Transcript of the

Joint FAA/Industry Symposium

on

Level B Airplane Simulator Aeromodel Validation Requirements

To the Memory of Daryl Schueler

Part 5 of 7

Transcript of Day 1

Washington Dulles Airport Hilton
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Transcript of Day 1

MR. LONGRIDGE: I'm Tom Longridge, I would like to welcome you all here. We are delighted to have this group. We know this is a very select group and many of you have taken time away from perhaps better paying opportunities to be with us here today. We think it's a very important exercise and I know I speak for all of us on the FAA side, we are delighted that you are all here.

All of you have, I believe, a copy of the agenda in front of you, as well as some materials that have previously been mailed to all of you that are going to serve as a basis for discussion today and tomorrow. I'm going to take a few moments to kind of give a little bit of background from my perspective, Paul Ray will do the same.

We are also fortunate to have with us this morning, Tom Toula. Tom [Toula] is the individual at FAA headquarters who is responsible for training policy for air carriers. He will give you a few remarks that reflect his perspective on the need.

As far as background is concerned, many of you are probably aware the FAA recently issued a commuter rule. Tom Toula will talk a little bit about that.

One of the most important aspects of that rule was the goal to establish one standard of safety for major and commuter airlines. One of the things that we need to do in order to make that happen is to make training equipment, and from our perspective flight simulators, as available to that community as it already is for the major carriers, and that is presently not the case today.

Another player in this endeavor is the Advanced Qualification Program. The Advanced Qualification Program is an alternative to the traditional regulatory requirements for pilot certification and qualification. It differs from the traditional programs in that it refocuses proficiency evaluation away from maneuver-oriented proficiency checks towards scenario-based line operational evaluation in which we test both technical skills and crew resource management skills together for jeopardy purposes, so that a pass/fail endeavor in an AQP is a scenario-based evaluation that tests both types of skills.

Another aspect of AQP that's relevant to training equipment is the fact we employ progressive evaluation in AQP, we replace the final proficiency check and oral with a progressive evaluation that's distributed throughout the curriculum. By virtue of doing that, we enable an air carrier to sign off proficiency at lower level skills and not have to repeat the evaluation of those skills at a later point in the curriculum. That particular approach definitely enables the use of and encourages the use of lower level training equipment throughout the entire curriculum, starting with ground school. It enables maximum use of flight training devices to sign off proficiency and procedurally oriented skills as well as for those maneuvers for which the FAA has enabled carriers to get credit for flight training devices.

But what it does not do is eliminate the requirement for a flight simulator. Because of the fact we have a scenario-based evaluation we want that scenario-based evaluation to be a true test of both technical and CRM skills. Although we can reduce the footprint requirement for a high end device with an AQP program nevertheless, we still require a flight simulator forthe final evaluation of proficiency. That's a very important point that people that are familiar with AQP sometimes miss, because of the fact that we emphasize crew resource management many folks think that all we care about is a CRM evaluation in the end. That's absolutely not the case. It must be a true evaluation of both technical and CRM skills. Okay.

One of the motivating factors for this meeting is simply the availability of training equipment for commuter airlines. I spent yesterday morning with a commuter airline who has experienced so much turn-over due to the fact that major airlines have been hiring all of his regional pilots, that he suddenly has a totally unprogrammed training requirement for which he is absolutely unable to obtain simulator time anywhere in the world. And he is going to have to conduct this training in the aircraft simply because of the unavailability of such training equipment.

His situation, I think, is quite typical today, this is a problem. And this is an issue that we seek to resolve here in the FAA.

Another consideration is simply, for commuter airlines, the cost of this equipment. We are dealing with much smaller airlines that perhaps don't have the budgets to purchase their own training equipment. Some of them are limited even in their capacity to rent simulator time to lease, dry lease it from training centers or wet lease it, as the case may be.

Cost is a significant factor for commuter airlines and if we want to create a situation that's going to encourage commuters to go to flight simulators and train, we are going to have to make it cost effective for them to do that.

Now the Regional Airline Association has come to the FAA with their own proposed solution to this dilemma. Their solution is well, we will take a flight training device perhaps a Level 5 FTD, we will go ahead and augment its capability, we will make it a Level 5^{++}, or maybe make it a Level 6^{++}. We would like to do at least our recurrent training in this enhanced Level 5 or 6 FTD that's their proposal to us.

We have an alternative proposal, that is to revisit the qualification requirements for a Level B flight simulator. Because our feeling is that whatever you would have to do to a Level 5 or Level 6 in order to augment its capabilities, such that the FAA would permit you to use it for the purposes that they are proposing, whatever you would have to do to accomplish that goal would in effect create a flight simulator, so why not focus on building a flight simulator to begin with.

There are a variety of advantages to that approach, from our perspective, not the least of which is we already have regulatory language which will permit an air carrier, be it commuter or major airline, to use a Level B simulator for 100 percent of their recurrent training needs. There is no requirement to go to the aircraft if you use a Level B simulator for recurrent training.

I should add that our focus in this endeavor with respect to trying to reduce cost is on recurrent training. We think that's the big cost, that's the big area, nobody is really complaining as much about the requirement to use a Level C or D simulator for initial pilot training. So our focus is strictly on recurrent training and a Level B solution. What we want to attempt to achieve is the goals that the commuter airlines have for less expensive devices with a Level B flight simulator.

And another very important point is we would like to do this without in any way degrading the standards for that device. We are not interested in allowing credit for a less capable device. We want to explore whether or not we can come up with a more affordable device without diminishing the performance qualification standards for that equipment.

So we have initiated a comprehensive program to address this issue. And this meeting today is really the first component within that overall approach. We are going to be looking at the data requirements for aeromodeling, we are looking at the data requirements outside of aeromodeling for flight simulators. We are looking at the motion cueing requirements for the device and we are going to be of course looking at the visual cueing requirements for the device. We are going to attempt to approach this in a systematic fashion and we feel that the most appropriate place to start is with respect to the quality of the device and the aeromodeling.

So that's what we are going to be focusing on entirely today. Aeromodeling. And as I indicated in the letter that went out, there are two considerations, one of them is of course revisiting the FAA's requirements for qualifying a Level B simulator. Looking at the extent to which the data requirements for doing so might be obtainable on a more affordable basis. But of course that in and of itself doesn't necessarily mean that the simulator is going to fly like the aircraft. We need to also provide guidelines which are not FAA requirements but nevertheless would be guidance to the industry on how they might more affordably go about acquiring the data needed to program the simulator so indeed the handling characteristics are such that they replicate the aircraft.

We will be looking at both those issues, and the tables[1] that were mailed to you are intended to support some discussion along those lines.

So our focus, what, if anything, it may be possible indeed that nothing can be done, but what, if anything, can be done to reduce cost with respect to how the aircraft data is gathered, what data sources are required, what points in the flight envelope will be matched for validation. Notice I say "what points within the flight envelope," not necessarily what maneuvers. This is an issue for discussion. Do we want to base this approach on matching a specific maneuver or do we want to pick optimum points throughout the flight envelope that we will be requiring for model validation purposes, and what tolerances, what level of accuracy will be permitted.

Okay. We want this to be kind of an informal free-for-all discussion. These are ground rules that hopefully will contribute to that. First of all, we know we have a very select group here. All participants are here as equals.

[1]The final tables resulting from the Symposium can be found in Part 7 - Appendix: Longridge, T., Ray, P., Boothe, E., & Bürki-Cohen, J. (1996). Initiative towards more affordable flight simulators for U.S. commuter airline training. *Royal Aeronautical Society Conference on Training - Lowering the Cost, Maintaining the Fidelity* (pp. 2.1-2.17), London, UK *(Appendix.pdf)*.

Because of the fact that we do want to record all of your comments, we would like to require that one person speak at a time. We do have a recorder here who will need to identify who is speaking. And after a while, she will, I'm quite sure, memorize who it is, but we would ask at least during the first several hours when you make a comment you preface it with your last name.

We will try to stay focused on the session goals and agenda. That will be my role, so we don't wander off too far.

Another very important point, clearly consensus is desirable. Consensus is going to provide the FAA with a high level of confidence, particularly given the group that we have here when we achieve consensus we have achieved a valid solution. On the other hand, we haven't asked you to come here to rubber stamp our ideas about how to proceed here. And that extends to the tables issues. We want to hear alternative viewpoints. So please don't hesitate to disagree with one another in the course of the session or to disagree with the FAA.

Time permitting, we hope to allow hearing virtually everyone's point of view. Okay?

Now I would like to give Paul Ray the opportunity to make a few remarks.

MR. RAY: Thanks, Tom [Longridge].

The main thrust of my comments are really towards thank you for everyone who has shown up here today. As Tom [Longridge] indicated, there are a lot of things you could be productively doing back at wherever you reside. Extensive time and discussion was spent over who was actually invited to this meeting today.

There is a lot of interest around the aviation community regarding this meeting. Not only within the States, but also abroad. Acknowledgments have been received from the JAA JAR-SIM group. Last week the JAR-SIM group met in London and they are well aware of our meeting that's being conducted these two days and look forward to the output from this process.

But thanks again to each and every one of you, we didn't have a single decline. Thanks again for your time in coming here. If there was ever a group of experts, on simulation, you are certainly that group. This group has the opportunity to establish a new foundation for the simulation and training community.

That's why you have been invited here today. The question we are asking I believe is the right question at the right time for the right reason. Tom [Longridge] has done an excellent job of summarizing that on the screen for us here today. Whatever we come out with tomorrow is an honest answer to an honest question. There is no preconceived [idea], at least on our part, [about] what the answer should be. Your input, your ideas on how and if we can get from point A to point B.

Thanks again, we look forward to all the interaction that's going to go on. I look forward to the comments here, the ideas bounced on the floor or picked up, put on the table and worked out. Thanks again for your time.

MR. TOULA: I feel like I'm in a room full of experts, but I definitely am not one of the experts in the caliber you folks are today. I think I can play more of a role of the user of what you talk about today.

Tom [Longridge] did an excellent job of briefing the need that we have, the urgency, I want to stress the urgency because I have had individuals as well as companies come to me and say they are very worried about what is going to happen when the full effect of the commuter rule, I'm not sure if everybody knows what that commuter rule does, it basically brings a lot of [Part] 135 folks who were training under 135 and require them to operate their aircraft at a [Part] 121. Train under 121.

The commuter rule, the training rule combined, mean a lot of people now, a lot of air carriers are going to have to train for CRM. I think one of the best ways of training for CRM is in a full-blown simulator with a practice of all things that can be thrown at them and they can practice the CRM, practice their skills and hone their skills in CRM. I think we don't want to lower what we have as standards right now, that we have guides. Some have proposed that the CRM training be conducted for LOFT scenarios so to speak, CRM conducted in Level 6 and Level 7 devices.

One of the problems we are facing of course with these folks is they don't have deep pockets that some of the operators that traditionally we think about, the Deltas, they don't have the money, the facilities, to have a full corral, so to speak, of simulation devices. They can't afford the 18 to 15 million dollar simulators, and my numbers may be off on that, but they certainly need some economic breaks here so they can get the quality training they need in a device that will support that training.

The needs of course are time. I can't stress any more, we need to move quickly. The commuter rule became effective, becomes effective in two or three days. And compliance requirements is a year from, I think it's March 19 or March 20, I'm not sure, of 1997. So we are looking at one year where these folks are going to have to start training under--to 121 standards.

We also have another rule-making project in the books that are going to actually require that air carriers train using simulation devices, flight training devices. If we go down that road we have to make the simulation devices usable and economical enough for these folks to use. We have a sense of urgency in time, I think otherwise what we are going to do is end up forcing a lot of carriers to do a lot of their training in the aircraft and airplanes and we don't want to go down that road.

So whatever we can do today, whatever you folks can do today, I wouldn't know an aerodynamic package from a Christmas package, to be honest with you, whatever you folks can do today to speed that process up I certainly appreciate.

I know the folks that now have to comply with 121 training requirements appreciate it also.

MR. LONGRIDGE: Thanks Tom [Toula]. Okay.

Before Ed Boothe presents the technical agenda, although everybody knows everybody else, it would be useful to me and to the recorder to go around and introduce yourselves to each other.

Tom Longridge from the FAA.

MR. BOOTHE: Ed Boothe. I used to be with the FAA.

MR. RAY: Paul Ray, still with the FAA.

MR. TOULA: Tom Toula, still with the FAA.

MR. KOHLMAN: Dave Kohlman, with Engineering Systems.

MR. BAILLIE: Stewart Baillie, National Research Council, Canada.

MR. HEFFLEY: Robert Heffley, Heffley Engineering.

MR. BAKER: Gerald Baker, FAA Wichita.

MR. SCHUELER: Daryl Schueler, FAA Wichita.

MR. DAVIS: Tom Davis from CAE Electronics.

MR. LEISTER: Dave Leister, I'm an ex Flight Safety International employee.

MS. BÜRKI-COHEN: Judith Bürki-Cohen from the Department of Transportation, Volpe Center, in this case working for the FAA.

MR. WILLMOTT: Stuart Willmott from SimuFlite Training International, Dallas.

MR. STOCKING: Chuck Stocking from Hughes Training.

MR. ELLIS: Dave Ellis, National Institute for Aviation Research.

MR. SMITH: Hilton Smith, FAA.

MR. NEVILLE: Kendall Neville, Boeing Commercial Airplane Group.

MR. ELDREDGE: Don Eldredge from Battelle.

MR. LONGRIDGE: Very good, thank you.

Now we will proceed with an introduction to the technical agenda from Mr. Ed Boothe.

MR. BOOTHE: Thank you, Tom [Longridge].

The only reason I'm coming around here is to turn off this light, because I don't have any use for it.

When I was putting together some thoughts for how to introduce these tables it had occurred to me that it might be well to just pass them out to you. So I did that. You have a sheet of thoughts I had as I went over how we would introduce the tables and what we might be thinking about as we work on them. So that's not a formal document, it's just some thoughts.

But to address the technical issues you have two tables, and to put them in perspective, I gave you the computer disk with straw man 1 and straw man 2. That's exactly what we intend these tables to be. They are documents to stimulate discussion.

There are two of them, the first one addresses simulator validation data. These are the tests, the FAA Advisory Circular for simulator qualification, the other is what I have called simulator programming data, and that's really, really that's taken from the IATA data document.

As I was charged to build a draft table, I kept thinking what can I say to build a table that isn't bad and how shall I approach this, and it really came down to, it's really already done, it's just not very usable for us. So what you have on table 2 is really my version of the IATA data document, but just so we keep ourselves straight, we thought it might be worthwhile for each of us to have a copy of those pages. So I'm going to pass these around. I took as an example the turbo prop airplane because I think that's the most applicable for the problems that Tom [Longridge] and Tom [Toula] have discussed with you this morning. There are some differences, of course, from the jet airplane case.

