Grimwood: This is Mr. ~~Jim~~ James Griffin, Rocketdyne, May 16, 1967. Mr. Griffin was on the engine part of the standard Atlas launch vehicle for the Gemini program.

Griffin: I guess a reasonable place to start describing our role in this program - the Atlas booster was basically developed as a weapon system some years ago. In 1961 it was decided to, essentially, split off the weapon activity - the D series weapon - and split off a section which was called, then, the space booster. At that point in time, it was simply a reidentified vehicle, identical to the weapon system. That vehicle, and those engines attached to that vehicle, then were handled by Space Systems Division and gradually evolved away from the weapon system, which then was emplaced and then phased out. And it kind of grew in a series of progressive steps into the standard launch vehicle that you're talking about today. You will be talking with General Dynamics about a number of discrete steps that took place in the vehicle itself to actually get into things like SLV 3, 3A, 3C and this sort of thing. The engines, themselves, did not evolve in a series of discrete jumps like this, but rather early in the program, before the advent of the SLV 3 series, the booster engines had been uprated from 309K to 330K - this was the booster pair. And on the MA-5 booster I guess you appreciate that you can't really consider them as two separate barrels in that they have a common gas generator supplying a centrally located pair of turbopumps. In fact, there is only one booster engine with two outboard barrels. This change was made prior to the advent of the SLV 3 series. There were some other fairly minor improvements that were incorporated in the engine, things like liner that came in rather early in the Mercury program. But as far as the engine configuration per se that was used in the Gemini program, it basically had been developed and used throughout the majority of the Mercury program and stayed pretty well constant throughout the Gemini program. There were very few unique things that we did throughout the life of the Gemini program, or throughout the Mercury program, specifically to tailor those engines for those vehicles. And, in fact, we simply delivered, as we did in the Mercury program, a family of engines---

Grimwood: You changed your start system on that Mercury program, didn't you?

Griffin: There were some changes at the end to specifically tailor the engines to mission-peculiar configurations, such as on the Mercury - a longer burntime on the sustainer for a mission.

Mission-peculiar changes not basic broad changes to the vehicle. So that kind of evolution of the system. Now the actual selection of which engines go with which vehicle was made by Aerospace and SSD. When we delivered the engines, they weren't delivered for a program and they aren't today.

Grimwood: Was there any difference in the excess Mercury launch vehicles that went to Lewis for other space programs, and the SLV 3 as used in Gemini?

Griffin: I think there may have been some minor differences - there were no significant ---

Grimwood: I know at one time I remember seeing something that they were considering, as a cost savings, using those excess Mercury launch vehicles in the Gemini program. Then you came up all at once with this decision here and nothing is said elsewhere.

Griffin: I think, with respect to the vehicles again, I think I'd like to recommend that you talk to the vehicle people to get that story. We're kind of in a position of being engine suppliers and really the decision-making structure of how the vehicles are selected, and all that sort of stuff, we don't get in on to any great extent. I guess all I'm saying is that we standardized fairly early in the sequence with a standard set of engines and, except for minor changes, they have stayed the same and are the same today. Throughout the Mercury program and the Gemini program.

Grimwood: The way this agreement's stated here - no development program - that would mean, then, that you paid no more attention to an engine that would have been a Gemini then to some other program supported by the standard launch vehicle?

Griffin: Or for the prior programs. I guess the point I'd like to make is that we put everything we know how to put in, in the way of testing ---

Grimwood: This is an operational production line?

Griffin: --- for the whole damned series. In other words, if someone came by and asked us what do you do uniquely to the engines, which, in fact, actually was done, our answer was we're doing everything that we could reasonably - that we would want to in the regular acceptance process and that, in fact, with regard to making

the engines, acceptance testing the engines, and delivering them, our process is the same today as it was during the Gemini program and prior to the Gemini program. It's an extremely tight process. We have very well-defined specs, and I think you might appreciate we've been building these things and gradually evolving those specification conditions since the mid-fifties. They were kind of stabilized pretty - a pretty effective set of test conditions and measurements and that sort of thing. It isn't like we're coming into a new product, I guess I want to say. It's a standard product - it's been locked on for a long period of time.

Putnam: You say the selection of which engines go on which vehicle has been up to SSD and Aerospace.

