got to safe your ordnance systems. Then you've got to insure that you've got integrity in your tanks so that you're not losing tank pressure. Because, if you've got a leak and you start losing tank pressure, these things can oilcan and you can lose the whole farm. Those are the main things. Once you have done that, then you get people out there and start fighting fire if you've got one. At the same time, I can't go into detail of what the spacecraft has to do.

Grimwood: We got that. But you do have to work with those people.

Albert: Absolutely.

Grimwood: The thing that I was referring to is you've got to have just enough people there and not getting in each other's way.

Albert: Oh, yes. Now, shutting engines down - the engine people say "Well, gee, we do this all the time on the static test stands. This is no problem." When you've got all your ordnance still on and you've got these large quantities of propellant and, obviously, these aren't boilerplate tanks. They're made as light as they possibly can. You get big shockloads. Obviously, the shockload in a shutdown is normally much greater than the shock of your start transient. So it's a severe thing. However, once you've established that you've safed your ordnance, that you've got tank integrity, and that you have got your valves closed. If you couldn't close your thrust chamber valves and that continued to leak through, you could have a problem of toxic vapors and everything. But in this particular case the thrust chamber valves did close. The shutdown was normal. Of course, then the big concern was "Can we repair this engine here?" Which we did. We actually got an expert down and he brazed this little pinpoint hole in one of the regenerative tubes. Then the big problem was the actuator. Without getting into tremendous depths or charts or pictures, let me just say the following: Inside the actuator, there's a little servo valve and the housing of that servo valve just wasn't strong enough to withstand the start transient structurally.

Grimwood: In fact, it formerly had been and somebody changed the design which weakened this thing.

Albert: This little servo valve was changed when they went to the tandem actuator. This was not as strong as the servo valve that had been in the basic Titan II actuator.

Grimwood: You just hit a point of memory there. So you went back to, more or less, the original design?

Albert: It was different. It wasn't the original design but it was similar and, actually, to make it light they had ---

Grimwood: Was that in the weight-saving program?

Albert: No. The weight-saving was so damned minimal I'd hate to accuse it of being a weight saving.

Grimwood: Some of that weight-saving program looked so ---

Albert: But it was a little valve in here that looked something like this, and where there are little caps and screws that bolt on here - I'm going to take a top view of this. This servo valve right here -

these were little dogeared legs that came out. I think this piece was a solid piece where these screws went in, and this thing had ruptured right there and lifted up off of the base plate that it was attached to. So it was a physical rupture inside there that allowed the hydraulic fluid to get down into the body of the actuator and then that pressure built up and there's a little port that had a little rubber gasket around it, actually, and the pressure blew out through that little rubber gasket down at this access port. So then they did a - they took this actuator back to Moog and Moog was under the gun, then, and analyzed it and found out what happened, found that this was not strong enough. Then they ran some real rigid tests -

Grimwood: Who was this Moog, now?

Albert: Moog was the vendor of the actuator.

Grimwood: Moog.

Albert: M-O-O-G. The president of the company is Mr. Moog. But Moog Actuators, they're a big outfit. But they were the vendor for this. Then they ran extensive tests. And then actually they took the test actuators and specimens to Baltimore and set up a tremendous impact test program, where they would put all the connections through the actuator, put all the proper pressures into it, and then they had a big pendulum device, and I don't know how big a weight they put onto the end of this pendulum, but so many hundred thousand inch/pounds of pressure would hit that lollypop end of the actuator and they ran some of the original ones and actually found out at what level it would break, they found it was too weak, or marginal. This gave them the confidence then that with the beefed-up little servo valve to go ahead. This was all done pretty quickly. You remember, our shutdown ---

Ertel: You shut down on the 8th and that day we announced a two-day hold, as I recall. By the next day, --

Albert: Let's see,you're Grimwood? And you're Ertel? Let's see, where were we?

Ertel: Just about to launch II.

Albert: Which did launch, as I recall - oh, was this the one that we - we launched right on time.

Ertel: But there were some problems - what was it a guidance problem or something that changed the angle of attack ---

Grimwood: But that was because of what happened to the spacecraft, though - the spacecraft had some burn holes in it so they changed the angle of attack. It really helped because they were able to save about 40 pounds of spacecraft weight.

Albert: You probably, also, have access to, or should have, the reports that came out after each launch, which give you the details.

Ertel: Of course, there's a lot of things that you can't read in the paper, things that never ---

Albert: In terms of dates, specific incidents but you've got that and you can tie this into the personal side.

Ertel: No, it was a real great launch.

Grimwood: Nothing to the launch.

Albert: The only - I was just looking - I see the one thing that did concern us was our secondary hydraulic pump - this came out in the postlaunch data - it did not build up properly. We did come close to having a shutdown. Remember I told you secondary hydraulic pressure was a shutdown prime order. We were very close to having a shutdown because of that. And that reminded me of that, because we then went into a program of replacing and supercleaning our hydraulic pumps on all the vehicles.

Grimwood: Yes, I've got that. A drop in launch vehicle -"there was a drop of" this is Kleinknecht speaking "the launch vehicle hydraulic pressure for a two second period before liftoff."

Albert: So we were in jeopardy of having a shutdown.

Grimwood: "And it was thrown into a flight path quite a bit higher than had been planned, which was corrected by the radio guidance system during the second stage boost."

Albert: This is something - you reminded me again - this is something we had in the whole program. We finally said, "That's right," and lived with it. But what he's talking about here is this is the Earth and this was our proposed flight plan and this is stage one - actually, stage

one was always lofted, and then as he said we did get a maximum steering command - radio guidance takes over, starts steering ten seconds after staging. They did give a maximum downward steering command for approximately another ten seconds. This is exaggerated but it did look something like this to get back into the proper trajectory -

Grimwood: It was 12,000 feet on stage one.