Let me pass these around. If you would each, I think there is 16 copies so there may not be quite enough for everybody. We will get a couple more copies if we need them.

We think it's probably best to start with validation data. So the part that's being passed around now will be the second table of discussion. And the validation data table was sent to you, it's also in the second half of this document. I don't know quite how Don Eldredge managed this, you have to turn it upside down and backwards.

MR. ELDREDGE: Don't ask.

MR. BOOTHE: Then you have to be from the Orient, because it goes from back to front.

MR. ELDREDGE: I'm left-handed.

MR. BOOTHE: The first table I drafted Stewart Baillie looked over, and also he had been working independently to put in some thoughts, so I incorporated some of Stewart's thoughts, and I thank you for that help, Stewart, in bringing that table up to a better level than it was.

Now in that table you will see a column called Level 6 and I think we need to explain why Level 6 is there. Level 6 is a flight training device. It began its life really as an advanced training device under the old Advisory Circular we did back in about '87. And it never, those of you from the simulator manufacturing side of things will agree, it never went anywhere. But I think the concept was valid, I think there was some misunderstandings as to why it never went anywhere.

One of the important considerations in the ATD was we could use a less--I don't want to say less rigorous, a more simpler like data collection process. So if you look at the Advisory Circular today you will see that all of the tolerances for comparing a Level 6, which is what the ATD became, are the same as a Level B simulator. We kept the tolerances the same. But the thought that got lost was there could be some relaxation at that level of data quality, I guess I can say, but of collection techniques you need a full-blown Boeing installed flight data acquisition system that gave you enough work to last the rest of your life and three or four other guys, too. That was the concept.

So I put Level 6 there with the thought if a data validation is good enough for Level 6, and if we extend the thoughts of Level 6 to a Level B in terms of how we can use it, then why isn't it enough for Level B? It's a reminder as we go along we use this ourselves in a meeting, preparing for this, and I chose to just leave it in there for that reason.

Now certainly not--I'm certainly not advocating that we dismiss rigor or that we just arbitrarily dismiss data quality, but I'm also saying we should keep in mind these relative levels and not require a more stringent data acquisition when we have got to do the same thing with the device. That doesn't apply across all tasks, for training and checking, and in fact when we get finished and say what we need to collect the total package, it may not even be applicable. It's part of the thinking that I wanted to stimulate amongst you.

Speaking of that, that's the whole purpose for these two tables, to stimulate discussion. I sat and built tables based on information I had, some of the ideas in the validation table concerning data acquisition, flight test suggestions, data sources, are things that I pulled out of a lot of places that they may be erroneous. So that's why we are here discussing that with you. But that's an important reason why we wanted to include Gerry Baker, and Daryl [Schueler] is kind of wearing two hats now, he has been in both sides of the business.

You notice as you go through the tables, there are times when I would say certification data and type inspection report, it seems over the years we totally dismissed certification, airplane certification data. When I say “certification” I'm referring to airplanes and when I say “qualification” I'm referring to simulators for the most part. So if I don't explain that, that's what I mean. But over the years we sort of dismissed airplane certification data.

And type inspection report, there was a time when maybe there wasn't very much information in those documents, but I don't know what's currently in them. My airplane certification work is quite old at this point, so we needed a fresh look of what's there and how we might use it.

One of the problems that occurred to lead to the dismissal of TIR data we don't train in extremes, so that data is no good. Well, to my way of thinking that's nonsense, because what we want in a simulator is a continuous model that's validated at some important points in the flight envelope, and I really am not all that concerned that I'm going to be using this device for training perhaps a mid CG at a medium weight, which is not really where I think we should be trained, but that's another subject.

If on this continuous model I can file a couple of validations that end up in the TIR, I think that's an important contribution. So that's why I have included those kinds of thoughts.

Another thought I had in mind as we did a validation table is to minimize the need for an inertial measurement requiring a flight data acquisition system. I couldn't get rid of it. And try as I may, I couldn't get rid of it, but I got it down to a limited number of cases.

Further, I wanted to just minimize the need for instrumentation at all. I can't get rid of that, either. Certainly there is some need for instrumentation, there is need for instrument calibrations, there is lots of needs that remain. But I think we have overlooked some of the simpler techniques that one might employ, and while I've taken a stab at some of those, again it might be totally erroneous, you might look at them and say Ed [Boothe], you have on the wrong hat, you can't do that. Please do that, I don't want you to take, as I said on my outline, there are no sacred cows on this, it's purely a document to stimulate discussion and get your input.

That leads to the next point of hand held instrumentation, certainly. I want to stress, and it's been stressed to me by people such as Stewart [Baillie], Stewart has been involved in a couple of recent important data acquisitions for commuter type airplanes so he had some recent thoughts on it. We don't want to dismiss rigor. We must insist on a rigorous flight test data acquisition. But rigor can mean a qualified crew and a qualified test pilot, a sharp pencil and a knee board and some hand held instrumentation. Not for everything you need but for some of the things you need, and I have tried to suggest some of those things.

Now, the thing I think that Hilton [Smith] and Paul [Ray] have to help us with is as we make these suggestions, and I'm going to come to you with hand recorded data maybe for some tests in a simple airplane, is that going to be acceptable for simulator acceptance and qualification by the FAA? So we need that input as we go.

So it's important to get this exchange going because those of us who may like to collect data and can go out and have a good time collecting data, but if these guys aren't going to accept it, all we did was have a good time and spend money. I think that's a very important aspect as we discuss these validation techniques. Of course all that leads up to minimizing the data cost.

One of the things that I think we are all interested in is at the end of the day can we describe an increment of the difference in cost? Let's take today's methods and then compare that to what we come up with here, and can we defend a significant cost. Because if we wanted--maybe data is the wrong place to look for saving money on simulators. I think that's one of the most important outcomes of the whole discussion is what's the cost increment when we get done, and if I can only reduce the cost of validation data five percent and the overall cost of the simulator is that significant, is that important, is it worth the effort?

Those kind[s] of thoughts are just as important to us as how to collect data. So I'd like you to keep that in mind, if you will, as we go. And then matters arising, well matters always arise, I learned to use that from my friend Paddy Carver at the CAA. He put it on his agenda and I learned to put it on mine. Things you don't anticipate always come up. Whatever comes up germane to this discussion I think is important for us to consider here. Okay?

The modeling data, which it's a second order of discussion, I think, although these things are not completely separate and independent, we might want to do some crossing over as we go, as we need to, but again the table is to stimulate discussion. Don [Eldredge] has again put that in a book which I have put down and can't find. And he has left us plenty of room for notes.

So the tables that you were sent have been structurally modified to put in the book and leave some notes room. Don [Eldredge] said he arbitrarily picked sideslip and he broke every table 5 sideslip and started that at the top of the page. I guess that's as good a place as any. But anyway, there is a lot of room for notes. And again, you might have to twist the book or something, but it is there. I haven't actually looked at this, I assume it is.

MR. ELDREDGE: No changes in the tables.

MR. BOOTHE: I take it he trusted the computer to put out the same stuff. My experience with computers is it's not necessarily so. That thing has another trick for me every time I use it.

Of course the real issue in those tables is aerodynamic coefficients, sources of them, accuracy of them from those particular sources, and again I have taken a really wild stab at what I think the accuracy of any given variable value might be from some source I might have named. And you probably, or may, totally disagree with me, but that's okay. I said this is straw man 2, we have to put something on paper or else we wouldn't have anything to discuss. So please don't think there is any sacred cows in there. I probably don't know as much about data sources as all of you do, so I just put something there for us to discuss. I think the rest of that is sort of self-evident relationship to validation requirements, matters arising, as we discussed, and recommended changes.

But at the end we would like some reviews and recommendations, and a cost increment which I did not write down on here, we would like to try to address that, and of course where do we go from here? That's true for most of the tables.

So with that I think I will take my seat and we can get started on the validation set and go from there. Thank you.

MR. LONGRIDGE: You are going to lead that discussion on the validation set?

MR. BOOTHE: I guess. Can I do it from there?

MR. LONGRIDGE: You can sit down.

MR. ELDREDGE: Tom [Longridge], can I just say something?

All of the things that you are going to say here are going to be recorded. And next week when I get the copies of the transcripts, they will be sent out to all of you individually. And you need to go through them and make sure everything that you have said has been recorded accurately. And then get those back, it will go out in a letter, whether from Tom [Longridge] or myself, asking you to review the transcripts, to make any corrections or change things that we might have got wrong when we recorded it, then get those back to us. We will send out a letter with all of that. You will have a chance to review all the transcripts.

MR. BOOTHE: If everybody can find proposed validation test data sources in their book of tables.

Stu [Willmott]?

MR. WILLMOTT: Excuse me. I wonder if it would be pertinent to determine exactly what type of aircraft we are talking about. There are five families of aircraft. And I guess the first family is concerned with [Part] 121. And then there are four other categories, the last one being helicopters. For Part 135 operators, regional operators, are we talking about all four categories other than 121? In other words, helicopter, single-engine, multi-engine, general purpose, and SFAR aircraft.

MR. LONGRIDGE: I think we are talking about multi-engine turbo prop primarily.

MR. WILLMOTT: Second class, in other words aircraft between ten and 30 passengers and greater than 12,500 pounds, that's the class of aircraft we are talking about.

MR. TOULA: Not necessarily greater.

MR. RAY: I think that's generally the group that's provoked the discussion, but if we could come to grips with--sorry, Paul Ray.

THE REPORTER: I've got you.

MR. RAY: If we can come to grips with the issues, the validation data and the programming data, if that's the right word to use, would be applicable to all aircraft, excluding helicopters.

MR. WILLMOTT: One of the things I did to familiarize myself with the aircraft that we might be talking about is get a list of the aircraft and the numbers that are operated by the Regional Aircraft Association in their annual report, and there are 3448 aircraft altogether. Ninety-seven different types of aircraft, some are single, some amphibians, some helicopters, are we addressing all of those?

MR. LONGRIDGE: No, standard air carrier commuter. We are not talking about single engine. You have to remember we are also starting this discussion on validation requirements that are going to apply across the board. We are not trying to come up with a solution that will work for one aircraft, we are trying to come up with a set of FAA validation requirements at this point in the discussion that apply to all those aircraft.

MR. LEISTER: I don't think it makes any difference what kind of aircraft, Stu [Willmott]. I think they are going to be carrying passengers, commuter--they are going to be commuter type service in the future. I'm dealing with a 210 now and I'm having more difficulty with it than any of the simulators.

MR. WILLMOTT: As far as the aerodynamics are concerned with this type of airplane, the aerodynamics of the control surfaces are probably more important than the basic aerodynamics.

MR. BOOTHE: I don't think I would limit the discussion to any particular airplane, but the fact that we chose turbo prop from the IATA data, which addresses other airplanes as well, I think it's a strong clue, but that seems to be the major problem area for regional carriers who are having to upgrade to large airplane operating rules. So I think the focus I took was turbo prop smaller airplanes. But we have to consider Beech 1900--or is it now a Raytheon--

MR. WILLMOTT: 1900--

MR. BOOTHE: --on up.

When you consider, I read something the other day that in that particular size, that airplane has 90 percent of the market. I think it's 95 percent or something. But then we have got to look on up through people flying Jetstreams, 31s, 41s, we have to look at even into the ATRs. But I don't think we need to be too terribly concerned, although I would not want the results to not be applicable. But when we begin talking Regional Jets and Fokker 100s, and 737-200s, and airplanes like that, I think those are covered in a different area.

But if one were to choose to build a Level B simulator, after we are finished, for any of those airplanes, including a 777 or whatever, these same standards will have to apply. I don't think we want to set out and say we are going to have two sets of standards, one for people who can't afford it and one for those who can. Because that puts the FAA back in this often spoken two levels of safety mode, and I don't think that anybody wants to even think two levels of safety.

Whatever we do from a perspective of a Level B simulator will be applicable across all airplanes, air carrier service, even some that aren't used in air carrier service. If someone wanted a simulator for 210, then the same standards would apply. But I think we have focused on where is the problem area today, and that seems to be in the smaller turbo propeller airplanes that the regional airlines are currently using for which they are having difficulty finding affordable training devices. I don't think our purpose here is to really diminish any standards. Our purpose is to find out how to do them better and cheaper. Or equivalently but cheaper, if you will.

Did I answer your question or just get on a soap box?

MR. WILLMOTT: My summary is it doesn't really affect the single engine aircraft, we start off with the twin turbo prop as the basis and then those same rules would apply to the other aircraft? Tom [Longridge] is saying it's basically the second category of aircraft that we are starting off with.

MR. BOOTHE: You mentioned one thing that I think is important to these tables. I would assume that we are generally dealing today with reversible control systems. So that makes a difference as to how we might discuss some of these, but we want to be careful that anything we might include on Level B could also be used for irreversible systems. Now generally that's a real easy route, rather than the other way around. So that's a thought to keep in mind. We must keep reversible systems in mind, and I think when some of the standards were originally done, people only thought big airplanes with irreversible control systems and sort of overlooked--

MR. WILLMOTT: That's more important for the second thing, which is the aeromodeling, it's quite different from one class to the other. Stewart [Baillie] has just done a recent aircraft and of course he has done some of the turbo prop.

MR. BAILLIE: With that introduction, Stewart Baillie. I actually without prompts brought a couple of view graphs to describe and to show what level of effort is required to gather the ATG data set right now for Level B and where the effort is spent.

MR. DAVIS: If I can ask a quick question. I'm curious why we are using [AC120-]40B in the draft as a baseline, I assume soon [AC120-]40C is going to be law.

MR. RAY: We are focusing on B and below. Any changes which can be agreed upon will [be] included in a change to 40C addressing Level B and below. Level C and D will remain consistent with international standards.

MR. BOOTHE: That's an important point.

Do I have to say my name every time?

THE REPORTER: No, I know who you are.

MR. BOOTHE: Now I forgot what I was going to say. What we do here hopefully will not affect C and D unless for some very good reason. But that may result in the Advisory Circular needing some revision to talk about data acquisition, and what's acceptable at A and B level but not acceptable at C and D level. I don't know at the moment how to handle that, but I think I would put that aside until we look at this with Level B in mind and see what we can get out of this. But I think it's real important for the simulator evaluation and qualification people to stay quite attuned and remind us if there is something we are approaching that they find unacceptable, because I would hate to get to the end of two days and then a week later find out well, no, we can't accept that.

So I don't want to particularly beat on you guys, but I do want you to let us know as we go. I think that's real important.

I'm sorry Stewart [Baillie]. Go ahead.