Griffin: They made that selection based on particular requirements for the mission, as they do for every engine. We deliver engines sequentially, and they are then selected and set aside and, in some cases, kitted and configured for specific missions, and they are today. So the basic criteria that the engine was accepted to has been standard and we expect it will remain so. Now what we did do on Gemini and it's since then applied, following the Gemini pattern, to really all of our launches today, and that is a thorough, an additional total thorough review of the entire history of that engine, just prior to flight. This goes back and recycles all your production data, all your assembly inspection data, your performance data, everything that you once looked at when you delivered the engine. You go back then with a special board of people that we've more or less maintained for the flight support area and relook at all that data, prior to flight time, and satisfy ourselves that - one, we didn't overlook anything in the first place; two, that we don't know more now than at the time we initially delivered the engine that ought to be applied and could somehow or other be overlooked - essentially a total reassessment of the suitability of that engine for flight. And actually present a document, a preflight review on initially the Gemini engines, and then gradually it's spread to where we do it on all the engines.

Putnam: Did you do this same thing on the Mercury Atlas?

Griffin: It came into existence in kind of an informal sense as the Mercury program progressed. I would say it reached a kind of a mature pattern by the Gemini program and it's pretty well stabilized and ---

Putnam: Do you know where that idea came from?

Griffin: It's pretty hard to say. I think it came from us, but I wouldn't be sure. I think it came internal to the company. It seems to be a convenient way to convince yourself and everybody else that you've done everything that you could possibly do with the data that you then have. By that time, you knew which engine it was going to be. You then could go back and look at - for instance, the individual little dispositions that were made way back at the beginning of the process, notes that were in the quality sign-off records, data review where somebody noticed a minor anomaly and dispositioned it - satisfactory for acceptance, for delivery. And you go back and question it all again, based on today's knowledge. It seemed to be a kind of a very desirable thing to do. And I think the main thing that came out of it really was - I'm afraid we didn't find any very major problems as a result of going back over the data - I think it's just kind of said we had done a pretty good job the first time.

Putnam: You kept all this data, did you, so that if something came up at the flight safety review or at the last minute before launch so you could go back and see if that anomaly ever occurred before in a test sequence?

Griffin: Every - we basically participated in that series of reviews. This was our review which we then presented to SSD - in an associate contract relation to SSD, we then presented this review to them and Aerospace and collectively we agreed that it was satisfactory. Then, at the Cape, prelaunch - about a week prelaunch - I would go down with my project engineer, Al Kwawer, and the two of us plus the normal field people who are there would then discuss with all the involved commands in depth any problems that we had had, either on this engine, any problems we had had anywhere on any of our engines. This wouldn't be just exclusively Atlas program engines. We'd look into the Thor, the H, or any other engines that had any current problems, any specific hardware problems that we'd been having, let's say, through the factory down to the Cape, and cover those in quite a bit of depth, initially with SSD and General Dynamics. The following day we'd have a general session with Manned Spacecraft Center, Scotty Simpkinson, Charlie'd be there sometimes, and who's the other fellow?

Ertel: Ken Hecht?

Griffin: No, works for ---

Grimwood: Hammack?

Griffin: Jerry Hammack would be there but ---

Ertel: Kappy?

Griffin: No, the other guy - I'm trying to think of - Mitchell. And we would go over these in some depth with those guys, especially those problems that seemed to be, let's say, open at that time, like something was being analyzed and we were waiting for some additional data. We wouldn't do this by ourselves. We'd be one of all the contractors - all the associates were involved with the particular effort. That then would result in a final X-minus one day review meeting, which was kind of a formal session with General Funk and Dr. Mueller -

Putnam: Flight Safety Review Board?

Griffin: Flight Safety Review Board. And normally speaking, the Flight Safety Review Board - by that time, all the previous machinations had pretty well been ironed out and that presentation was basically made by the military, who were launching the vehicle - Colonel Allen, Jack Allen ---

Grimwood: Albert?

Griffin: No, Albert - wasn't he the Agena?

Putnam: No, he was the GLV guy at the Cape.