Albert: But I think at the final cutoff --- but this took appreciable - and this lost him - but this stayed with us. The same thing happened on III. And I think finally the great guidance experts analyzed - we thought that stage one put out a lot more thrust. I remember betting with my propulsion man that, hell, we put out over 500,000 pounds of thrust instead of 430,000, and this was part of the cause. But they did do some commutating factors and I think that later on they built their trajectory based upon what it would do. On III the same thing happened. I know this gave John Young and Grissom a little start because here we were at stage two flight and were nosing down below the horizon, see. And as a good pilot he knows that you don't - that if he was heading down below the horizon something was wrong. That isn't the way to gain altitude. So that did cause Grissom and Young a little bit of a start, but it happened on this one, and we didn't understand it and it happened again because we thought that was just a high thrust situation, but they finally - I don't think they ever fully understood it, but it happened every time so they compensated for it.

Grimwood: The way he presented it at that time, he probably didn't understand it then.

Albert: I don't think anybody fully understands it now, but it ocurred. They did - I think they do understand it a little better. All of our early trajectories were lofted from predicted.

Grimwood: We've got III in here hard by the time that we got II off.

Albert: Well, then, I think from then on we pretty much stayed ahead. We were - at launch time, or a day or two before or a day or two after launch - we were always getting ready for the vehicle to get here. Dineen liked to have that next vehicle in the stable so people could ---

Grimwood: The fact is you really almost had two vehicles in the - you'd have a vehicle in the stable before you got III off, by just a

little bit. The same day that you got ---

Albert: I don't have the dates.

Grimwood: And then - this is interesting right here - the first month, the third month, the fifth month, the eighth month. You were getting close to this two-month launch center which came about in '64. We were getting a trend here from III on on deliveries. I know, at a meeting Dineen recommended to General Funk that he bring up - see what people could do. They had already had this launch in '64 - the manned launch, unfortunately the hurricane and a few other things in there, changed his concept on checkout and getting that ---

Albert: After IV we went through a change in checkout philosophy, too, here, again, where we more rigorously than ever said that the factory-testing had to be done right. It is flight-ready out of the factory and we decided that, based on proper factory data, we would not have to redo a number of the tests that they ran in the factory.

Grimwood: How did you change - what were you doing here before, say, physically - like the spacecraft that formerly, in Mercury, spent a hundred days in the industrial area and they were talking about taking all the components apart - and it seemed like there was something about a horizontal tandem test that you were ---

Albert: No, we never had anything planned for that.

Grimwood: You never did?

Albert: Out at the Cape, I've still got our documents on that --- I think a lot of it is - we cut down on a lot of the tests that we did in flight controls, which reproduced data that was already gathered in Baltimore, and instead of that we went to more of a verification testing situation. As a matter of fact, during the period that the vehicle first got down here, we used to call it subsystem functional verification testing and then later on we called it subsystem verification testing. We stopped a lot of the functional ---

Grimwood: Was Hutchison down here with you? Fountain Hutchison?

Albert: No. He was - we were here a year together and he was on the Titan II program. He was down here for the later Titan II program part while Gemini was getting started.

Grimwood: When he first heard of the two-month launch centers, he said that didn't bother him at all because he said - he mentioned the Titan II - we have been getting these birds ready.

Albert: It didn't bother me either, to tell you the truth. I felt that we certainly had that capability and I felt then, and as I told you earlier I still feel that you're in a healthier posture by keeping the pressure on. Two month launch center is a healthier launch center than three month.

Grimwood: Did you ever get where your people got a couple of days off during the week?

Albert: Oh, yes. This is another thing. People are - people perform as a function of the pressure that's on them, too. Not that you keep pressure on people continually and get the most out of them, but in terms of efficiency of workers, we find that we put an efficiency factor much lower on certain parcel of work four weeks before launch than we would the week before launch. In other words, a certain test that had to be done - it would take longer to do four weeks before a launch; if you repeated that same piece of work a week before launch, it would get done a lot quicker. I think we applied ---

Grimwood: You have to kind of watch things like that, don't you?

Albert: Oh, yes. Which we did.

Grimwood: Because a test program is only as strong as your people.

Albert: Oh, yes. Absolutely. But people pace themselves, too, and quite frankly, I did the same thing. Hell, two weeks before launch you worked 18-20 hours a day. There was no such thing as a small problem. Everything was a major thing. But I think everybody had this feeling. After a launch, although we had a schedule, people would take time off and relax for a week or so. Even though we might be erecting a vehicle. But things were much slower paced. We did this intentionally after the launch. You'd follow the activities of the recovery and everything. The pace would just settle right down and then it would slowly build up again to the time - in fact - this is off the subject a little - but I told you we ran these simulations? It always amazed me, but we would be razor-sharp on the day of launch. Then we'd have this down period, or lull, or low activity for a week or so. Then the new vehicle would come in and we'd run its preliminary tests and the subsystem verifications. So now here we were four or

five weeks before the next launch and we'd run these simulations again. It was amazing how rusty the people would be now. I don't know whether play-acting isn't as rigorous as an actual hot launch, and people didn't try quite as hard, but we'd run these simulations and guys would make mistakes that they hadn't made before. And then you'd run these for two or three days, and they'd get sharp again and stay sharp up through launch. But there always seemed to be, not only a drop in the work level and the efficiency of the workers, but also in their competence really. So you'd sort of let down and then you'd sort of have to build it up again each time. I guess this is a natural things because you get the same sort of thing with athletic teams or anything else.