MR. BAILLIE: It's okay. I just wanted to say my sort of background in this. When I first was aware of the problem, the question was how can we validate existing models? And so I spent the time just looking at existing model validation.

The trade-off there was the depth of the model validation versus flight test and data handling cost. Intrinsically that doesn't mean we are trading off model accuracy because I had taken as a given there was already a model we were trying to validate. Really we are dealing with level of training transfer, I don't know how that fits in this whole process.

With that in mind, I looked at a recent example, the aircraft is still on the hangar floor, of what it takes to do the Level D international test guide. Our data gathering was 67 channels plus some 20 odd discrete events. We had the aircraft in the hangar for six weeks. Of that period it takes nine days to do the flying. And so 21 percent of the time is actually gathering the data and most of the time is the installation.

So regardless of what we choose in maneuvers, the importance is minimizing how much effort you have to deal with the aircraft in installation and removal of sensors, the variety, I'm sure this is not new to anybody, these are from a previous program, the variety of data can be anywhere from flight data recorders, sensors already on the aircraft, installed potentiometers, brake pressures, control forces, that's the full Level D package.

I asked our instrumentation people what their ideas were on what takes time. Inertial is easy, you strap it to seat rails in the center of the aircraft, anything that is a computer, nosewheel steering computer, any flight data acquisition units, anything already on the aircraft is easy to tap onto.

What's more difficult is when you get in mechanical things, potentiometers, control positions, AHRS, attitude heading reference system, usually that's a little more difficult because the signals are kind of hard to characterize.

What's most difficult is oleos, trim tabs, anything you have to develop the installation. Those are the easy, most difficult and end up defining where the savings can be. If we keep it simple, you save time. But you are only going to save, like I say, 80 percent of the aircraft time. On the hangar floor.

That's all I wanted to say.

MR. LONGRIDGE: Thank you.

MR. WILLMOTT: Is it possible to get a copy of those?

MR. BAILLIE: I can get a copy.

MR. ELDREDGE: Let me see if I can get some copies made.

MR. BOOTHE: Thank you, Stewart [Baillie]. I think that's an important piece of information on his experience as to where he spent the time, and I'm sure there is others here who might, David Kohlman and Bob Heffley who might confirm or argue.

MR. KOHLMAN: I don't have any specific figure. All our experience, I think Daryl Schueler will concur, says those numbers are right on. The greatest part of your time and expense is installing, calibrating, and then removing. It takes much less time in terms of aircraft time to do the flying.

MR. LEISTER: I would like to add one thing to that. I think a large part of the expense of flight test comes from having to instrument the control surfaces, the elevators, whatever. When you come right down to it, when you build a simulator, you are building a box where a pilot is working with the control positions that he is used to working with in aircraft. And he does not know what an elevator or aileron or angle of attack is or anything like that.

I think one of the biggest cost savings could be released by not requiring surface positions, externally measured surface positions, things like that. I know most of you would argue with me about that. But I think I can build as good a simulator as anyone with just the internally measured positions, the control forces and positions, nosewheel positions, the rudder, pedal positions and forces, what the pilot actually feels and perceives in the actual airplane cockpit, rather than the externally measured things.

And I'm not advocating building the model without rigorous aerodynamics. You have to do that, you have to build a good aeromodel, but you do not need the externally measured parameters, I don't think.

MR. DAVIS: Well, I disagree in some respect. I think if the premise is we already have a model, I tend to agree with you to a certain degree.

MR. LEISTER: Even if you don't have a model.

MR. DAVIS: If you don't have a model, I challenge anyone to come up--

MR. LEISTER: You can derive the hinge moments that will drive the surfaces, the positions in the cockpit to be what the pilot feels or however far the positions move in the cockpit in the airplane. You can derive that from the flight test data without knowing what the elevator, the rudder or aileron is.

I worked at flight safety years ago when we didn't have the luxury of flight test, getting flight test data other than going out and getting video data and hand held force gauge, very crude measurements in the cockpit. We learned to derive a pretty solid model from just what the pilot is looking at, what he is feeling, what he is seeing, rather than the typical aerodynamically measured thing.

MR. BOOTHE: Bob Heffley has a comment.

MR. HEFFLEY: Yes. I think you must know what the correlation between cockpit control and surface is.

MR. LEISTER: You have to be able to measure the cockpit control.

MR. HEFFLEY: But the cockpit control can be quite nonlinear.

MR. LEISTER: Absolutely.

MR. BOOTHE: What I would like to do is incorporate those thoughts, I don't want to cut anybody off, Chuck [Stocking].

MR. STOCKING: That's all right.

MR. BOOTHE: Go ahead.

MR. STOCKING: I was going to say I recently have done a couple of programs where we did an entire aircraft from scratch, and to develop the control laws we went out and we measured the airplane, and that was the substantive--we defined the control laws exactly by measuring the aircraft, even cable stretch. I put on the gust locks and went through the airplane exactly, saw where the stretch was until we had a reasonably accurate model to use in the simulator, what we miss, those little fine details went into the coefficients. So--

MR. LEISTER: That's what I'm saying.

MR. STOCKING: What I'm doing is replacing not having access to the airplane data by having access to the airplane to develop those models. It worked quite well.

MR. BOOTHE: So what you are doing is measuring the cockpit control displacements?

MR. STOCKING: Right. Calibrating the airplane before we go, basically. Defining the control laws.

MR. BOOTHE: You probably will find some thoughts like that through this table. I didn't advocate that we not measure control surface deflections, because that's the sort of thing that comes out of the kind of discussion we are having. I know I have got to get some forces to feed back to the control loader from someplace, it doesn't necessarily mean I have to measure at the surface. So I think those thoughts will flow out as we get into that part.

But while we are beginning this table, if you--hopefully you have had some time to go through it. One of the things I did do was when I said minimize instrumentation, one of the things I did was try to shift some thoughts to some steady state measurements and try to avoid having to have an active measurement of angle of attack and sideslip. Now that may not be successful, but you will see those thoughts through this paper.

And one thing that you will find as we go through is I have added a whole lot of trim runs that are not normally required in the validation, thinking that if I had enough good trims at various configurations and speeds, and level flight, perhaps I could correlate angle of attack and not have to measure it in active maneuvers. Now I may be all wet, but that's something that I've done in this table. I didn't address not measuring surface position and I did say if the airplane has flight data recorder sensors, then there is a sensor and we need not replace it. The flight data recorder itself is a pretty low resolution device, but Stewart [Baillie] tells me that's not true of the sensors. So perhaps there is a source and I would incorporate thanks to Stewart, those thoughts here, too.

So maybe as we go through we can stumble on, excuse me, stumble onto those very ideas and put them into the right place as we go through the table. I would like to just go through it, unless you would like to do it in a different order. I mean, as long as we cover the whole thing.

MR. KOHLMAN: May I say one more thing that I think applies to all of these conditions that we are going to be looking at here one at a time?

I think that echoes what Dave Leister is saying. We are trying to reduce cost, and so the question is not necessarily do the data exist, but do we want to require the effort and expense to match more parameters than we really need? And I think a rule here ought to be that it doesn't make sense to force a validation match of a parameter that in the simulator does not physically exist and the pilot cannot perceive it, such as control surface position. It doesn't physically exist in the simulator. Now I think as an aerodynamicist you have to compute it at some point in the loop, but the pilot doesn't know it's there. So whether we have it or not, why require the extra expense of matching that and other parameters that are only in the computer but don't exist for the pilot.

The goal is to make the pilot perceive the simulator as closely as possible to the airplane. And so we should only require matches of parameters that he can see, read, feel, and as another guideline, only to the resolution that the pilot can perceive and read on his instruments. To require more resolution is requiring something that is going to be transparent to the pilot.

MR. SMITH: That's correct. And in a lot of respects. But I think the philosophy has been that the ATG just present a limited number of cases in which we match it with flight test data, and the attempt has been if we rigorously check these few cases, then it would match the airplane throughout the envelope. And the purpose of doing that, probably the philosophy incorporated, has been that you have to make sure say for correct aileron effectiveness, that the sideslip is correct. In this particular case you are checking you may have a lot of sideslips, and aileron effect is right, because other cases in the envelope where you may only have sideslip and get roll due to it, or cases where you are rolling with aileron with zero sideslip, maybe keeping very coordinated with the rudder, those points would also match because it's possible in a few test cases that you have the aileron effectiveness off one way and the roll due to sideslip off in the opposite direction, granted there are other checks, checks in sideslips to verify the static, basic aileron effectiveness, but there are many other terms in there that I think the philosophy has been we feel more comfortable if the model replicates the airplane.

MR. KOHLMAN: I think that's a good point. If we don't have enough matching points within the envelope, you can force fit the model to match the isolated discrete points and it won't be correct with the other ones.

MR. BOOTHE: I don't think that Dave [Kohlman] was suggesting we not have those measurements, I think he is suggesting that we derive them from a different source rather than literally measuring them.

Is that correct? You have got to have them to develop the model.

MR. KOHLMAN: That's correct.

MR. BOOTHE: But you can get them, according to Dave [Kohlman] and Dave [Leister] and I think Chuck [Stocking], too, by means other than direct measurements.

That's really all you are saying, is that not true?

MR. SMITH: Well, you get the effect of them by doing what Dave [Leister] says, measure the cockpit control positions throughout all your testing and you can do that. And this kind of leads into something that, you know, I'd like to say a little bit, our overall objective is to, you know, produce a device that the bottom line regardless of what we say, FAA Level C or D or whatever, it winds up having to be acceptable to the trainee as a device in lieu of the airplane. And no matter if we, and I think Dave will attest to this, if we build a device and give an FAA qualification and the operator starts using it and all the pilots go through and complain “this thing ain't like the airplane,” your training goes down like mad. Most operators will do something about that.

Probably a case of that is probably the biggest training operator, independent of the operator of the airplanes, is constantly updating simulators. In the last five years I have noticed they have gone out and done new test programs in order to get a better set of data in order to get it to match the airplane better. That's the bottom line.

What we have done typically over the years is require a lot of objective testing. Here again, you have to go to the subjective evaluation, if you get a lot of objective data and sit down with the pilot and even the inspectors and show them that all the objective data matches, when he comes to a point that's questionable, he doesn't feel--he may even want to revert to asking someone who is more experienced, more current in the airplane, or maybe going and checking it in the airplane. It's not like the airplane, because subjectivity is a very difficult thing to do.

But what it does is, having all that objective data match, it kind of, I don't want to say intimidates, but it alerts him to the fact that he should be real careful when he evaluates this thing, if you have a question, check with someone else, get another opinion or two. Expert opinion from someone from the airplane. And I guess it's difficult to say, you know, what is required to do that.

And we talk about modeling data and validation data, and essentially it's all the same in a way, you get one set of flight test data, even if you have coefficients, predicted data, you are going to use the flight test data to extract from it however the classical or other means to validate your predicted data and come up with basically flight test correlated coefficients, and then you turn around and put them in the model, you turn around and match them to the same flight test time history data or static data you have. It's basically the same data, but how well you match that flight test data is, like I say again, the first step to get a simulator that's acceptable. And it's difficult to say. I guess the people who are in the business of doing this pretty much have to determine, you know, how they are going to get that data. It's difficult, I guess from my perspective as a regulator, to say you have to get this data this way. Of course we have done that, but they have the ultimate responsibility to match a set of data, then that pretty much dictates what kind of methods they are going to use or what kind of data they are going to get to do that.

Maybe--Dave brought up a good point, that we can possibly require, you know, not require matching of control surface, and maybe put more emphasis on matching cockpit control positions and forces.

MR. BOOTHE: Thanks. I don't think anybody here is suggesting a less rigorous process. I think the suggestion is, is that we look at a less labor intensive, a less costly way of getting to the same end. And in the end you still will have the data that you are concerned about, it's just that some of it may not be direct measurement.

Is that a true statement?

MR. KOHLMAN: I think so.

MR. BOOTHE: You still have to have those variable values to generate the model and then you have to have the validation data. But the point I could add, we want a simulator always to stimulate a pilot for a given task as the airplane would stimulate a pilot. So that's a thought that I keep in mind as I think about these things, if I can't produce the correct pilot stimulation, then something is not right with the simulation.

And all of us Stu's [Willmott] and my age remember those contemptible simulators we had to fly. We certainly don't want to revisit that. So we are not here to degrade the quality of simulation in any respect. We are here to try and find a cost increment by doing things better.

MR. RAY: I would like to amplify what Ed [Boothe] said and what Hilton [Smith] was touching on, can the FAA reasonably accept validation data that is less comprehensive than what is currently required for a Level A or Level B simulator. The answer among the people we see in this room is undoubtedly yes. How does that float with those not in this room? That's the issue we have to wrestle with.

The thing we cannot do in good conscience to anyone is to back up to those days with the data requirements and measurements that we applied to those contemptible simulators of a number of years ago. Such a device was the topic of a conversation Gerry Baker and I had last night. If you put the flaps down, the pitch was wrong, totally wrong. We can't throw the baby out with the wash and revert to those type[s of] devices.

How do you quantify that process that you go through to include the rigor required so that we can achieve the desired product with only internal cockpit measurements? As far as validation you have to have something in place I think to ensure that foundation is still there so you don't back up 20 years in time. We can't afford to do that. That's our concern. Can we alter the validation? The answer is clearly yes. How do we do that? That's the issue on the table.

MR. WILLMOTT: I don't have a copy of [AC120-]40B in front of me, but I thought it used to say control surface or pilot control, as far as that is concerned.

MR. LEISTER: Yes.

MR. WILLMOTT: And I would whole-heartily agree with Dave [Kohlman] and Dave [Leister], that you could replace the surfaces by the pilot controls and you can replace angle of attack, because that comes about from the pitch attitude and the flight path angle, but for the class of aircraft we are thinking about here, sideslip I'm not sure about. When you have got slip streams from the propellered aircraft, even in symmetric flight, if I can call it that, generally you have sideslip. And although there is nothing that the pilot can see normally to measure it when he is on approach and doesn't have a crosswind, he can see if he has a sideslip or not. I'm not sure what we could put in place of that. That's important for verifying a simulator.

MR. LEISTER: I would question how accurately can you measure sideslip angle? Especially in a slip stream, you can't do it. It's a nebulous term really.

MR. BOOTHE: Let me hear Chuck [Stocking] and then I want to comment on that. We will press on.

MR. STOCKING: Go ahead. I was going to--

MR. BOOTHE: Let me say in this table I have pretty much eliminated measurements of angle of attack and sideslip. Did I do it correctly? Did I do it well or did I screw it up? Excuse my language, but that's what we have to dig out.