Griffin: Ok. Well, Jack Allen was our Atlas guy. He would basically make the presentation and if there were any problem areas involving any of the associate's hardware that were either unresolved or were still significant at the time of that discussion, sometimes the associates would be called up to make a little brief discussion. At the conclusion of that meeting the thing was essentially bought-off for flight and, other than being around for the flight, the postflight data review, then we'd head back here. I'd say that one of the other things that kind of summarized this - that entire process, as

far as we're concerned, goes on for every flight and still does today. We do it for military flights out of Vandenberg, for flights for NASA ---

Putnam: You go through this routine ---

Griffin: For every flight. The difference is the degree of personal attention, the amount of time that's spent, for instance, by Al and myself on the specific details of the flight - so the process goes on every time; the difference is the personal attention of the management people involved who spend a great deal of their time for the Gemini flights, to check, to dig in, to satisfy ourselves, in a lot of detail, that each one of these steps has adequate redundant people that are doing it. But the process itself is implemented for all flights. For instance, on a normal flight I'll just sit in one review session, as will Al, where guys will present the results of all these various studies. On the Gemini, we did personally dig into the damn thing in depth, each anomaly, and being prepared to react if a problem should show up on the pad which we should have seen coming - finding that everybody in blue had a last minute pad problem - and so we'd be on the phone and get what ever would be required. Now we had very few problems throughout this program. The technique and everything was there, but for the most part the engines went through pretty damn clean. They were - we really had no major engine, really - many minor engine problems. We had a few inconveniences but the things functioned well during flight.

Ertel: What happened to IX?

Griffin: 5303? Is that the bird you're talking about? I don't remember - yeah, I do - I take it back. GT IX. That one was a beautiful example of how you handle a problem that occurs on a program like this. It looked for a while like - ah, ha! we had an engine problem. It turned out we did not.

Ertel: Were you at the Cape when it happened?

Griffin: Yes.

Ertel: What were your feelings at the time

Griffin: Get the data and find out what the problem was. We'd

been doing it for 15 years.

Ertel: But you were, I imagine, hoping - did you feel that it wasn't the engine right from the start?

Griffin: Yes - or rather rapidly thereafter we thought it was the engine. It took about a week or so to really prove where the problem was. And I think they came up with a totally definitive proof in a matter of a month or so. The basic data analysis, we were very, very intimately involved with. We were down at General Dynamics - Joe McNamara, who's a vice president, Al and I and a couple of other guys went down and spent the whole weekend, day and night, down there looking at the data until we were able to satisfy ourselves that the basic performance seemed to be all right. I think - in talking with Dick Keehn, you kind of ---

Putnam: Did you see that film? The tracking camera film?

Griffin: Oh, yes.

Putnam: That was really a good - they really had it on there.

Griffin: It took a while to really be sure that the performance was ok. We had a lox leak on the flight and we've since incorporated some kits in an area which tends to reduce this possibility. And really the only question, right after the first day or so, was did the lox leak - which is not necessarily a bad thing - in any way affect what had happened to the other equipments. And by General Dynamics testing a number of systems, simulating lox leaks, they gradually proved, system by system, that it had no effect, so we kind of gradually eased out of the role, but for a while it gave us a damn good start. The team that worked on the whole program, though, at least from the Atlas side of the house, was a team that had been working together for just one hell of a long time, the General Dynamics people involved, our people involved, really, the key guys we were speaking of, have been on the program since its inception. We've just about - the fellows from General Dynamics and ourselves here - have been on the Atlas since it was first fired. as an engine - I was on the stand when we ran the first acceptance test on it.

Grimwood: It's become a career.

Griffin: Yes, it has. It just keeps going forever. So we were

pretty much used to working together and we were in a position where we could handle and analyze these kind of problems regardless of whose systems they were. I think the biggest thing that got to me - when the thing showed a problem in flight - I really didn't give so much of a damn whether it was our problem or their problem; it was an Atlas problem. You get that feeling after being associated that long---- and if we should eventually track it down. The thing we had to find was to track it down to a specific cause that we could fix, regardless of whose system it was in. That was really the primary thing that stands out. And it was able to be tracked very definitively to a particular wire and to a particular - I mean, in a circuit - and a particular series of things that could have caused them all, which was picked up on subsequent vehicles. The program was, I thought, pretty well run because, again, not only with - like General Dynamics and ourselves - but the bulk of the entire team had been involved with the Mercury program and they were kind of used to working together. It was a pretty close knit team - just about everybody on it had been working together on, really, the manned space activity for a number of years. There weren't many strangers in that entire loop, so communication channels were very tight.