Grimwood: Do you remember anything on IV and V?

Albert: Um, hm. III, of course, there was a lot of concern because it was the first manned launch. I think that everybody realized that and I think that it went very smoothly considering it was the first manned launch.

Grimwood: Well, it was so hard by - what was worrying people - like the seat hadn't been qualified - so many things ---

Albert: Right. There were many things and I can't say that III was absolutely smooth, because everybody was aware it was the first manned launch, the first time there'd ever been a man on the Titan, the first time a man had been in the spacecraft - there were all these uncertainties. But things went very - in spite of that, and I told you about the changing hydraulic pumps and this sort of thing, but by and large it went pretty smoothly. And then IV. Of course, IV went pretty good. The one thing that you always think of on IV, though, is during the launch our erector problems. This was the first time we'd had an erector problem. You remember that went down to 12 degrees and stuck. At that point what we call our "fail-safe jaws" grabbed the erector rods ---

Ertel: It was stuck for 35 minutes or something?

Albert: Well, actually, it was an hour and 16 minutes delay in the total launch. Then we were able to bring the erector up, but then we'd start to bring it down again and these jaws would grab again. This was a real serious thing. Actually, what had happened was some body had gone into a junction box to look for water, and although they did not have the proper paper to do this, actually lifted

a connection to put some moisture underneath it and put it back incorrectly. So it was a human error that caused it. Of course, during the count they finally ---

Grimwood: Machinery is so unforgiving.

Albert: It sure is. Jumpered around it and got the erector down. This was serious for several reasons. First of all, during the time period, we had done a lot of work in coming up with our safety plans, our abort criteria, the action in the event of a pending problem, the action in the event of an actual emergency, when you could use ejection seats and when you couldn't or when you had a clear path - the danger here was, with this erector at 12 degrees, you didn't have either, so at that particular place, if there had been any problem there was no way to get the astronauts out of there. You didn't have a clear ejection path for the seats; the astronauts couldn't get to the platform and come down the elevator or anything; and you couldn't get a cherrypicker in between there. So here all of our great precautions that we thought we had worked out, and we had spent a lot of time on these, we found that this was one that we hadn't provided for.

Grimwood: Which one did the cherrypicker get up to?

Albert: That was on V, which I'll tell you about. But later on - after this, then we did come up with a sling arrangement,which we had in the white room on all subsequent launches, that was attached to the bridge crane and we did - the bridge crane could go out far enough to put this sling right down by the door. So if that ever happened again, the astronauts could have gotten into this sling down from the bridge crane - and we actually tested this. And although the platforms would be sloped, they could still get out through the erector. People said, "Oh, gee. Let's get that erector down." Of course, you didn't want to get that erector down and lose your capability of getting it back up for astronaut safety. This was our first big erector problem. This, then, became something we talked about through the whole rest of the program. I guess that takes care of IV. Now, V - this was during one of our wet mocks and we had gotten the erector down properly and we were going to run this egress simulation and couldn't get the erector back up. We tried for many hours to - not many hours, I guess it was about two hours - to get it back up and they finally said, "Oh, we've got to get the astronauts out." So we used the cherrypicker to get them out. The funny part of it was I saw Gordon Cooper that night and I said, "Gee, I was crushed that we

had to go through all this." And he said, "You know I was real glad we used the cherrypicker," because it seemed that he was in charge of astronaut egress on Mercury and Gemini and he was the one that always advocated the cherrypicker and everybody else said, "Hell, no. You'll never use it." So he said, "Really this shows that I was right." So his old theory finally got to be used. So he was real nice about it. And on that one here's another case where we had done some preventive maintenance on the tachometer generator and one of the motors and lo, and behold, the technician had put brushes in backwards, so the tachometer motor worked alright going down but wouldn't give a safe signal in bringing the thing up. This time, then, we really let - really went through a lot of maintenance procedures - not for just this instance, but everything. And we did a real thorough job on that, in that they were all detailed to a much greater extent than they had been before. And we came up with one rule that we kept through the rest of the program. And that is that we would never do any preventive maintenance unless we could run a complete functional test thereafter and a complete end-to-end test, so we came to the point where we never did any preventive maintenance after our last combined systems test on anything.

Grimwood: That just didn't do any good at all, seeing that thing lying there on television.

Albert: Oh, hell, no! I'll tell you - and particularly with the erector system, then, we came up with a big, thick document and a trouble shooting manual and we had drawings on every detail and we had a team that was all set, that was standing at the ready at all times. And we never had any more erector problems. We even went to the extent of running an erector cycling test after spacecraft mate and within ten days or so before launch, which I think was unnecessary but it was a psychological thing that - if you had a problem, you could say, "Well, dammit, it worked ten days ago," rather than you could say, "Well, it worked at the last launch." So we ran an erector cycling test. But the erector worked. Those were the two main erector problems. But the erector was always under the gun from then on.

Grimwood: You get down to VI.

Albert: Well, this was at first a big letdown when the Agena ---

Grimwood: There's another thing I want to bring out here before -

it was in the period just before VI. You've had all kind of countdowns now that are necessary and how did you go about working out the procedures for all of these countdowns?