Also, if you look at page 6 of the validation test data, I just--I'm not going to start here, but I want to refer you here to, temporarily, to right at test No. 2.a.(1), these are the same test numbers used in the Advisory Circular, column position versus force. If you look under the proposed test technique, I have sort of addressed the very thing we are talking about here. And looked at using flight data recorder sensor or something similar to what I think Chuck [Stocking] suggested earlier, select control positions measured on the ground, using a surface measurement protractor, there are devices for doing that sort of thing. So that we have some numbers to go with the elevator position versus the cockpit controller position.

Now what I didn't do was work in cable stretch and those sort of things. I'm sure our ingenuity can figure that out, but I have incorporated some of these thoughts and I don't want to get our cart in front of the horse and just dwell on this one thing. I would really recommend we go through the table test by test and then as we go through them, maybe one will relate to another. And we can come back.

But I am happy to say that my thoughts aren't too far off of yours on this subject because I have tried to look at some ways of eliminating some of the difficult measurements.

MR. STOCKING: There are factors within the industry, Stu [Willmott] has a list here of 97 aircraft, there are factors that are outside of aerodynamics, if you will, that will affect what we do. One of them is the change in the capacity of the computer. I now have a home computer that has ten times the capacity of the simulators I built ten years ago.

The other thing is the cost to build a simulator. The approach that we are taking in an experimental program within our company is we want a program that will simulate all 97 aircraft without change, without changing a line of code. Now that may seem ridiculous, but it's really not. We are falling back on making theoretical models that have all these factors embedded in them, we need control surface position, we need angle of attack and all those positions. But when you go to validate what you have done, all you need is what you have seen in the cockpit; right? And collecting the data to put in there, we now have great engineering tools, like Roskam's model, you put in the geometry of the airplane, it gives you a coefficient. Then you validate it.

You are looking at it from the cockpit, which is just the answer, you don't know all the component parts. We have developed a theoretical model that has all the component parts and then we see if the answer is correct. So these factors are going to influence what we do. That's all I want to say. Look at the big picture, because there are forces driving us to develop these models that will be used on airplane after airplane, they will be refined, corrected as we go along. Real high fidelity models, much higher than we are using now. That's what it takes to lower the cost and improve the simulator.

MR. LONGRIDGE: But you still have to validate the models. The question is, what of all the things you could validate are you going to validate.

MR. STOCKING: Within the cockpit, you are going to look at what's in the cockpit in greater detail than you are now. I need real good accurate control positions, I need real good accurate forces, you will concentrate there instead of all the pieces all over the airplane. There is things you will--well, it's a complex problem.

MR. BOOTHE: It is. And I don't know how to address it except one piece at a time. But what you are saying is the guy who was asked, how do you fly that great big airplane, it's such a massive thing, you just fly the cockpit, the rest of it follows. And that's sort of what we are going to do here, is fly a cockpit. If that's the solution, then that's what we need to think about. So, I mean, I never flew from the tail. Ken [Neville]?

MR. NEVILLE: Ken Neville. I guess I have a little concern about simplifying the models to the point where the aerodynamic characteristics would not be a function of these pieces that the pilot can't see. It's true he doesn't know where the elevator is, but the aerodynamic characteristics physically are a function of the elevator. They are a function of angle of attack, they are a function of pitch rate, so when the pilot applies a force to the column, these things are happening in various combinations. And if you try and bypass that and just make the pitching moment be a function of column position, that might work for a specific maneuver. As Hilton [Smith] pointed out you can match one test that's required in an ATG, but it may not match anywhere else if you don't have these pieces modeled correctly.

MR. BOOTHE: It's not my understanding we are not going to have those things.

MR. LEISTER: You misunderstood. The model is as rigorous as it ever has been. You just drive the various things like hinge moment, coefficient, whatever, that will drive the cockpit position and force to be correct. The model is as rigorous as ever. You have to drive all that stuff.

MR. DAVIS: You still model surface. Nobody has insight as to what it is when you have a wheel position you get right. What happens in a malfunction state? Again we measure wheel, we measure roll rate, things match, we don't know where the other surfaces are. In this case if one of the surfaces locks out, how do we know they are where they should be and the effect is correct?

You wouldn't know the aileron, you are in the right spot--

MR. LEISTER: You wouldn't get that in a flight test--

THE REPORTER: Gentlemen.

MR. DAVIS: --you wouldn't be able to establish that you are getting the right spot, in that instance you can still debate whether each surface is correct.

MR. LEISTER: There would be no difference, you are still modeling all these entities. Your aileron, spoiler, whatever, are not going to be based on flight test data, you don't have flight test data, there is no reason you can't still rigorously model that. Whatever.

MR. BOOTHE: I think there is some misunderstanding here already.

Stu [Willmott]?

MR. WILLMOTT: I was going to say I don't think anybody has suggested doing anything as far as the modeling is concerned. What we are doing is addressing the subject, which is validation testing right now. And this is a way of reducing the number of parameters that you have to compare and everything else. To some extent what we have done is say okay, we can do that cheaper, but we still have got to get all of those things for the purposes of doing the modeling. To some extent we may not see much cost [difference], but we certainly have fewer problems when you don't have to compare so many variables when you are validating the simulator.

MR. BOOTHE: Or you don't have to, I think where the cost saving is, you don't have to instrument and collect those variables in the flight test if you have an alternative means of identifying them and assigning them the proper value and using them in the model. Is that not what we are saying?

MR. KOHLMAN: I think there are two scenarios here. One you start with an airplane that you have never modeled before. You have to go out there and instrument the control surfaces. I certainly agree you can't build the model without that. But having done that, then the cost of validation is a function of how many of these parameters do I have to sit down and match? Even though you have the data, I'm saying we can save by not having to match a lot of things that the pilot can't see or experience directly. Now I think they are going to match pretty closely anyway, but we are trying to save time and effort.

The other scenario is we already have a model for a Level 5 or Level 6 training device and the customer wants to upgrade to Level B. Then we go out and do just the validation flight test and we would like to get away without having to instrument the control surface and do the matching. Perhaps we will have to fine tune hinge moments and control surface effectiveness, but we don't have to instrument and measure them to upgrade to Level B.

MR. BOOTHE: I guess I agree. I refer you back to page 6. I almost said that, not quite, so I think if I could just summarize that point, that there is no intent to not have those values, those parameters included in the model. In fact if I understand modeling at all, you have got to have them, otherwise there is going to be some real missing links. If we don't know where the surface is and we don't have a reasonable estimate of the hinge moment, then you don't know what to tell the controller, so I won't know what the cockpit forces are.

So you cannot not have it, it's just a question, as Dave [Kohlman] said, of a direct measurement and a direct comparison for validation. Why can't we use another source and another measurement that's more directed?

MR. KOHLMAN: That's correct.

MR. BOOTHE: Stewart [Baillie]?

MR. BAILLIE: Stewart Baillie. In keeping with that idea, the original process we have for approval test guides ensure that we are modeling all of the variables by matching most of them, as you were saying, Hilton [Smith]. With a reduced matching set, how does the FAA have the authority to say I need to check to make sure that the model has those parameters in it? You have said we will do this, we will do this, but the fact of the matter is, unless you guys have a regulation that you can use unfortunately as a club, in the long term you will get simulators out there that don't have those terms. And so the question is, are you going to add a regulation that says in addition to matching these maneuvers, you have to demonstrate that? Yes, angle of attack is a function in your model, and your elevator control surface position is a function in the model, how are you going to address that? Because otherwise you will get the Microsoft simulator that's been tweaked to match the ten or 20--

MR. BOOTHE: That's already addressed, I think, in the Advisory Circular. And that does require some measurement of surface position in some cases and angle of attack and sideslip. But for Level B, and trying to look at how can we maintain the fidelity, if you will, and lower the cost, we try to eliminate some of those measurements, we can't get off that subject to get through here to find out where those things are. And so I think that this table reflects some of those thoughts, but again I want to be quick to say they may not be in the correct places and they may not be the correct thoughts, so it's our job to straighten that out now.

But I think that thought or that philosophy has been partially addressed here at least. As I said earlier, I have tried to eliminate sideslip and angle of attack measurements, I might have done it erroneously, but nevertheless that has been my approach. I have tried to take, you got the Ed Boothe cheap data collection. When I say cheap, I don't mean American cheap and poor quality, I mean British cheap and low cost. So I have already tried to put some of those thoughts in, and so I'd like to suggest we go through here and find out how they will affect us and whether or not we can do these things.

Again, I did some trade-offs like that to trade off angle of attack, as I said, I added a bunch of trim lines, because I think in level flight I can get a correlation that will convince me angle of attack is okay to model if it matches those conditions. I have added some things and taken away some things. But the total package is still here addressing each and every test in the Advisory Circular now.

If there are some of those tests we should argue about and perhaps suggest eliminating, I think we can grope into that too, I think that's what we should be about.

MR. SMITH: Could I ask Dave [Kohlman], when you were talking about some of those parameters you wouldn't have to match, were you referring to not having to match and show presentations in the ATG? You would have to match those parameters, wouldn't you, in developing your model?

MR. KOHLMAN: Well, let me give an example. Just Monday I did a flight test for a Lear 35 for a training device. And I collected about 15 different data points with fish scale type force, video camera, and noninvasive physical measurements in the cockpit: control position, wheel position, pedal position. I didn't know what the rudder position was, or the aileron position or the elevator position. And I knew the stabilizer position just from reading what the pilot could read.

We are going to take that data back and match all those points with the training device. And if they all match within the required tolerances, the FAA will approve that as a training device. And I'm presuming as an aerodynamicist, that those control positions are reasonably accurate, even though I didn't measure them, if everything else is consistent and the model is based upon the full airplane set of parameters.

MR. SMITH: But in your model or your data analysis you will take those cockpit control positions, go through the gearing curve to determine where the rudder and ailerons are, so that's the control surface positions put in your model in order to do your modeling rigorously.

MR. KOHLMAN: The modeling has been done, we don't have to do any more modeling unless these don't match.

MR. SMITH: But the model itself will have to know where the aileron and rudder is.

MR. KOHLMAN: Exactly. At anywhere in the process the simulator is computing and will print out what the control surfaces are doing. I'm not recording them nor am I required to match them, which is going to cost a lot of money, much, much more than the pretty low cost flight test--

MR. SMITH: I agree with that on a control surface position. But like angle of attack and sideslip, it seems like you have to know a little, because there are a lot of functions, systems that require angle of attack or sideslip, maybe stall warning, stall horns, things like this are programmed specifically as a function directly of angle of attack.

MR. BOOTHE: They are in the model though, they have to be in the model.

MR. SMITH: You have to know what angle of attack is, in relation to the other parameters, in order to make the stick shake.

MR. LEISTER: You can derive that from the data.

MR. KOHLMAN: Indirectly I do get that. I did a bunch of trim points where I can read pitch attitude on the artificial horizon, then match it.

MR. BOOTHE: Exactly. That's what I incorporated here.

MR. RAY: One comment. Stewart [Baillie], you made the comment earlier, about the Microsoft. That's the "me toos" of the world, they will come to the FAA, say "trust me, I got that off the airplane on this day, trust me, I went to Microsoft and bought my $39.95 program, slapped it in here, and it works." That's the motherhood statement process I think on the fidelity of the model you already have, that layers in on top of this. If we can come up with, we can go through this, but there is a side issue we need to address at the end, which is that motherhood statement, whatever you want to call it, that goes in front of all this, the ethics that reside in this room on how you do that, from point A to point B, we are not trying to exclude the "me toos" of the world coming in, we are trying to encourage that.

But if they are going to get in this arena you better have a process that can give the confidence to the regulators that that device you are building in fact performs the function it's designed to do. If we don't have that process or motherhood, then this is a wasted effort. And I want to make sure we quantify that assumption that's underlined, I'm convinced we can do this.

But the other piece of it is, I hate to refer to it as motherhood, but that's basically what it is inside of this room. To me it is. I will shut up.

MR. SMITH: Let me add one thing to what you said. You are right. Even though they get our acceptance, the FAA's acceptance, that's not the final test. The final test, when this thing goes into service, if it don't fly like the airplane you are going to find out.

Isn't that right, Ed [Boothe]?

MR. BOOTHE: That's right. But I remind us all that I began this discussion with no sacrifice of rigor and no sacrifice of quality. And so when we get to the end we need to have satisfied those requirements.

What we are trying to do is look at how to maintain that rigor and that quality with less cost. And if it is proper and rigorous and of high quality, to shift some measurements from one place to another, to do things simpler, to do some hand held flight test techniques, then I think that's what we ought to address. So I would ask us to keep these thoughts in mind the last hour, and as we go through this table, because we are not here to, as I said, revert to contemptible simulation. I suffered through enough of that, I don't want anybody else, I've been a victim, if you will, and I don't like being a victim and neither does anybody else. So we are not going to sacrifice our simulation quality.

We know what the standard is, to stimulate the pilot correctly. I think it's just that simple. But it doesn't mean that we have to keep doing things the way we always did them to accomplish that end. And so if we can keep those thoughts and go on through and look at these techniques and discuss them and then at the end, look at the overall package, I think that would serve our purpose a little better. So let's just start at the beginning of the table. Page 1 on.

MR. TOULA: The upside down one or rightside up one?

MR. BOOTHE: I guess you open the book at the middle, turn it upside down and work from the right. I thought the Japanese were pretty smart about that, I have always picked up a magazine and thumbed through it with my left hand from back to front, it seems to work nicely. I have to read the end of an article before I read the beginning. The Japanese do magazines that way. It's a nice idea, but I didn't know we would pick it up here.

The first thing there is a minimum radius turn, I don't think there is any need there for anything but what's in an AFM or ops manual, nothing else required. I think that's probably what we are doing now. So unless there is some further discussion, I think that's fairly accurate stuff in an AFM. Gerry [Baker]?

MR. BAKER: Most of them came out of an operations manual.

MR. RAY: If I could throw a comment in on the Level 6 FTD. I would agree it doesn't necessarily have an impact on a Level 6 device unless you raise the ante and have visual systems attached to a device. The potential impact would be increased if a visual system is added on the Level 6. Lacking the visual, does it react reasonably on the ground as opposed to the old skidding ice routine?

MR. BOOTHE: But that's no different than what you would expect now.

MR. RAY: No, that's true, it just becomes a player, that's all.

MR. BOOTHE: Next is rate of turn versus nosewheel steering angle. I have taken again a simple position there of how we might look at that without extensive instrumentation. And perhaps you can give me some feedback. I've just put some sort of protractor on the tiller and suggested video to record a steady state measurement. I think the video is fine in a steady state condition. That's a steady state measurement, anyway. I think one could come up with a quite accurate measurement for different nosewheel steering positions.

Now if you want to relate the tiller to the wheel, to the nosewheel itself, then I think that's really sufficient to use what's known about the gearing in the airplane. Truly there is some backlash and bending and torsion, but is that significant for that test, I ask you?