Ertel: Just a few faces missing, like McNabb ---

Griffin: Yes, he disappeared part way through. He was there for part of it. I went to his going away party - I remember the next day.

Grimwood: Culbertson's gone also, isn't he?

Griffin: Phil Culbertson - yes, I think he's up at NASA. Of course, General Funk retired almost ---

Grimwood: Yes, we talked to General Funk last week.

Griffin: Paul Cooper took his place.

Putnam: You didn't ---

Grimwood: I'm going to send you a copy of the Mercury history.

Griffin: I'd be very interested. I'd really enjoy having one.

Putnam: You didn't really have any special attention or requirements placed on you by Aerospace or the Air Force program office? Separated from the SLV 3?

Griffin: No. In fact, if you - except for the degree of emphasis. That's the prime thing.

Putnam: How was that manifested? You were at more reviews. Did you hear more from your management in Rocketdyne - did they pay more attention?

Griffin: They did, yes. I think the primary part, as far as our particular involvement goes, we on the program spent a lot more of our time checking and rechecking on the working level. Our management, of course, was a lot more interested in terms of following it and assisting us and obtaining any assistance we need - for instance, in this failure investigation our vice president came along in case there was anything the company could do to run stuff, to simulate - it turned out we didn't because it very quickly got out of our system, but if it had been --- in terms of degree of attention, amount of attention, amount of time.

Putnam: The basic pattern was set.

Griffin: Yes. The only thing is we kept - we pretty well kept our original team so we just about had all the experience at our fingertips that the company had, right there in our group, more or less.

Grimwood: What was your position at Rocketdyne here?

Griffin: Program manager. I became program manager of the Atlas after John Glenn's flight, just shortly thereafter, and I have been ever since. I picked up the Thor about two years after that. And Al Kwawer had been the project engineer on it since about that same time period.

Putnam: Did you say had some specific stuff there?

Griffin: Yes. There are just some - I just kind of - you weren't asking about anything in particular - the engines kind of backed down in a kind of strange fashion in the whole manned space program. The die was cast in Mercury. The subject of qualification of the engines, as a unit, for a particular manned spacecraft

operation - that happened a little bit before my time. I'm sure that in your Mercury program you made some notice of this fact. But essentially the thing that really allows you to say the engines were man-rated was the fact that they had flown the astronauts, damn near. They had been development-tested to a tremendous extreme - they had a tremendous development history behind them.

Grimwood: That's the reason I want to send you a copy of that book, because we go into that manned-rating aspect in there, of the Atlas.

Griffin: Really, in our case, in terms of the engines, we started off with an engine, you might say, that had been used to fly the astronauts and didn't do much to it, slmost nothing. We started off with an engine that, just by the fact that it had flown men, was man-rated, if by no other reason than that you'd already made that determination, and we weren't changing it. So the question really was ---

Grimwood: I heard a guy say yesterday that you never want to take your eyes off that Atlas, though.

Griffin: You never want to take your eyes off anything. A wise old sage once said to me, I forget - a number of years ago - he was Colonel Langdon Ayres who was program director - I don't know whether you remember him - he said something about - we were in a meeting with one of our vice presidents years ago and there was a kind of a junior officer in there who was just berating the fact that no matter what kind of assurances one could give them that you had developed something that could cure that problem, they couldn't be positive of that until you had flown a number of vehicles. This was way back in the early days and Langdon said something about - he says, "Well, son," - he'd just finished giving our guys just absolute hell about how come we didn't - and Langdon says, "Well, son, that's why you don't stand too close." I guess the name of that is you don't ever take your eye off of any of them. When you said fully qualified, I just said the booster engine operated to 330,000 pounds of thrust. In fact, you might just want to keep this thing here. And we didn't want to take a half a barrel here. They had been uprated to 330,000 pounds. We actually down-rated the verniers. Perhaps this is a minor point to you, but we reduced the vernier thrust down to a lower level, to the