Albert: Well, we had a lot of meetings and a lot of sessions together. We identified all the common usage of equipment, for instance, the range command carrier, the GE guidance system, the time periods in which the Agena had to playback with Houston, and the time periods that our spacecraft played with Houston, and all the other range support ---

Grimwood: There's one thing that you have to be careful about during this countdown - that's what you said. Because you had your decision-makers on launch just listening in to the countdown, and if somebody says, "Well, we got a big problem here," and then didn't identify this problem ---

Albert: Of course, I have always maintained a little bit that the simultaneous count was not quite as complex as we made it out, in that, if everybody played the game right, and everybody took care of their own business ---

Grimwood: That's what I was talking about. There's so many people playing the game ---

Albert: But if I had a problem on 19, I didn't want anybody telling me what the problem was, or how to solve it, or anything, any more than if Jack Allen over on complex 14 had a problem, and he said he's got a problem and he's got to hold - well, we just hold right with him. But there were an awful lot of pieces that had to fit together. There's no question about that. The hub, really, was Mission Control Center in Houston, because they were playing with all the outside activities, including down here, including the range, and, really, the only things we had to coordinate with 14 was GE guidance and the range. As far as what was going on at 14, that was completely independent of what we were doing. If they went into a hold condition, we had established the hold points and we, obviously, would hold with them.

Grimwood: All right, you've got the situation where the Agena goes up and goes nowhere. And you sit there until about T minus 43 on the spacecraft, and that was probably a pretty damn low time.

Albert: That was an extremely low point, extremely.

Grimwood: When did you hear about this plan - you, personally --

Albert: The recovery plan on that? Well, I guess - when was -

Grimwood: October 25.

Albert: The launch attempt of VI - maybe six months before that. As a matter of fact, when did the Russians make this spectacular of theirs?

Grimwood: That was in April. [March]

Albert: After that spectacular, we - and I think we down here did quite a bit - and I think we said, "What in the world can we do in terms of a spectacular?" And we knew that VII was the long-duration one. So we, actually, Joe Verlander and I and Chuck Chicketti and I had a Captain Shirer involved, and I think the four of us did most of the thinking about that. And I'll tell you what our thinking was then; it'll probably seem a little unusual. But it was to try to get two manned spacecraft up at the same time. That was the objective. What we thought we'd do - as you know, there was complex 20 adjacent to us, which didn't have any program on it then. Titan III-A was through. So our plan was to take vehicle VI on complex 19, and check it out electrically, completely, with the spacecraft on it, too; get through with the spacecraft AGE there. Then demate the spacecraft in the normal fashion, put it in bonded storage, then take the launch vehicle and not separate the stages, or anything, and get one of these Sikorsky Skyhook helicopters and actually pick it up in the vertical condition and move it over to complex 20. And then build a fixture that would align it between the A-frames as you brought it down on the launcher at complex 20. So here you would have just picked it up and moved it over. Now, while it was over there, you could perform all the long-time required for engine leak checks and things like that. You couldn't check it electrically but you could check your propulsion system and hydraulics and that sort-of thing. Then you bring vehicle VII in, go through its total checkout, launch it in its normal fashion, then bring your already checked out launch vehicle, put the spacecraft back on it - and we had it worked out we could launch it within about five days in that sort of posture. I think the only people who were enthusiastic about it was us down here.

Grimwood: The rest of them kind-of looked down on it.

Albert: We took it up to SSD, briefed Funk and Dineen, and they sort of gave it lip service and Chuck Mathews said he didn't think it - and it didn't fit in, really, with the Agena rendezvous launches. Ev Christensen - I briefed Ev on this one time when he was down here - I guess Bill Schneider was -

Grimwood: That was his first job as mission director was -

Albert: VI.

Grimwood: Because he said he was dumbfounded that the Agena didn't go. They always went.

Albert: An old Lockheed man, maybe. I don't know. But, at any rate, that same afternoon of the scrub, Christensen and Schneider talked to me about it - they said, "Well, what about that old plan?" And I thought, "Gollee!" We hadn't done anything with it. The plan wasn't quite detailed at the time, so I said, "Well, let's look at it again." But I really felt that - I didn't think that was the way to go. As a matter of fact, I hated to take vehicle VI down. I was advocating "use the same vehicle and put spacecraft VII on it, and let's don't demate and go through this whole rinky-dink." At least, that was the direction I was pushing. Go ahead and launch VII. But then, I guess, Walter Burke and John Yardley, who were in on this old plan since I had talked to them about spacecraft and everything, felt the spacecraft certainly could do it. I don't know who they talked to - Gilruth ---

Grimwood: They left from here and went to Houston ---

Ertel: Gilruth and Mathews.

Albert: It wasn't their idea that day, because we'd talked about it that same afternoon with Christensen and Schneider and Chuck, a little bit, I guess, that day. But I guess they're the ones that really, then, pushed it, and made it effective. Then we waited down here a day or two, trying to decide on the pros and cons of deerecting vehicle VI. It was true that the spacecraft would have to be changed. There was a little difference in the performance of the two vehicles. One had another hundred pounds or so and that -- I think we finally changed it and that was the argument that was used, although we knew that there was something more coming along - the performance wasn't that much different, although it was a factor that was discussed.

Grimwood: VII was down, wasn't it?

Albert: VII vehicle? Yes, that's right.

Grimwood: It came in the 16th and the 18th.

Albert: But you - but normally it's not a good thing to change - just to change a vehicle, handle it if it's already been checked out and ready to go unless there's good reason for it. What we were trying to do was find out the reasons for it. But at any rate the decision - I think we pulled it down, although we knew the decision was in the mill before the decision was finally made, and then we took the vehicle and put it over in airconditioned space and developed a little device so that we could maintain positive pressure on the tanks the whole time. And put it in bonded storage and put a guard on it. They did the same thing with the spacecraft. I remember talking to Preston. Then everybody and their Goddamn brother thought of millions of things they wanted to do to both the spacecraft and the launch vehicle. And they had more darned mods they wanted to make. If you talk to Preston you'll find that he had to take a real strong attitude on the spacecraft; I took the same thing on the launch vehicle. By God, here we were going to launch it. We weren't going to buy those things. But here we had something that had some integrity established. So we really held that - people wanted to take out all the components, you know, and run them through laboratories and everything again. We did this to an absolute minimum. So then we went into the checkout of VII. And that I would say was probably our smoothest overall operation. Toward the end I think the spacecraft had a computer problem on VII, but from the launch vehicle point of view, we had less component change-out, less problems, or less things to worry about on VII than any other. So if somebody says, even now to this day, "What was your smoothest vehicle that everything went most closely according to the script?" I'd say "VII."