MR. BAKER: You are obviously assuming you have a power steered airplane. You have a lot of airplanes in the category you are talking about that are mechanically steered airplanes, some--force is a major impact, you have some that have very strong forces to move the airplane. I'm not so sure you shouldn't consider some type, if you have an airplane with force pedals, you should consider some type of force input.

You take a Beech 1900, Beech has an optional power steering, but 99 percent of the airplanes don't have it. And your steering--it's not a simple thing. Steering in a two engine operation is nothing like steering in a one engine operation, some airplanes you can't hardly steer on one engine unless they are powered. There are a lot of variables. I think you have the simplest case here, is what I'm saying.

MR. BOOTHE: Are you suggesting, Gerry [Baker], we should add a force measurement from both the tiller and a rudder pedal?

MR. BAKER: I think you have to consider the airplane you are working on. Some of the Fairchild airplanes, the old ones, had tillers, the new ones don't have tillers. A lot of airplanes are that way. So I think you have to start with what airplane, what configuration are you looking at here. And the test techniques and measurements would have to vary, depending on the type of steering system.

I think there is probably a simple way to do it, but I think you need to consider all of those matters.

MR. LONGRIDGE: So we would change it to say if not power steering, then we need force input measures appropriate to the aircraft steering system.

MR. BAKER: It's one of those things where it would sure be nice to have, say a mechanically steered airplane with no mechanical steering rudder pedal position, rudder pedal force.

MR. DAVIS: I think there is a lot of merit in that, but the question in my mind is, is that going to increase the requirements?

MR. BOOTHE: Not necessarily. I think Gerry [Baker] is saying--

MR. DAVIS: It is if you have to start matching force now.

MR. BOOTHE: That's true, but if that's what the airplane has and we need this information, then we have to address that airplane.

MR. BAKER: If it takes 100 pounds of rudder pedal force to turn the airplane and you put ten pounds in the simulator, the simulator is never going to get past the customer.

MR. DAVIS: Absolutely. I think it's checked qualitatively now and I think we ought to leave it that way.

MR. WILLMOTT: I think the original purpose of this test was to check steady state turn rate versus steady state nosewheel, that to my knowledge is always what it has been there. But over recent years we have tended to make it into a nosewheel response test, not by rudder pedal, by tiller input. I wonder if we want to clearly define what we are checking here.

MR. BOOTHE: Later on when we do control force and position measurements, then there is a requirement there to measure rudder pedal forces. So if we look at the total package we are going to have to somehow be prepared to do that anyway. And if you have got to put a force transducer on the rudder pedal for the other test, then you have it for this test. So I don't think we are adding anything, necessarily.

MR. BAILLIE: Taking part of what I heard Stuart [Willmott] just say, I will probably ask this question on each maneuver, so I will just say it once, the one question I have is how does this maneuver apply to what current training is supposed to be doing? Is it essential that the pilot knows how to taxi the aircraft through recurrent training?

A lot of maneuvers, you look at them, they are validating a simulator, but if the task of that simulator is not around that maneuver we are wasting our time and wasting our money.

MR. SMITH: Except that even though that's not a training maneuver, if in the process of training he taxies the airplane around and it's significantly different from the airplane, that's going to throw him off.

MR. BOOTHE: Maybe it would be a good time, before we have a cup of coffee, for Tom [Longridge], if you don't mind, to give us a generic scenario of a line-oriented evaluation under the AQP and let's see what a person has to do to relate these training events that Stewart [Baillie] is talking about. Because it's my understanding an LOE can have a great amount of variation and it has random events which may or may not occur in the next--could you give us a summary of what one is?

MR. TOULA: Not just LOFT, Ed [Boothe], it's a proficiency check.

MR. LONGRIDGE: I think the point is that I mentioned earlier, was that an AQP, we conduct scenario-based evaluation so the individual is going to go essentially through and be evaluated for pass/fail purposes. I think in that context fidelity is an important consideration. The individual can always say of course I couldn't perform in this thing, it does not fly like the aircraft at all. In a scenario we are talking about from pushback to docking, it's a complete scenario. I think from my perspective we want to see the fidelity in the flight simulator all the way through.

Now your point with respect to recurrent training I think is an argument that would apply to an FTD where the fidelity may not be important for the task at hand, it's not a requirement for the FTD. When we come to a scenario based pushback to docking assessment system, that's where we are going to see it.

MR. BAILLIE: If that's the case, then you want the exact fidelity of a Level D simulator and you are only going to get it by using a Level D simulator. We have to--I would propose you have to stand back and say this simulator is not going to be as good because of the role that it's going to be used for.

MR. LONGRIDGE: I think you could get into a philosophical argument in that regard. We are taking the position that the current existing regulations that apply would continue to apply in the context that we are looking at in the future. Namely you are permitted to use a Level B with its existing level of fidelity for 100 percent recurrent training. You can use a Level B for scenario to scenario based level training. What we are looking for is an equivalent capability in the future with hopefully a more affordable device that emotes the same standards of quality.

MR. KOHLMAN: Could I make a comment?

I think Stewart [Baillie] took the words out of my mouth, as to what are we going to use this Level B simulator for? If we are not going to use it for Level D type jobs, which is gate to gate, and everything has to be just like the airplane, if it's primarily to help the regional airlines meet the new requirements and it's primarily for recurrency training, then we ought to really focus on quality and fidelity in the areas that are important for recurrency training. And those are the things that the pilot doesn't get practice doing every day when he is flying the airplane.

He gets to practice taxiing every time he is in the airplane. I'm not saying it should be way off, it's going to have to be good when it's accepted, but it doesn't have to be matched.

The things that should be matched are the critical training problems such as V_1 cuts, and the multiple systems fail situations you can't practice in the airplane. That is, where you are going to do the recurrent training. Don't spend a lot of time and money matching things that he gets practice doing every day and are not critical.

MR. LONGRIDGE: But I think the FAA already made that distinction with respect to allowing you to use a Level B versus C or D.

MR. BAILLIE: If that's the case, why do you even worry about the taxi model? Every case costs money, mostly in effort.

MR. TOULA: You have to worry about that, outside of AQP taxiing is a requirement, if you are doing proficiency checks in a training program, you have to do one of those basically every six months unless they are all in training. So the requirement for taxi is there.

MR. LONGRIDGE: It's there in AQP, too.

MR. WILLMOTT: It's all part and parcel of takeoff.

MR. BAILLIE: Let's match it in the takeoff.

MR. WILLMOTT: Well, this turn rate is a low speed type of takeoff in a crosswind.

MR. LEISTER: You better have two or three of these tests in there for different speeds.

MR. RAY: It could be your tolerances are different. Let's not get hung up on what we are actually testing here. As Gerry [Baker] says, if you have a hundred pound force required on a given aircraft for rudder pedal steering or nosewheel steering, is ten pounds in the simulator reasonable? Clearly not. What is a reasonable tolerance, is it within five pounds.

MR. BOOTHE: I can tell you my legs and feet are not going to notice the difference between 90 and 100.

MR. RAY: I agree.

MR. WILLMOTT: I think some of these things we have already in Appendix 2 or Appendix 3, subjective evaluation, where certain special aspects of an airplane like the bungie forces on the Beeches, Cessnas and a whole lot of others, are important, would be assessed by the pilot doing all these subjective evaluations. This particular test dates back from the days when simulators didn't even have the right turn rate for a given nose wheel input. The purpose of the test was to ensure if you put a given amount of pedal or tiller in, you got the right turn rate. We weren't even in the right ballpark in the early days. This has grown from that to a point now where we tend to use it as a dynamic test for the nosewheel steering system. And I don't think it was really meant to be there. I think that perhaps can be a subjective evaluation on the part of the pilot.

And as we said, we don't want to make these requirements more complicated than they exist right now for Level B.

MR. BOOTHE: There has been creep. I think that creep has probably been on both sides of the fence, but what you are suggesting is let's really go back to the original intent here.

MR. WILLMOTT: Nosewheel tiller versus turn rate.

MR. BOOTHE: Or the rudder pedal position.

MR. WILLMOTT: Or the rudder pedal position.

MR. BOOTHE: Forces will get picked up at another point. So we have to do that anyway. But for this particular test, I don't know that we need to really mention that, do we? We do need to address rudder pedals, if that's ever the steering mechanism, and we maybe need a comment to say as applicable to the particular airplane. But do we need to add something here that we are going to do somewhere else?

MR. RAY: The point about the subjective, in many cases that's overlooked unfortunately, we don't have the benefit, with most of the initial evaluations, of the expertise that we have with Gerry [Baker] or Gene [Bollin, FAA, Aircraft Certification Office], or somebody [else] from the certification office. We just don't have that level of expertise on our typical evaluation.

In many cases we are down to that pilot with that airline who may have a bias going in, a training department that needs to use it 30 minutes after we stop the evaluation. If there is a reasonable objective measurement that is not intrusive, without driving the instrumentation cost out of sight, and we can do it with gauge only rudder pedal, then it's reasonable to do, I think.

Is it an added test? Maybe. But is it reasonable, does it contribute without driving cost on the data acquisition end. I think it's reasonable.

MR. LONGRIDGE: That was an excellent discussion. But we are five minutes late for our coffee break. I suggest we take 15 minutes and reconvene at a quarter of.

(Break taken.)

MR. LONGRIDGE: We are going to continue. Let me say it was pointed out to me that some people had comments, raised their hand, weren't called on. If you have something to say, raise your hand high so whoever is leading the discussion will be sure to call upon you.

MR. BOOTHE: Thanks, Tom [Longridge], if I did that I apologize. I didn't mean to not recognize anybody who had something to say.

A couple of points came up during the break that I think are worth thinking about. We are looking at the validation tables, so let's assume we have a model and the simulator works, we are looking at validation, we hope to get to the modeling table, I'm not sure we will, but let's just go on the approach we have a model and we are validating it.

The other thing I think is worthwhile here is just taking a quick page-through of this table, so that we know what's coming and we don't try to bring things forward that maybe we will be looking at later. So it does follow the Advisory Circular, but there is no reason why everybody here should really be familiar with the Advisory Circular. So let me just step through it.

There is two main sections, those are typical airplane stuff, performance and handling qualities. We are starting in the performance part, we are in the taxi block. From there we go to the takeoff block and a lot of the same argument might apply. I'm not going through those tests one by one, but just to see what's ahead of us, there are a number of tests in the takeoff block ranging from ground acceleration to rejected takeoff.

Then we have a climb block, which you know is typical of normal climb, climb with an engine inoperative and so on. And then at the end of the performance section we will get to stopping or decelerations.

Then there is a little block on engines, which is really nothing but an acceleration and a deceleration under the flight conditions given in the Advisory Circular, which I don't recall offhand, but I think they are like takeoff and approach. So as we go through those, you will see things in the takeoff section that might address some of the issues in the taxi section, so we have to look at the total package.

Then we move into the handling qualities portion of the table, and the very first thing it says, control checks. So there is where we would find some measurements that we would likely apply to the taxi case, but we happen to be doing them in the static control checks where we measure force versus position of the cockpit control systems and correlate that to some surface positions. How we do that we will discuss as we get there.

Then we have the longitudinal handling qualities, for those it addresses things like effects of various configuration changes, like flaps and gears, it addresses trim cases, maneuvering stability, static stability and the dynamic modes of classical longitudinal dynamic modes.

And similarly for the lateral directional case, we have the typical lateral directional measurements for airplane handling qualities, and if you were to look at a handling quality spec you would find these same kinds of maneuvers listed.

And then finally there is landings and ground effect.

So as we begin with one or two tests in taxi, let's keep in mind that there is much more to come, and before we get too involved in one particular test, let's look ahead a bit and then we can come back. I don't want to diminish any discussion on any particular block of the table, but I'd like to do it in total context, I guess is what I'm trying to get at.

So with that, I think we probably are ready to proceed to takeoff. Although I have added to the taxi area, on the rate of turn versus nosewheel steering, an acknowledgment that it may not be a tiller, that rudder pedal position may be necessary for rudder pedal steered airplanes, and then in parens measurements applicable to the airplane steering system, so we have that latitude that we are not trying to impose--we are not trying to impose a measurement on somebody for something that doesn't exist.

Of course the simple solution to this is, let's go back to the Douglas B-26, where it didn't have any nosewheel steering. Are there any more comments on the taxi area? Stewart [Baillie]?

MR. BAILLIE: There was one, the comment about while you are suggesting the video be the data source, you really just mentioned the yaw rate versus input and video would be one possible source of that data.

MR. BOOTHE: Very good point, yes. A source, that doesn't mean you couldn't get it from some other sources, in fact whatever--I think whatever you can support and justify for measuring that heading rate change is fine. I don't think that we should dictate it, how something gets done, it should simply be here is the thing that probably ought to be measured. But I don't think that there is any attempt to dictate exactly what gets measured or how.

If you can tap into the heading indicator and calibrate that and come up with a rate of turn, personally I don't see the reason why that shouldn't be done.

MR. DAVIS: Can you use a stopwatch to time the 360? Is that adequate?

MR. BOOTHE: Are you asking me or them?

MR. DAVIS: Everyone, I guess.

MR. LEISTER: It is, if you know the speed. It's as good as anything. Absolutely.

MR. BOOTHE: You have to know--but you have to know the speed, anyway. That's a tough one. From my way of thinking, you know, a steady state 360 degree turn here, using a stopwatch, I don't have a problem with that.

MR. BAILLIE: You mentioned speed, but you haven't described it here. Do you have to match speed in the test?

MR. STOCKING: There is no other way to determine turn rate without speed.

MR. BAILLIE: Then how are we measuring speed?

MR. BOOTHE: I neglected it by error. I'm sorry. I don't know.

MR. BAILLIE: That's a difficult one to measure. Unless you have a differential GPS these days.

MR. WILLMOTT: I'm told that you can get those devices and just connect them up to a PC relatively simply.

MR. BAILLIE: Everything is relatively simply--

MR. WILLMOTT: We are about to do a test involving that.

MR. BAILLIE: We thought about duct taping a GPS antenna on top of the aircraft and doing the test that way. That's the only way, though, that I'm aware of that you can get adequate ground speed for this.

MR. BOOTHE: That's a good point.

MR. BAILLIE: Or an inertial solution.

MR. KOHLMAN: Or wheel turn rate, tire turn rate.

MR. STOCKING: Whether you have speed at the CG or at the nosewheel.

MR. WILLMOTT: Didn't you previously use a radar gun, too?

MR. KOHLMAN: We did. But I don't think at that speed.

MR. SCHUELER: Not at turn speed.

MR. BOOTHE: Do you want to add some suggestions here for speed measurements? GPS is a good one.