minimum level that the vehicle actually needed in terms of both roll and yaw control. The reason it was worthwhile to do this was because the verniers are a very dependable engine in terms of never causing a flight problem; they're a very inefficient engine - they're a very small but very inefficient engine - they never were made to be efficient, they were just made to - there wasn't a requirement, there wasn't a problem associated with efficiency, and we talked about ways of making them efficient, but it's never been desirable to do that. So the cheapest way to make them more efficient was to just put less propellant to them and put the propellant someplace that's already more efficient, namely the sustainer engine. So by somebody employing a little intelligence, what they said was, "We'll cut down the vernier thrust for the whole flight period, so even though the engines don't use much propellant, if you count five minutes, that's still quite a potfull." So instead of putting all that through the verniers, they dumped it to the sustainer and effectively picked up more sustainer burntime and less - I'll say better performance out of the aggregate of the system. The other thing they did eliminate here - again - was the solo requirement for the thing in that the Agena could supply the proper solo. Are you familiar with the vernier solo operation after the sustainer shuts down - there's a couple of little tanks that apply propellants to fire the vernier during certain operations. We were able to cut that down. But those were kind of two separate little items. Ok, this dented tube thing - this was kind of minor when they ran a truck into - backed a truck into the thrust chamber itself. The tubes they're talking about are the tubes that make up the Bell thruster, and they were creased, so we flew chamber men, project men, down to Texas, looked it over, and took pictures and came back and discussed it in some itty-bitty detail -

Grimwood: This was a guy that stopped for lunch somewhere, wasn't it? That's what I heard.

Griffin: I don't know what the heck happened to get him in that pickle.

Grimwood: He had stopped for lunch and somebody ran into it. Probably got a red streak on it.

Putnam: He was taking the engine down - the whole vehicle? The whole Atlas trailer? And somebody backed into it?

Griffin: Well, what he did - the chambers kind of stick out just a little bit and it has a cover over it - kind of a cardboard cover or fiber glass cover - he creased the side of the truck and ended up pushing in the tubes - a kind of a dent that looks like - you know, it'd cost you about a dollar and a quarter to get fixed and it's $85.00. We sent a couple of guys down to look for it and we explained that in - just to give you an idea of the care on the program - a normal program, two guys would have looked at it, taken a picture, and we'd discuss it very briefly, and send out a little telegram and that's the end of it. This one, we discussed it with a number of different experts, with Mitch on the phone for about an hour and a half -

Grimwood: It kind of hit them down there. I remember ---

Griffin: And it should. That's the kind of care that gets you a good program. When everybody's that interested. We explained it in a lot of detail to a lot of people and by the time we were through there wasn't any question regarding that - the satisfactoriness of that tube history, anything else that hadn't been answered and documented - it was just a tidy way of doing business - and it's that kind of attention, I think, that really got the program into the ---

Grimwood: It got a red crease down the side.

Griffin: You might just - well, these are kind of minor -- we were talking about the thrust chamber here and ---

Grimwood: This is the sort of thing we need.

Griffin: That just sort of puts it in the proper terminology. General Dynamics went into a great -

Grimwood: Can we have this?

Griffin: Yes, you're welcome to have it. General Dynamics has a nice write-up in their report on what actually caused it. I don't attempt to comment on that - so they did survey electrical connectors, etc. And I think they may have done some other things downstream. And I think that was about it. Actually, they kind of quit buying engines; they've got about two years' worth - a year and a half's worth of engines in stock right now for which they're

making vehicles, for which they are making --- so our activity right now is flight support and logistic activity. There may or may not be a separate additional procurement, probably instituted by Lewis, for an uprated version of the Atlas. These discussions are going on right now - do some things to uprate the total thrust for some of the heavier missions. There also is an outside possibility that the Air Force might require - Lewis did - some additional military type Atlas, and then of course the whole E and F series --- that program into use. They've already started launching those.

Putnam: They've got those down at San Berdoo?

Griffin: For the most part. The hardware's still going in there. It's a very moving program.

Putnam: I used to work at SSD and before I left there in 1965 they were talking about getting out of the Atlas business. It seems to be very difficult to do.

Griffin: What gets it to be difficult, I would suspect, is the damn thing works pretty good. We've had 29 space successes, granted that's not a tremendous amount.

Putnam: I was there at one time and they had - didn't it get up to 40 something. I know a lot of the launch vehicle guys were saying, "Well, we're going to get that Atlas out." And General kept saying, "No."

End of Tape