Grimwood: All right, now you come down to this point in December ---

Ertel: VI-A, No. 1.

Grimwood: -everything goes nicely ---

Albert: One point I want to make - during this whole time of checking out VII, there was another parallel effort going on on. And that was all the planning that was necessary for the rapid turnaround. I don't have them here but I have out at my Cape desk - we essentially established a countdown back in the - that identified every task in great detail - we were going to work around the clock. We established a schedule for those items that we knew were normally damaged on

a launch. We established kits and the tools were ready. Everything that the man needed to go in there and start working. We had the welders standing by at launch that were going to have to come in. We had the VI launch vehicle in its readiness configuration. The SRO for the range support was going to work around the clock, too. We scheduled chow trucks.

Grimwood: I didn't know about that.

Albert: We scheduled everything. So we had a plan that I'm real proud of, and it worked out to a gnat's eyelash, of everything that was necessary to do it. So you're right. We launched VII and, normally, as I say, you had that letdown. Well, that didn't occur after this. Boy, I'll tell you. We launched VII and then everybody went to work. I was really concerned for the first couple of hours, because, boy, everybody was so excited you'd think they were going to launch the next day. And I really stayed in the blockhouse just calming people down. Gee, they were saying, "That welder's not there - go in with a sledge hammer so you get that piece of metal out of there!" The first hour everybody was tired. It was pretty hectic. Then things settled down and our schedule was based on launching nine days after. Then we were ready to launch eight days thereafter. And that's when we had our next shutdown. People performed better. There was a complete absence of human error. Tasks were done in half the time they normally took. I think that people really responded when the pressure was on them and when they had to perform like that.

Ertel: The adrenalin was way up.

Albert: The adrenalin was running and the efficiency level was extremely high. And one thing we did during this time period - we didn't sacrifice anything. We had worked out in detail what we had to do to get to our sim flight test and then we said, "From sim flight test on, we're going to do everything the way we always do." So we would establish a baseline and then proceed normally so we wouldn't overlook anything. We also, during this time period, insured that every test that was run, every test procedure, was given the same depth of review in the pilot safety working teams. So when we got ready to launch VI-A, we had exactly the same level of confidence. Also during this time period we used this data comparison program and checked any trends or anything there. So I'd say we sacrificed nothing. Some people played little games with greater order of risk and all this, but I'd say that that was

not the case because we reverified everything in a logical plan. We used our same test procedures, our same review cycles, our same data gathering, in fact, maybe even more because everybody worked a little harder.

Grimwood: On the launch of VI-A and the shutdown. That was the umbilical plug that came out and started the clock which would have shut it down.

Albert: The tail plug. It did shut it down.

Grimwood: What do you remember about the story of finding the dust cover?

Albert: I remember everything.

Ertel: Everybody said "Ask Jack Albert about that."

Grimwood: That's the one we really have to have. How did this come about?

Albert: Let me draw you a little picture here.

Grimwood: I've seen a picture of how the dust plug fits in.

Albert: Let's establish the baseline of where we are. We - this was on Sunday and everybody was saying, "Don't launch on Sunday." But we got down - we had the shutdown. Everything was perfect and, as I pointed out earlier, our shutdown parameters and one was if the programmer was running. There are two little plugs that pull out when you fly away. One of them pulled out and that started the timer, and the timer, of course, not being at zero, caused our shutdown. Now, that's all we knew. I remember getting back to the office and we felt that that plug had not been put in and seated fully in the detents. I remember General Funk was pacing up and down. "By God, I'll go out there and put that plug in myself if I have to do it." See. And we were busy checking the records - was it put in according to procedure? When was the last time it was checked? Did we have quality buy-off that it had been properly twisted into its detent and everything? And to this day we feel that it was properly put in. And we did find, running a large number of tests, that some did pull a lot easier than others. So, to correct that, we did, from then on use - we didn't redesign that particular plug - but we used plugs that had a tighter than normal pull force. We selected them and

we also safety wired them so that they had to pull through the wire also. So that's all we knew. For an hour or so after launch - the tail plug had pulled out and shut us down. Something completely uncalled for, we thought. Now, about an hour and a half after launch, or thereabouts, I got a call from - I'd say it was Jack Wiegand in Aerospace who had just gotten the engine data - and subassembly one - this is time going this way again - looked - and this is thrust - looked like it should have looked. It built up, had a spike a little bit in here, and was starting to level off and I guess this is the way it should have looked, and I guess this was the three seconds that we actually shut down and then right here it fell off. So this is what subassembly one - subassembly two did the same thing. Started to build up here, and did this at the shutdown. If I superimpose one on the other - it built up like it should have built up and did like this. So subassembly two data just didn't look good at all. As a matter of fact, we had scheduled a meeting with General Funk and George Mueller and Gilruth and Chuck Mathews and Dineen and everybody in my office an hour or so after launch to go over the tail plug thing. About five minutes before the meeting, I had seen this data. So I remember putting it on the blackboard, I forget what the specific items were, but one was "Review of the Tail Plug Installation" which was all right. The fact that all the other systems were all right. The recycle that we could do on the tail plug. And 4 was the engine data. Well, I don't think we spent very long on that - but when we got down to this point - and Doug Ward, the Aerojet man, was in there - I brought this trace down - I knew that we had to discuss those -

Grimwood: Was Doug familiar -

Albert: Hell, no!