MR. BAILLIE: The important thing is you also have to match ground speed. How you get ground speed is up to you.

MR. SMITH: If you can maintain the constant, you know, turn rate, the problem is when you are doing a test you want to maintain a constant speed. You've almost got to monitor it as you are doing the test. So you have to have some measurement of it, somewhere. Maybe you do this by off the nosewheel or outside or whatever, I don't know. Because you can always compute that in terms of--

MR. BOOTHE: That's a good point, Hilton [Smith]. If you don't have--if you have a steady rate of heading change, an invariable heading rate, then you have got a constant speed.

MR. SMITH: And you compute it.

MR. BOOTHE: Once you have gone around in enough circles to get stabilized and you have a constant rate of heading change, then maybe computed speed would be all right. Is that crazy?

MR. STOCKING: Time and distance is a valid measurement of speed.

MR. SMITH: But you are right, you have to make a bit--you have to get the right power setting to maintain that.

MR. BOOTHE: Now the control tower may think you are crazy, but that brings up a war story I will save for later.

Any more comments on that? Shall we simply add ground speed measurements and leave it be? Or do you want to include some specific suggestions? I will just add if heading change at constant rate, then you can compute ground speed. How is that?

MR. STOCKING: Constant speed.

MR. SMITH: Constant heading rate.

MR. STOCKING: Constant speed turn.

MR. BOOTHE: But if the heading rate change is constant, then the speed has to be constant.

MR. STOCKING: You can increase or slow down then modulate the angle to keep your turn rate the same. If you say constant speed turn, then you lock in the term.

MR. BOOTHE: Maybe you can do that, I don't think I could. Chuck [Stocking]?

MR. STOCKING: Leave it to chance, somebody will do it.

MR. WILLMOTT: What we have in [AC120-]40C for that is a minimum of two speeds greater than turning radius speed with a spread of at least five knots. That was picked up in 40C. The fact that it's not in [AC120-]40B--

MR. BOOTHE: I don't think we need to apply that to Level B, do we?

MR. WILLMOTT: No, it's just that you just need to put whatever the equivalent is. Turn at constant speed, whatever you said, is fine.

MR. BOOTHE: I have some additional notes for constant speed and constant heading rate change. They are dependent, so--

MR. WILLMOTT: That's fine.

MR. BOOTHE: --it should work out.

MR. STOCKING: Constant rate at a constant speed meaning you don't want them to move the tiller.

MR. BAILLIE: Sorry to add something else, but that suggests of course absolutely no wind in the test environment.

MR. STOCKING: To run it that way would be nice.

MR. BAILLIE: Otherwise you won't get constant rate.

MR. BOOTHE: Stuart [Willmott], everybody knows that flight test people work at dawn. Isn't that right?

MR. WILLMOTT: And on the side of a runway which has a nice angle--

MR. BOOTHE: Let's not take the common sense approach. Okay, can we move on to takeoff?

The first test in takeoff is ground acceleration, and to my recollection this is something that would have to be done for airplane certification, is it not?

MR. BAKER: It is, but how do you get access to the data?

MR. BOOTHE: Well, good point. Is a TIR in public domain?

MR. BAKER: No, not necessarily. It depends on the manufacturer. He can make you come through an FOIA, and if you request things and if he claims it's company proprietary data, you can't get it.

MR. STOCKING: I have been turned down flat.

MR. BAKER: Unless you have some ability to work with the particular company that built the airplane, it would not necessarily be available.

MR. WILLMOTT: What could the Regional Aircraft Association do about that?

MR. BAKER: I would think they could help.

MR. WILLMOTT: The people that buy the airplane have got the hammer, presumably, to get that information.

MR. BAKER: To me it would benefit the manufacturers. You are talking foreign manufacturers and a lot of different organizations.

MR. LONGRIDGE: Most of the foreign--most of the commuters are employing aircraft that are manufactured overseas. That's a problem. They could do a lot better job than they are, they need to coordinate their efforts.

MR. BAKER: Your original statement is correct, the data is available. Whether it's accessible is the question. It would be highly desirable, and I think to the manufacturers' benefit, to provide this data. How you convince them to do that--

MR. BAILLIE: From the other point of view, if you already have a ground speed system for doing the turn rate, this is a trivial test.

MR. BOOTHE: Yes, it's not our intent here to say this is the only way you can do it. We are trying to find a way that might be the least costly and using readily available data. But that's not to say you couldn't collect that data, particularly if you are instrumented for other purposes and want to do it that way.

MR. BAILLIE: I was just saying we have made that instrumentation requirement already.

MR. BOOTHE: Yes.

MR. DAVIS: Not necessarily. With a steady turn and time you can calculate ground speed, so if that was your option on the yaw rates.

MR. SCHUELER: The instrumentation for low speed, high speed, are maybe completely different depending on how that's done.

MR. KOHLMAN: We also have a number of points with a strap-down inertial system, i.e., accelerometers. For the takeoff run we have the data directly measured.

MR. BOOTHE: That brings up a good point. You notice in the right-hand column there are three points with a double asterisk. What that double asterisk turns out meaning, if you look at the bottom of the chart, hopefully it's still there, is that we needed some inertial data acquisition system anyway for those points.

But again, I was trying to minimize those tests on which that double asterisk might show up. I think in this whole context if you have to have it there and you choose to collect more than those minimum number of tests, that's strictly up to the person doing the test. But if the data is available from some other source, then we can just skip that measurement and that would be the least costly solution, I think.

But Gerry's [Baker] point, how you get it, is a tough one, and I don't know quite how to address that. But I do believe it is to the airplane manufacturer's benefit to provide some of that data, but I think many of them look at it as a liability issue rather than a support the industry issue.

MR. BAKER: I think quite often engineering people agree with you, it's the lawyers on the staff that won't release the data.

MR. SMITH: But Dave [Kohlman], that acceleration you measure, isn't that fairly accurate to just take acceleration, integrate that for speed and distance? That's how the airplane gets speed and distance.

MR. KOHLMAN: Acceleration and speed.

MR. SMITH: And you get it on a normal takeoff, it's not an additional test, is it?

MR. KOHLMAN: That's right.

MR. HEFFLEY: The one thing that doesn't fall out is the wind.

MR. SMITH: We assume--well, you are right. Yes--well, but that gives you true ground speed, though the wind is not a problem.

MR. HEFFLEY: The wind will have an effect on the ground acceleration.

MR. SMITH: It will have an effect on the performance of the airplane.

MR. KOHLMAN: The acceleration will be a function of air speed. You do need to know the wind.

MR. SMITH: You need to know that for takeoff, don't you?

MR. STOCKING: Stu [Willmott] *(sitting beside him)* just raised a point, too, we have always talked about the flight manual, if it's acceptable to use distance to 35 feet or 50 feet, whatever is in the flight manual, you are talking about now using the flight manual as the data source as well.

MR. BOOTHE:. All right, what does that do to it, Gerry [Baker]? How much is a flight manual factored or how much fudge factor is in it?

MR. BAKER: Nothing on takeoff. You have got some--of course you don't know a lot of flight manuals--what you have got? You don't know whether it's accel stop or accel go. You have no idea. Some of them are not balanced, some of them are balanced. Some of them just publish a set of data, period. You could assume it's balanced, that is you can assume you would be accel stopping, and I mean that's the legal distance you have to have to take off, either way you go, but there are factors involved on an accel stop, they vary dramatically.

MR. BOOTHE: But if one knew the certification basis of the airplane and had available an AFM, could you then derive the correct value or is that--

MR. BAKER: I don't know why you couldn't use the data, you would have to leave it up to the aero types mostly, but you say you know what speed you have got, you know the distances required, I'm not sure why you couldn't match it that way.

MR. SMITH: Isn't most flight manual data computed and it's mostly used--it's a guaranteed number.

MR. BAKER: It represents a minimum thrust engine.

MR. SMITH: It's going to do better than that.

MR. BAKER: Takeoff performance represents a minimum thrust. The V_{MC} represents a maximum thrust, so you flip-flop there.

MR. BOOTHE: If we match the thrust.

MR. BAKER: To me I don't know why it wouldn't match.

MR. BAILLIE: How do you know what the thrust is?

MR. WILLMOTT: Usually for minimum engine thrust they take two percent off.

MR. BAILLIE: Can you get the manufacturers to say that that data is for N percent off?

MR. WILLMOTT: Where is that hidden? Sometimes there are statements in the flight manuals, sometimes you can get it from the manufacturer. Actually what I'm saying is for the jet and not a prop.

MR. BAKER: Now turbo prop engines, that's true, most of them do have a minimum takeoff torque requirement in the flight manuals that you have to match for takeoff.

MR. LEISTER: The problem with that is when you get down to V_{MCG} and tests like that, you are going to get a mismatch, because the airplane are going to be different than the hand held.

MR. HEFFLEY: From a practical standpoint, if you don't know the conditions of your data source coming from a flight manual and you don't know exactly what those flight conditions are, you are creating all kinds of work for yourself. In the end it's better to get your own and know what the conditions were.

MR. NEVILLE: Is there any reason you couldn't combine, this is what we have done at Boeing, is combine the ground acceleration test with the normal takeoff. They are really the same thing, normal takeoff is required from brake release to 200 feet. It includes a takeoff acceleration. Now you have consistency, it's the same test, you don't have to worry about different thrust.

MR. BOOTHE: I don't see why you couldn't. People do that anyway, and they take a segment of the takeoff and call it ground acceleration, so right where you were, are you suggesting maybe we only need one test, we don't need ground acceleration, all we need is takeoff?

MR. NEVILLE: You could show it as two separate segments. It would be the same test.

MR. BOOTHE: We still want to show acceleration up to rotation, so we would have to segment it. But it is the same data.

MR. NEVILLE: Right.

MR. BOOTHE: I agree with that.

MR. HEFFLEY: Question. On this ground acceleration, I guess I have always assumed that the thing that's of interest here is the acceleration profile as much as just the time to arrive at a particular speed.

MR. BOOTHE: Time and distance. But that doesn't really address the profile properly; right? Some people take it upon themselves to match the profile, certainly that's acceptable but I think the Advisory Circular just says the time and distance.

MR. KOHLMAN: I was just going to say that that's the only thing the pilot can sense again in the simulator, is time and distance. Because even in the motion simulator, you can't give him an acceleration cue that is real life. You have to wash out the accelerations or you get longitudinal acceleration by tilting, then you lose normal acceleration. So time and distance really is, to me, the most appropriate thing to match.

MR. BOOTHE: That's what I think the Advisory Circular asks for, I ought to have the Advisory Circular handy.

MR. SMITH: I am going to check. I think it says time and distance data is required unless specifically a snapshot is specified or noted.

MR. KOHLMAN: To answer your first question, Ed [Boothe], we have typically reported all of the accelerations in addition to air speed and sometimes wheel rate.

MR. BOOTHE: You have to install a sensor on the wheel.

MR. KOHLMAN: Yes. If there is an autobrake system on there, then you have a signal that you tap.

MR. BOOTHE: This leaves lots of possibilities here. It sounds like the type inspection report is not one of the better ones only because of availability, but if the manufacturer is willing to share that data, then I think the TIR would be first choice. Because you would know the conditions, you would be able to have an audit trail for the whole flight test procedure, and that data would be readily available.

But if that information is not shared, then we have alternatives such as if you have got--if you have got to have an inertial measurement system for other purposes, then you might as well use it here, in fact could one not use some sort of a GPS for this, short of having a strap-down inertial system? All of those should be acceptable, but are they cheaper than what we are doing now?

MR. BAILLIE: They are the same as what we are doing now.

MR. BOOTHE: They are the same.

MR. BAILLIE: We haven't reduced anything yet.

MR. BOOTHE: You don't make this sound very encouraging. What about this idea of using a stopwatch and markers? Can we get good enough doing that?

MR. WILLMOTT: If you do a full power then brake release so you know what your power is.

MR. BOOTHE: Oh, yes.

MR. KOHLMAN: That may not be possible. The test I just did on Monday with the Lear jet, we tried to do a full power chop standing on the ground, we couldn't get there because it started skidding over the ground.

MR. BOOTHE: Then you ask the question, does it need to be full power? We are trying to match acceleration with some thrust. As long as we match the simulator to the test condition, does it have to be a full power? I don't want to do it at 50 percent power.

MR. STOCKING: You can do it just after brake release, take it from point to point.

MR. BAKER: How do you account for all of the wide conditions, again I'm the novice on simulators, but how do you account for the high altitude conditions, the hot day conditions, without having access to thrust? I don't see how you can ever get there.

MR. BOOTHE: There are engine thrust decks normally used in simulators, quite often--some of you programming folks can help me out here, they come from the engine manufacturer and from there one is dependent upon your aerodynamic model and your atmospheric model to properly effect those.

MR. BAKER: You still have to have a thrust deck that measures that particular engine with the particular nozzle configuration. There are a lot of variables involved. Again I'm speaking of what's required for basic certification. I don't know how simulators have done that in the past for a variety of conditions. If you are checking ground acceleration, that's probably one condition, I don't know if you even specify ambient conditions or altitude or anything.

In aircraft certification you have to do a variety of weights and at least low altitude and high altitude to extrapolate the data, you are only allowed to extrapolate so many feet. Obviously you don't need the exact same data in a simulator, you are not truly taking off from an airport where you have an obstacle at the end, but I know simulators are quite frequently used like they are exact things, you know, we get in some courses, you are taking off at Denver on a hot day and you use every bit of the runway going out of Denver.

I have often wondered how realistic they are. I don't know how they are set up in terms of attempting to match data like fuel length, particularly for the nonstandard conditions.

MR. DAVIS: It's important to keep in mind this is just a spot check in the simulator. A lot of what you are talking about goes into building the simulator. The FAA can't run all the tests, there isn't enough time in the year. Again, this is a spot check, and certainly the simulator should be representative of all the things you have touched on and functionally they are checked.

MR. BAKER: I don't know how far it went.

MR. DAVIS: It goes far.

MR. BOOTHE: Stu [Willmott]?

MR. WILLMOTT: What I was going to say, I think you were talking jet when you were talking there. What we normally get from the engine manufacturer is a program that represents the engine in a steady state condition for any condition, temperature, pressure, and it also gives us the effects of power off deck for the engine accessories and for bleeding the different things, and what we normally do with that is exercise it and get what we call corrected engine curves that apply throughout the whole flight envelope of the aircraft.

When we are dealing with propeller aircraft, we also have to have power coefficient curves versus advanced ratio and blade angle, and torque coefficient curve versus blade angle and advanced ratio, which then integrates normally with the turbojet.

I haven't done a piston, I don't know if anybody knows how a piston is done, but normally that comes in the modeling side and it is modeled to cover any conceivable situation that a simulator can get into.