Grimwood: He didn't know this?

Albert: He didn't know this.

Grimwood: I talked to Doug.

Albert: Does he admit he didn't know?

Grimwood: You can't - what I was trying to do was to get - was this Aerospace or was this Aerojet?

Albert: It was Aerospace data that I had seen. I don't want to detract

or give anybody - it was a timing ---

Grimwood: I heard that Doug didn't really believe it to begin with.

Albert: Well - it would have been found. Aerospace does get data quicklook - you don't have to be a propulsion man to determine this. Actually, they did try to build a big case up with Bob Redding as being the one that discovered this. Sure. Bob was the first one that I know of that saw it, but this is just because he had the piece of paper in front of him first. Anybody would have seen it. But, I brought a copy of this down to the meeting and I remember putting this on the table in front of Doug. Poor Doug said, "I don't know if it's wrong or not. It doesn't look right ---" That's all he said - but he was very noncommittal, but you could tell that he was concerned about it.

Grimwood: Lou Wilson said he was out at Aerojet and he had been trying to analyze this thing just by listening to the telelvision. And gave a call to Doug.

Albert: Well, nobody knew anything about this until the data was made available.

Grimwood: He said it didn't sound right to him, but he said - "but my hypothesis was wrong."

Albert: You mean the engine ---

Grimwood: Yes. Wilson said even the sound ---

Albert: Well, this could be.

Grimwood: He said, "My hypothesis was totally ---"

Albert: At any rate, had this tail plug not fallen out, this would have given us a shutdown a couple of tenths of a second later. Now the interesting thing is - had this tail plug been earlier, we never would have had this data. We'd have launched again and had another shutdown due to the engine. So this was almost a calibrated time period that that tail plug fell out. If that tail plug had fallen out three-tenths of a second earlier I don't think we would have discovered it. Then Aerojet did a real thorough analysis out at Sacramento. They started working this thing, and from the data, although when Doug was shown this data cold he was extremely nonplussed, they did determine that

it almost had to be in that gas generator system. So then we had a meeting that night - 9 o'clock, I guess - with George Mueller, Chuck, the Martin and Aerojet people, and Dineen, and we identified certain components in the engine that we did want to pull out - some of the lines into the gas generator, and the lines out of the gas generator, and everything. So, here again, we maintained control and said, "Ok. We're not going to do this until we get the procedure all written up and identify the steps for quality check." They had opened some of these lines the night before, so I went to work early the next morning - they still had found nothing. And, finally, I guess about 10 o'clock the next morning they actually found the dust cap in the top of the gas generator.

Ertel: I think if Funk lives to be a thousand he'll never forget that day, because he said an hour after the shutdown he had to sit out there and face the press and try to answer questions of the Bill Hineses and the Julie-babies with no answers at all.

Albert: He didn't know. We knew almost nothing about this. This was just from a piece of data and, as I said, even the engine people hadn't had a chance to look at it. The only thing we really knew was that the tail plug had fallen out. Then, of course, they recreated the whole situation.

Grimwood: Let me get one thing straight. This was nothing out of the order at all - for Aerospace to have been looking at this piece of data?

Albert: No.

Grimwood: Ok. I kind of got an indication at one place that this over and above the call of duty.

Albert: No. I wouldn't say so.

Grimwood: This was what they should be doing?

Albert: Yes, sir. That's why we got them the data and that's why we always insisted that, on any test, Aerospace get that. This was their job. This is right. We have provisions for them to get data very expeditiously for this very purpose. Not only for a launch bit for all our major tests. I always expect, after a combined systems test, to get the word from Aerojet immediately or before they went home.

That was their job. That each individual system guy was to review that data before he went home, because I raised cain a couple of times when a guy went home. I won't - as I say, I can't give them extra credit, but you've got to give credit where credit is due. They did identify. Now any engine man would have detected it. It was a very obvious thing. This wasn't a subtle little glitch that somebody saw. Then they did review that they had made this disconnection up in Baltimore and, trying to be extra careful but not following real good practices, this dust cap was put in there and had not been removed.

Grimwood: I talked to Fuzz Furman.

Albert: To who?

Grimwood: Fuzz Furman.

Albert: I think it was an unfortunate set of circumstances.

Grimwood: It was a shift change.

Albert: Yes, it was in the middle of a shift change and I think everybody tried to be so cautious and so careful and it just didn't get removed. Now, unfortunately, and it's still the case, there's no way you can detect that thing on any test that - we have no flow test through that port that can detect it, so there's really no way to detect it unless you actually start the engine. All of my friends thought how stupid could my people be down here in leaving that plug in.

Grimwood: Did you see Schirra after that particular shutdown?

Albert: I'm not sure whether Wally and Tom were both over in my office or whether it was just Tom. I think they both were.

Grimwood: Because that would probably have been - you know, he's got the test pilot attitude -- this would probably have been the low point of his career. He's up in his forties here. He's the old test pilot and that could have been his last shot.

Albert: Oh, boy. Now I will say this, though, that, based upon the astronaut training, he did not and he should not have ejected. I think they overplayed that a little bit. They're always talking about the two cues, you know. He had one cue and that was that the programmer was running. Talking to Tom, Tom, actually, knowing

that they had a three-second hold on, was going "one thousand, two thousand," well, he didn't get any further because that's when they sensed the shutdown. But it was a tough situation. But the programmer was moving. And also ---

Grimwood: Are you saying, then - I've heard many places that according to mission rules, they should have ejected.

Albert: I don't think so. No, sir. I'm saying "no."

Grimwood: You're saying according to mission rules they should have stayed in.

Albert: They should have stayed in.

Grimwood: That's a good point to make.

Albert: That's right. The programmer was running, this is true. But, talking to the astronauts, they can sense liftoff and they do know that it's three seconds from ignition to liftoff. They did not have that seat of the pants feeling that they had liftoff. As a matter of fact, you get tremendous vibrations while an engine's building up and you're still held down. When you're free, those vibrations stop. So you can detect it. It's easy to say what I'm saying here. But the time element is so fast that you don't have - three seconds is almost no time to do all these things. You don't have ---

Ertel: They didn't bring a checklist.

Albert: ---a checklist that you can take your time in doing. And I'm sure it's pretty damn rough when you see that programmer running. But they did exactly the right thing and exactly what the mission rules told them to do, in my judgment.

Grimwood: You don't even think the programmer would give them a psychological feeling ---

Albert: Sure it would. It probably would.

Grimwood: The people out at Weber were of the opinion that Stafford would never have ejected anyway. They said he was afraid of that damn seat.

Albert: None of them wanted to eject, actually, on the pad.

Ertel: Wally didn't want to, either. The FBBC.

Albert: They keep on about the two cues. There was just the one cue. I don't want to minimize the criticality of the time phasing there because this is real, real short. But Tom told me he had gone "one thousand, two thousand" and then they sensed the shutdown.

Ertel: There's another important point in that sequence - the fact that there were two guys sitting down in the blockhouse with a finger on a button, too, that could have - the overall training of the group as a group was ---

Albert: But, now here again you had your criticality. When you have a shutdown and that particular one we did have quite a bit of propellant coming out of our pressure sequencing valve and it took us quite a while to get that flow stopped and there was a fire to fight. Still, it was not a critical thing, inasmuch as our tanks were holding up good. We knew that we had our thrust chamber valves closed and we knew we had our ordnance safed and we did - we were concerned; in that particular case, we did leave the astronauts in there a lot longer than we wanted to. You'll probably hear this discussed and that's one of the things that we did fix after that - a tube on our pressure sequencing valve which does have an overboard tag end tube which would prevent that from spilling. That was a tough thing to solve, and we never solved it to my satisfaction. But we solved it, or we notched it so that it would break when you pulled away, but, hopefully, it would not break on your engine start transient. And that would have prevented that. We also had all the equipment necessary from then on, on the pad, to actually get the water connection into the engines. You hate to get the astronauts coming down until you get the erector up and until you've actually flushed all these regenerative tubes with water because you can still get a cough or a burp in there. But it takes too long to do that. Then one of the things we worked on was to, if ever that happened again, we felt we were in a much better posture to quickly safe things, to flush the tubes and the chamber and prevent that pressure sequencing valve overboard drain continuing to leak.

Grimwood: After you got through VI, did you really feel like you were just hitting, more or less, an operational stage in the program. After you'd gone through this VII/VI, wasn't the rest of it kind-of ---

Albert: No.

Grimwood: You didn't get an anti-climax after that?

Albert: Well, it was an anti-climax in a way, but the year 1965, culminating in that, had been such a marvelous year, that I actually - things settled down ---

Grimwood: What could you do to top this?

Albert: Well, we really had a number of meetings with our people stating that now the pressure was really on us.

Ertel: To keep the record up.

Albert: Yes. That '65 had been so great, that I called all the crews together and told them that '66 was going to be our very toughest year. Because '65 had been so good, we'd accomplished so many things, that very instance was going to make '66 a tough year; that we still had five more manned launches. These were then going to be the rendezvous launches ---

Grimwood: The rendezvous and the two-month centers ---

Albert: ---and the challenge on '66 somehow was greater because '65 had been so good. Then, of course, '66, we were playing with these very short windows and everything, all the things they tried to do with rendezvous.

Ertel: You had seven seconds. What did you think when they came up with that figure?

Albert: Here again, I guess I started saying this earlier - by this time we did have confidence in our system; we had confidence in our people. But, progressively, we'd all gotten smarter, too. Therefore, we concerned ourselves with just as many problems; however, the magnitude of the problems was much less. And we still had this philosophy - if there's anything, any little glitch on data, any step in a procedure that could be done better, anything that you could question at all, our job was to question it and resolve it to our satisfaction. We did just that. We still spent hours on things that seem very, very small. I'll say this - the launches never got routine. We never felt that monster was operationally ready and it can't fail. We knew, as things progressed and we had

experience with things that had caused problems, and therefore were more widely aware in the back of our minds that we had a long, long laundry list of things that could go wrong.

Grimwood: You didn't really get that feeling?

Albert: No. We sure didn't. And then as we got close to XII, I think things got even worse.

Grimwood: You wanted to leave 'em laughing.

Albert: Yes. Golly, you hated to end up - and you could never guarantee the reliability of this thing and you knew all the insignificant damn little microswitches and everything which could goof you up. So - no, things never got routine or matter of fact.

Grimwood: When you first heard of this M=1 rendezvous, how did you feel about your bird then?

Albert: Our experience, and this is one thing that's helpful - since we'd had success ---

Grimwood: I mean your weapons systems background where you had ---

Albert: That didn't bother us too much, really.