MR. BOOTHE: But as Tom [Davis] pointed out, the validation is pretty much a limited point validation in the flight envelope simply because of the number of possibilities. Based on the concept that if one has a complete and continuous model, then you should really be able to validate it at any point selected in the envelope and we just pick some points. I guess one could always say that in between we don't know what's going on, but I think that would show up in--I'm sure there are cases where simulators don't perform correctly in other points in the flight envelope because I think there you could find some history of simulators being designed to check validation points and the points in between are a little less rigorous.

We don't invite that sort of thing, but I know it has happened. But how far can you take a validation point?

MR. BAKER: For example, are there any validation requirements on field lengths in a simulator?

MR. BOOTHE: Yes.

MR. SMITH: How about rejected takeoff?

MR. BOOTHE: But rejected takeoff is the one that really addresses that.

MR. LEISTER: From my experience, the flight safety instructor gets in there and you do a lot of rejected takeoffs, you end up with a very solid model as far as that's concerned.

MR. SMITH: Actually along with what Gerry [Baker] was saying, international standards as well as [AC120-]40C draft incorporates some of those standards. The landing cases now are required to have three; medium, light and heavy weight landing, one of which is a flight test case, the other two can be manufacturers engineering simulator generated cases.

MR. BAKER: That's what I was leading to, though, do you really need that requirement for this category simulator? If it is, it appears to me that you are trying to train for pilot proficiency here more than anything else, not whether he is operating off the proper field length or this type of thing, if you kind of ignore the field length situation and zero in more on handling characteristics and ability to fly the airplane, I'm not--somehow you have to try to save some cost somewhere.

MR. BOOTHE: But if I could address again what I think is a typical line-oriented evaluation, then this very thing may apply. One would ask a pilot to consider proper takeoff calculations and to assure that he does have proper field length or to check that a runway is usable, are there prevailing conditions and airplane configurations and weights, and if that's part of the scenario, then you have to make sure that the simulator is not too far off, it can calculate a takeoff distance or a distance to, gee, I don't know what gets calculated, but if those distances are involved and whether or not one can use a runway or not use it, I think the simulator has to directly reflect takeoff within some reasonable tolerance.

MR. SMITH: But this test, if I might add, the test actually validates a lot--it validates the power, the power variation with speed, drag, coefficient of friction on the ground, it validates a lot of parameters of just the model integrity, so it doesn't really, you are not really just checking distance, per se.

MR. BOOTHE: Let me go back then to my simplistic approach. Is the most simple case we could use a stopwatch and accurate runway markers? Is that a fair way to say we could do this? A runway marker might be standing a person out there to observe.

MR. BAILLIE: Provided that you can characterize what thrust was set somehow.

MR. BOOTHE: Yes, that was sort of a given that I didn't address. But yes, you do need to be able to document the thrust. Otherwise it's a useless test.

MR. SMITH: Are you going to be able to accurately read markers along the runways?

MR. BOOTHE: Most runways these days have distance remaining markers. All we have to know is the approximate distance and work between a thousand foot increments to pin that down. But I think if you pin this down to a hundred feet or so, it's good enough for me.

MR. SMITH: I don't know if the model validation, if you have the strap-on inertial system, I don't see any point--

MR. BOOTHE: I agree with that, Hilton [Smith], but I'm trying to identify the least costly case regardless if you have the strap-down system, use it.

MR. HEFFLEY: Ed [Boothe]?

MR. BOOTHE: If you don't, let's look at the least costly ways here, is what I'm trying to get at.

MR. HEFFLEY: Along those lines, I think there is the case where you could have gone out, gathered all of your data, come back, developed your model, and decided you need a little bit more data. In which case you may want to go out with a minimal amount of instrumentation and just use a stopwatch and a runway marker. And in that case you want to be able to take advantage of that situation where you are just gathering some limited initial data.

MR. BOOTHE: Good point. In here I have said power settings hand-recorded, which would imply one would with brake lock set a power and go from there, if that happens to be torque on a turbo propeller airplane, then you want to hand record it. Again, the fact that you rigorously kept knee board records with the most simplistic measurement technique, I still think ground acceleration could be accurately done, I have not heard anything to contradict that, with a stopwatch and a relatively crude distance measuring system. Is there any objection to that?

MR. SMITH: I hate to be a dissenter, but from a validator's point of view I would feel more comfortable with acceleration rate.

MR. BOOTHE: I'm not too concerned about your comfort, I'm concerned whether you will accept that. I don't mean to be smart, that's what we are getting down to, what is the least costly that will suffice?

MR. STOCKING: Maybe we want to back up and look at this for a minute. We have a whole bunch of tests here and if you have to, for any one test, install accelerometers or some device in the cockpit for that test, in other words nothing else would apply, then you are setting a minimum instrumentation requirement which would be there for all of these tests. So we are dealing with individual tests when we may go back and look at what it is to satisfy the entire set.

MR. BOOTHE: I agree. I think Bob's [Heffley] point is valid there.

MR. HEFFLEY: You may have taken them out, you may have removed them, and you have to go back and get something. In that case, you want to be able to take advantage of minimal instrumentation. This is where you really do save money over having to reinstall your instrumentation package.

MR. STOCKING: When I first started looking at this I was saying gee, for each level of certification I would probably be looking at the minimum implementation, data collection implementation of some kind for each one of these. Each category would have a minimum rather than each of the tests within the standard.

MR. RAY: That's where I was going to go with my comment. You could inadvertently mislead or a person could misuse the words there because of what is stated later on in normal takeoff. You mislead, could potentially mislead the person, into thinking they need somebody standing by the side of the runway with a stopwatch. Normally on takeoff they omit that and try to work around that somehow. I think it makes more sense to use a piece of the normal takeoff. If you want to go back and validate that if you link the two together, as somebody suggested earlier--

MR. STOCKING: We have done that. We have actually used part of--

MR. RAY: If you want to validate that.

MR. BOOTHE: I'm not disputing that, I think to come up with an overall solution here I don't want to take the position oh, well, I have to have an inertial system for the other tests, I will use it for all of them, to me that violates the premise that I built this. If that's where we want to go, then we can go that way, but I don't think we will arrive at the least costly solution that way.

So my approach was to, how can I do this rigorously but the least costly way and if--oh, I know, I have got an inertial system I may need for some other takeoff, but I still think I need to address this test and say what's the cheapest way to do this test. Come to that solution, then if I end up doing it by using the inertial data system, that's okay, too. That's sort of the approach, if we don't want to go that way I don't think we are going to end up with any significant overall cost reduction.

Suppose I could get the takeoff data somewhere else but it didn't happen to include ground acceleration in the form I needed? So that's a thought to keep in mind, too. I do agree we have to look at the overall thing. But I don't know how to minimize cost without looking at each test.

MR. DAVIS: I have some concerns about the accuracy of what we proposed, I think it approaches the tolerances, 120 knot, half a second perhaps, I don't have a calculator, but I think you are approaching the tolerance on distance, I think it's a good method to get some data, get a more warm and fuzzy feeling for what you have. If that's the one piece of data, do you want to use that in the simulator? I don't know.

I think the inaccuracies are approaching the tolerance, that may be something to play with, I don't know.

MR. BOOTHE: If you guys say “Ed [Boothe], you are wrong, we need inertial system there,” that's what we will write down.

MR. BAILLIE: But the other question is, does a Level B have to be as accurate as Level D? And then that's in runway distance, do you have to match the Level D standard?

MR. SMITH: No. But you have--it's got to be the same--well, it has to match the airplane. Here again, I have to say I have to separate, it's a model validation test.

MR. BAILLIE: But how well does it have to match the airplane, I think is the crux of a lot of this.

MR. SMITH: It's one of the easier tests, of all the tests, to get accurate data.

MR. BAILLIE: If we establish on this easy test what sort of quality of model we are looking for, then perhaps when we get to the more difficult tests we won't have the same discussion over again.

MR. NEVILLE: That brings up a good point. I guess it's my understanding that the discussion here refers to the application of the Level B simulator to recurrent testing and a normal takeoff including the takeoff roll is something that an experienced pilot experiences every time he flies the real airplane. How important is it that the simulator match that extremely well?

MR. LONGRIDGE: It has to replicate the aircraft at least to the level that it's not going to interfere with the performance of a task which admittedly he already knows how to do. We are going through an entire scenario, the simulator has to be able to support all the tests from pushback to docking. If the performance of the simulator is such that his performance is unsatisfactory, we can't have a situation where that's going to be attributable simply to the capability of the simulator. Because this guy's license is on the line even though it's recurrent training every time he shows up.

MR. DAVIS: I think there is a lot of things that the simulator has to do that aren't tested objectively presently. A lot of system operations and stuff like that. I don't think anybody is saying it doesn't have to work. We want high quality data in the simulator, certainly the simulator has to be reasonable, regardless of whether there is a requirement there, to match within five percent or 200 feet.

MR. LONGRIDGE: That's the crux of the whole discussion; how do we define reasonable? Yes?

MR. HEFFLEY: Well, if it's a matter of tolerances, it's a matter of demonstrating that your test is good to certain tolerances, you can and you should always estimate what those tolerances are in any test. And even though you might use a very simple measurement method, you can still estimate what the goodness of that measurement is. And I think that if the bottom line is that we have got to demonstrate measurements to given goodness, then all we really need to know is the measurements of goodness for that test. And as part of the test you demonstrate the goodness of your measurement, whatever it is.

MR. KOHLMAN: I think another point is that we should be matching parameters that are the relevant parameters. Has anybody flunked a takeoff check because he rotated 300 feet further down the runway than the manual said, and is the instructor or the check pilot ever really comparing the lift-off distance to some other parameter? The important thing is rotation speed, lift-off speed, pitch attitude after takeoff, and climb rate. And I think we are focusing on the wrong parameters. Sure they have to be reasonable, but if we match the other things it will be reasonable.

MR. BOOTHE: It will be reasonable. Dave [Kohlman] is looking at the total package. If we could move on.

MS. BÜRKI-COHEN: The more hand-held measurements where actually a person goes and has a reaction time and takes measurements, the more important it is to think about how experienced the people who actually measure those things have to be. Especially when Paul [Ray] talks of the "me toos" of this world. And also what I'm wondering is how many measurements, because we have these hand-held instruments, we have the human reaction time, and how many measurements should we take? Do you think of taking just one measurement and that will be it? Maybe that's just by coincidence a time where the reaction time wasn't very good of the person who pressed the stopwatch. I think we should perhaps address that also, at least put in some caveats.

MR. BOOTHE: That's a good question for some of you folks who have been doing this. Don't limit yourself to one run unless you think you did a magic job on the first one.

MR. HEFFLEY: I think you expect to be challenged, possibly on a measurement, therefore you may really have to be able to describe how you achieve the certain quality of measurement. And maybe you do average three runs.

MR. BOOTHE: Maybe you do three and throw one out because you knew it was--go ahead.

MR. WILLMOTT: I was going to say a couple of things, one for you, Tom [Longridge]. We are halfway through item 3. And there are 54 tests here which is just the first part of the agenda in the discussions here. Do we want to continue on this? There are some things that I would like to say and I'm trying to discipline myself to minimize what I'm saying, so we can proceed.

MR. LONGRIDGE: I have a feeling that some of these items we are discussing now will apply across the board.

MR. WILLMOTT: The second thing, we are coming up with ways and means of getting data, like the stopwatch thing, and Bob [Heffley] has just hinted at it, somewhere along the way we have to come up with a procedure that's acceptable to the FAA for acquiring the simple data by which it can be approved by you.

I always remember a guy at [...] called [...], I don't know if Ed [Boothe] remembers him, but I remember him getting very irate one day when he was talking with the FAA--he was a pilot with [...]. And he said if he had a piece of data written down on a back of half an envelope that was good enough to program a simulator with. And I have forgotten who the FAA inspector was at the time, but he was in total disagreement with that. And, you know, the point is there has to be a way of acquiring that data that's acceptable to the FAA.

MR. LONGRIDGE: Yes.

MR. BOOTHE: That's a very good point. I would expect before an operator would undertake such a procedure as we are talking about, that he would prepare a flight test plan and coordinate it with the FAA before going out and spending money. I sort of left that as a given. But it's a good point to bring up because the worst thing one could do I think is go out, collect the data and then bring it in and say here is what we have done, take it. It also avoids Paul [Ray] and Hilton's [Smith] problems of the "me toos." I think if this ends up in a written permitted approach to simulator data acquisition, those things will have to be said very clearly, that it requires certain qualified personnel with the proper backgrounds and that a flight test plan must be presubmitted and agreed before the test would be acceptable. That's, I think, given to the process. We are just looking at the nitty-gritty here of how to do those things, but I think everybody should understand you have got to coordinate it ahead of time. So is there any reason to think otherwise?

MR. RAY: It's the assumptions that people make on what's needed. I have heard a story, I think it's reasonably accurate, that some who have never built a simulator believe all they have to do is get the data for Appendix 2 for a QTG without talking with the FAA. I am hoping sincerely that they succeed, I sincerely do, but my gut instinct is it might not work.

MR. WILLMOTT: They will go out of business very quickly.

MR. RAY: They may, I would hope not. But that's part of that front end assumption that we make and I refer to it as my motherhood statement, this is assuming that you go through, submit the flight test plan, get the interaction with us. To avoid the pitfalls of going down the wrong road so you come out the other end with data that nobody could use. That's part of the motherhood statement I keep referring to that would be embedded in part of this. To cover the assumptions.

MR. LONGRIDGE: I think your points are well taken. My bottom line as far as these two days, I want to get through these validation tables. Because that's going to establish what the FAA guidelines are with respect to the aerodynamic programming. We hope to finish that, too, that's something we recognize can continue to evolve on the part of industry whereas we have got to come out with whatever revised guidelines on the FAA side we are going to come out with. So that should be the focus of at least what we attempt to complete. And I think some of this preliminary philosophizing is important, I would hope that once we get through that we will proceed through the rest of these tables a bit more rapidly.

MR. BOOTHE: Can we move on to the next, 1.b.(2)? I didn't mean to impose my solution to 1.b.(1), but I didn't really hear any disagreement that that's a permissible least costly case. Realizing that rigor is important. Gerry [Baker] might confirm, I have done braking tests on airplanes for certification not much more sophisticated than this.

MR. BAKER: I've not done that on a Part 25 airplane.

MR. BOOTHE: [Part] 23 I mean.

Moving on to 1.b.(2), minimum control speed ground, an important number, but a number that's usually available in the airplane flight manual, again I don't know about that number in the flight manual, how good is it? It seems to me it ought to be pretty good since a good bit of the performance of the airplane is calculated based on that. And also it's an important number from a safety perspective, so is that good enough to take out of the airplane flight manual?