Grimwood: I mean you'd had success in launching on the ---

Albert: We had a good record of launching pretty much on time. Chris Kraft and a number of the people, at that time, wanted to put in a long built-in hold. We went through that exercise and you probably heard of the STL report that states your probability - but we had many go-arounds on that, during this time period. I was against a long built-in hold, and I think most of us down here were. We had a big meeting down here one time with Chris and Chris went along with it, but they brought up so many things, such as the erector and everything, that we were sort-of bounded by two things. They wanted to put the astronauts in as late as possible and still have a built-in hold. I don't like a built-in hold for several reasons. First of all, it's something that people instinctively depend on and always defer things and say "Well, we'll do that during the hold." It's a period in which - you set a tempo up for a certain launch and then all of a sudden they say, "Well, here's the built-in hold," and that tempo just degrades. Plus the fact I like to check. We used to run a complete test, auto-

sequence test of our whole flight control system at about T minus 20 minutes, which I felt was most important. Then we'd run a link test on our guidance system four or five minutes before liftoff, so I like to run our critical systems test as close to launch as possible. And if you want to do all that, you can't very well have a built-in hold. A built-in hold, of course, is - the closer to launch it is the more valuable it is, if it's going to cause you to launch on time.

Grimwood: Now the incentive contract has come about. Did you have any ---

Albert: We had an incentive contract all the way through on the vehicle.

Grimwood: You did? Were there ever any - was Martin ever squeamish on a hold costing them money?

Albert: No. Martin played that game just as straight as it was possible to play it.

Grimwood: Kappy told us that on the spacecraft side that they had to call a hold and he said, "I was surprised. McDonnell accepted my word that I'd take care of it."

Albert: As far as continuing the count, after a count was started, Martin was only under the gun for $25,000. The philosophy that I always had was - Verlander, or Hello, or Walt Smith had - was that that was insignificant. That's too small a piece of money to even concern ourselves with. Their biggest gain was really in performance, which - so our concern during a count or any games like that, no, we never - I was well aware of all the incentive parameters and one thing and another, but - and I was always ready to make my own judgment and direct them to proceed with the count or something like this.

Grimwood: You have to be many things, then - a lawyer ---

Albert: Yes, but I never had to use it. Another thing, during the count, we - particularly in some of these later launches, and the EVA activity when they increased the weight of the payload, the spacecraft and the adapter section ---

Ertel: They added 400 pounds ---

Albert: We were always talking about a what we call a negative margin below 3 sigma. And, of course, we kept very close track of that, as a function of the propellant temperatures and everything.

Grimwood: Did you ever really get worried about that, though, because in that three sigma thing there were so many parameters - it was highly unlikely that all of those things would go wrong - so did you ever really worry about it?

Albert: I never really worried about it but we had a sort-of a magic number in the back of our mind that we would certainly not be comfortable in going below. I guess this was a minus 200 pounds, or something.

Grimwood: Who got worried about the spacecraft weight? This is going back a little bit but ---

Albert: This was of concern all the way through this whole program. Based upon the experience of Mercury, they saw how this growth curve came up and, as you know, every couple of months, particularly in the early part of the program, we used to have these senior management meetings, the vice presidents of all the contractors involved, and General Funk, Gilruth, everybody. That was always discussed - the weight growth of this was always considered; there were always a few things that could have been done with the launch vehicle to increase its weight-carrying capability, but it carried a pretty big dollar sign on it. At all times, they always analyzed the prospective weight growth of the spacecraft and made the trade-offs that "should we go into this program" or "how much of this program should we go into for increasing the weight-carrying capabilities of the launch vehicle?" The considered stretching the second stage tanks. One that a lot of thought went into was reducing the ullage volume in the stage two tanks, but this would require an extensive study of a certain dollar magnitude. They were talking about up-rating the engines, and many factors - quite a laundry list was considered every time.

Grimwood: By the time you had gotten to this one that had hit 8374, you were almost a thousand pounds over that old 74 figure that they'd started off with.

Albert: That's right. But, here again, by the launches that had taken place before we knew what our three sigma weight-carrying capability of the vehicle was.

Ertel; That changed, too.

Albert: Yes, that changed, too. Absolutely. And first the people figured out probabilities and we knew what the probability was of getting below that weight-carrying capability. As you pointed out, all the number of things. There was an appreciable cushion there.

Ertel: I think that pretty well I've run out of questions. Were there any things or problems with the launch vehicle after VII? I don't remember ---

Albert: I guess one that plagued us throughout was this hydraulic test selecter valve. We had to replace a couple of those on a couple of vehicles which caused us - we had a problem with that on IX and then we had to change another one on X. So IX and X, the point that I mentioned I'd like to make here was the change-out of the hydraulic test selecter valve.

Grimwood: How did you come out with spares? On replacing things? Because early in the game you were all right because you can draw on other things but now as you work closer toward XII, the storehouse, to have been planned right, should be running dry.

Albert: And it was. That was something that concerned us, I guess, from vehicle IX on. I guess, to answer your question, I'll have to say that that damn planning in that had to be pretty good because for the launch of XII we did have our flight-ready and laboratory-checked tools, spares on all of our critical components, and I think no more than that. But we, down here, were in our normal posture of having extra auto-pilots and extra rate gyros and extra damper packages ---

Grimwood: Did that cross your mind?

Albert: Oh, yes. It was something that actually was planned. We started thinking about this on vehicle VIII or IX and really worked toward that goal. When we did have problems with the components, and had to go back to Minneapolis-Honeywell or any given component, this was of grave concern to us. It worked out extremely well, because we were in an excellent posture on the launch of XII. On XII, we actually had to change two auto-pilots - two days there - and we still ended up with a couple of spares that they were able to check out in Baltimore and have ready for us. So I think the planning on that was very excellent.