MR. DAVIS: It should be.

MR. BOOTHE: And then do simulator tests accordingly to validate that it's modeled to that same condition.

MR. BAKER: I don't know that all flight manuals tell the exact conditions it was determined under.

MR. BOOTHE: Yes, that's a problem.

MR. BAKER: What thrust conditions, again coming back to turbo props, most of those frankly will be flat rated.

MR. BOOTHE: I'm sorry, Gerry [Baker]--

MR. BAKER: Most of the turbo props are flat rated. Under these conditions you are going to be under some torque flat limit. It's probably a good assumption it should be--go to a flat limit, go to your test.

MR. BOOTHE: But to determine the conditions, I mean, for a Part 25 airplane this speed more or less determines a minimum V_1, does it not?

MR. BAKER: Correct.

MR. BOOTHE: So it's got to apply across the board to whatever takeoff condition I'm working with and it's of course not necessarily a constant but I would think it would have to be a pretty good number.

MR. BAKER: Oh, yes, it should be a good number.

MR. BOOTHE: If we were to simply take that from the airplane performance data that is furnished by the manufacturer, is that good enough?

MR. BAKER: I would hope you could go into the simulator as part of a validation test, put the conditions in, your critical conditions in, run the cut, run a full fuel cut there, too, it's not an idle cut but a full fuel cut here that you would not deviate more than the requirement in the regulations for that particular--keep in mind there is two different deviations, you have a 25 and 30 foot deviation, it should be equivalent to your dev cert. If I had a simulator that was more than that, I[’d] have a problem with the simulator.

MR. BOOTHE: Where about certification that deviates more than that, where it has been picked by the applicant based on his purposes and the deviation--

MR. BAKER: Some of them do that.

MR. BOOTHE: So then when we test the simulator we have got to know that, so it still should be a good number.

MR. BAKER: Should be.

MR. RAY: So I guess back to conditions again.

MR. BAKER: One of the most difficult things is accurately measuring deviation. And some manufacturers are starting to go to differential GPS now, it's proposed at least, correct? To measure that. We haven't seen it yet but it should work. On this airplane I would think estimates, you know, we have done a lot of V_{MCG} where you know the size of the concrete slabs on the runway and you can eyeball it pretty darn close. You are talking 14 foot slabs in a lot of airports.

MR. DAVIS: Based on some recent experiences I'm concerned about the FAA's view on just having a number for displacement. It seems that time history is an absolute requirement for displacement, I don't know if you want to comment on that.

MR. RAY: That gets back to the conditions Ed [Boothe] and I were side commenting here, know what the deviation is. We have two cases here, experience, where in the sim if you have it modeled that it deviates 30 feet or just inside 30 feet but in fact on the certification test it only deviated five feet or less. I would think it reasonable that whoever is presenting the sim acquire accurate data somewhere. It’s probably wrong to open to page 6.5 of the flight manual, come up with a number and assume it's 30 feet. You need to do the investigation backwards to the company, wherever, to find out whether in fact it was a 30 foot deviation or less.

MR. BAKER: I'm not sure you could go wrong if you are trying to cut costs again if you made an assumption that the airplane deviated the max. And even testing--

MR. RAY: That could be reasonable.

MR. BAKER: Somewhere you have to believe the cert data of the airplane. I believe the cert data more than I'm going to believe a bunch of so-called flight test people testing it. They did it under very controlled conditions, I've done back to back opposite direction V_{MCG}, it's a fact you have to be in almost zero wind conditions to get a good V_{MCG} validation.

I will tell you this, we ran into a simulator several years ago with one of the manufacturers here that the simulator on the original validation, another guy and myself tested it on an actual fuel cut, it took off in the boondocks, we backed it in, we said the maximum it could be was 25 feet. We set it on 25 feet, I don't really see anything wrong with that. And then do some cuts would make more sense to me than spending a lot of time trying to validate something. You have to keep in mind this was done under ideal conditions, it was computed for maximum thrust engine, it has a lot of variables. If you go out and test an airplane, you are not going to have that.

MR. RAY: Tom [Longridge] has a question in the back of his mind, I can see it gnawing away. I agree with Gerry [Baker], I think it is reasonable considering the level of simulation, if you up the ante to Level C or D, different ball game, now you are talking about zero flight time initial training as opposed to when a person is exposed to the airplane, to acquire training before certification.

MR. BAKER: Most manufacturers are going to take advantage of full deviation, get the lowest V_{MCG} they can. Now keep in mind some of these don't have V_{MCG}, commuter categories do not.

MR. BOOTHE: Let me just--Stuart [Willmott]?

MR. WILLMOTT: I'd like to point out a number of problems with using the flight manual V_{MCG}, we do that when we don't have anything else on our sims, but you normally don't know the weight, you normally don't know the CG, you normally don't know the temperature, some aircraft like the Lear 25, for instance, it would run at a temperature of minus 20 because it works out that's when you get the biggest thrust.

In the case of these propeller aircraft, there is one engine cut that's worse than the other engine cut, and you don't really know how much rudder the person has put in. The nominal value is 180 pounds pedal force, if that gives you a full rudder deflection, that's fine, if it doesn't you are not really sure. And then the other thing that has a really marked effect on deviation is the delay between the fuel chop and when the guy puts in the rudder pedal. And all of those things affect the deviation that you get in the simulator.

MR. BAKER: That's correct.

MR. BOOTHE: They all affect deviation you get in airplanes.

MR. BAKER: There is even more than that, because you said 180 pounds, some airplanes are 150 pounds, all Part 23 are 150, some Part 25 are 150 pounds. You don't know whether it was a force limited V_{MCG} or a control limited, you have no idea. On the airplane.

MR. WILLMOTT: The other thing, of course you can't take credit for the nosewheel, so the nosewheel is normally castering or in the air.

MR. BAKER: There is a lot of variables.

MR. RAY: Isn't that incumbent upon whoever presents that to the FAA for certification to know the answers to that? Is it reasonable to know all the answers to that when they come in with their data?

MR. WILLMOTT: We are getting into an area we have already gotten into twice before, if this is to be a totally viable program to come up with a cheaper way in which the regional airlines can get, you know, what will be simulators cheaper, it's obviously good if all of the aircraft manufacturers can support the whole program. By data like this. You know, it may be it's a team effort on the part of the regional airline operators, the aircraft manufacturers, and the FAA. It would be very, very good to get all of that data and I'm sure it's--that's a TIR type test and they have it in the type inspection report which would be very useful to have.

MR. BAKER: Again I go back to what I said. All these factors, the odds of someone going out and reproducing all these is pretty remote. I would just--I would rather see just pick, take the number and accept it. And put a deviation in. I think it would be reasonable. That's my opinion.

MR. RAY: If we go in later and test it, let's pick a number five knots or ten knots below that, I would expect to see a significantly larger deviation, if I chop it higher than that, it should vary appropriately. We have all seen poor simulations where an engine cut simply isn't representative.

MR. BAKER: I would rather see a larger deviation, personally, than something too small.

MR. RAY: At the correct speed.

MR. BAKER: Right.

MR. SMITH: Yes, you err on the side of being over.

MR. BAKER: On the training aspect. The fact of life is there will be larger deviations than the manufacturer because of wind effects and other effects that aren't taken into account. You know, in a crosswind V_{MCG} is going to be a lot higher than what's published in the flight manual, but you don't have to take that into account.

MR. BOOTHE: Taking Gerry's [Baker] advice, the first entry in 1.b.(2) accept, now if one can get a hold of a TIR, that's all the much better. But is there any objection to leaving that as written?

MR. DAVIS: I want to clarify one point if I may, because of the difficulty we have had in the past. The FAA is saying they don't require time history?

MR. RAY: For?

MR. DAVIS: Lateral deviation. This has been a sticky point.

MR. RAY: I beg to differ. On the [Levels] C and D, different story. We are talking about B and below. The C and Ds, your other response is absolutely correct. Time history.

MR. DAVIS: I'm speaking from experience.

MR. BOOTHE: Can we leave that one? Let's get Stewart Baillie in, Stewart follows lunch; is that all right?

MR. LONGRIDGE: We have sandwiches set up in the hallway just adjacent to this room. That hallway. You can bring them in here and eat. We will reconvene at 1:00.

(Lunch break taken.)

MR. LONGRIDGE: Let's continue now with the tables.

Let me just say tomorrow before we depart, we want to broach the issue and get the recommendations of this group about what the FAA might recommend to its own management with respect to perhaps what we might do, what changes we might make in the aircraft certification process that might better provide the kind of data we are looking for. So I just want to mention that we will revisit some of the broader issues, things that we can do besides what we are doing right now that would also help us to achieve our goals of more affordable simulation.

MR. BOOTHE: Before we continue, I have one administrative matter to cover. Somebody unnamed in this room said I would figure out how to reimburse you for the airline tickets. In order to get money to reimburse your airline ticket, I have to invoice to get the money. What I need to know is how much money. So tomorrow morning could everybody have their airline ticket receipts so we can make a copy of them and then I can go home, add all that up and submit an invoice for the money, so that I can then respond to you when you invoice me. Now there may be a bit of lag here, first order, while--

MR. KOHLMAN: What's the time constant?

MR. BOOTHE: I knew somebody would come up with that one. But the sooner I can get an invoice in to get this money the sooner I can respond to you. So if we can just collect those in the morning we will figure out a way to go get them all copied and I will take care of that. But I need to know how much money that is for. So we will collect those in the morning. Thanks. It could be about 60 days. Let's see, that means it could be 90 days before you get paid.

MR. WILLMOTT: That means you get 64 percent of it in 60 days.

MR. KOHLMAN: It will be forever before we get the last bit.

MR. SCHUELER: Notice they didn't tell you this before.

MR. BOOTHE: I wouldn't dare. Now that we have the engineering out of administration.

The next item in the table is still 1.b.(2), but it's an alternative to minimum control speed and it was Stewart's [Baillie] suggestion so perhaps I would ask him to go over it for us.

MR. BAILLIE: Sure. My approach was that we are not necessarily concerned about matching the data, we are concerned about training the pilot to do the appropriate action once he has recognized and diagnosed a situation in the aircraft. As our friends from certification have said, every time you do a V_{MCG} you can get a different number based on a lot of variables, so the actual matching of center line deviation doesn't tell you whether you have actually got a good dynamic model or not.

The important thing in my mind would be those things that the pilot would see in the engine failure on takeoff, large yaw rates, visually as well as vestibularly, lateral accelerations, and that sort of thing. And the other important thing to match is the required force on controls to get a reasonable behavior.

With that in mind, I would suggest rather than trying to do what's called V_{MCG}, which is a certification maneuver, we put the aircraft in a situation of high thrust asymmetric thrust while rolling down the runway, and match dynamics that are important to the training environment, the force to keep the aircraft close to the center line, so it is no longer a V_{MCG} test, it is a test of asymmetric thrust on takeoff. The dynamics of the build-up of asymmetric thrust would be significantly different if there was a fuel cut versus an autofeather failure, which is a prop mechanical failure of some sort, and whatever case we choose is not going to be the one that the pilot sees.

So in the interest of simplifying the test, throttle chops to idle are probably acceptable with the understanding that the engine model in the simulator has all of these other types of power loss. And time constants with those. So it's just a completely different approach rather than trying to match center line deviation V_{MCG}.

MR. BOOTHE: What about instrumentation?

MR. BAILLIE: Well, if you are going to match yaw rate, control input and lateral acceleration, that's it. And somehow documenting the throttle time history and speed. It's significantly different, it's significantly more onerous than a V_{MCG} test, but it points out V_{MCG} is not any guarantee of getting the dynamics right.

MR. SMITH: That sounds good. You could do several points. You could do a couple of below V_{MCG} and a couple above just to verify the model.

MR. WILLMOTT: I think that is similar to the tests that the FAA allows us to do for quite a few years when we have not been able to get data from the V_{MCG} test, it is called a low speed engine failure test. I think it's close to that, if I understand you.

MR. BAILLIE: The main difference is let's not worry about runway center line deviation, that's a fundamental part of all of this. Let's make sure we get the first half second or second of yaw rate correct. Because that's what the pilot picks up, that's what you want to recognize and diagnose.

MR. RAY: Stewart [Baillie], you were talking about the data that you have that you built into some models, would it be reasonable, with that data in hand to then, as Gerry [Baker] was pointing out, go in and simply do the V_{MCG} test and see if it's reasonable? Within 30 feet? On just a sim result compared to V_{MCG}?

MR. BAILLIE: But within 30 feet you could have completely wrong dynamics and match it within 30 feet.

MR. RAY: I'm asking is it reasonable, is it reasonable to do, as we have done with some of the older sims, is that a reasonable test to do on just the sim itself? We are talking about validation data.

MR. BAILLIE: I guess I would say it's necessary but not sufficient.

MR. DAVIS: I don't think it's unreasonable, but let's say you go on the airplane and do that, what's going to happen? The AFM says 108, you fail at 108, I don't know what you are going to get. You get all kind of things, depending on the ambient conditions, is it reasonable to do it in a simulator? I don't know. What's a reasonable result? I don't know.

MR. RAY: There is a paper on the issue which addresses the C-130. I apologize for not bringing the paper with me, I do have one back in the office. It was written by Lyle Shaefer, I believe, who I believe is the chief C-130 test pilot, it had to do with [the] C-130 V_{MCG} tests they did. Is anybody else aware of that paper?

MR. TOULA: Is that the one that crashed?

MR. RAY: [No.] They did 186 fuel cuts on a C-130, never logged one minute of flying time. The UK came up with the issue that V_{MCG} was 15 knots higher than Lockheed’s number. Setting aside a number of other issues in the paper, he went through and did an excellent job of describing the test, how they did it, the importance of the case of simulation, the correct modeling of loss of lift when the engine failed, when the wing dropped, keeping the wings level, everything being consistent, and proved the same speed time and time again.

I'm sorry I don't have a copy of it with me, excellent paper. But that airplane, because of its similarity to all prop driven aircraft, may help us in the instant case. I just wish I had the paper, I'm sorry, I will send one to anybody who wants to see it.

MR. BAILLIE: Dave [Kohlman] just asked me the question, why did he do it 180 times and to what level instrumentation did he have to get the same speed?

MR. RAY: A lot of those questions aren't in the paper. I wish I had all the data, it's just an excellent paper to read, to point out the difficulty with V_{MCG}, but properly done I think it repeatedly shows the same speed time and time again. The same weight, same speed.

MR. BAILLIE: I think the philosophy still has to be you are trying to train a pilot to initiate the proper behavior. And so you should cull out what are the significant events and try to match them rather than trying to match the whole maneuver to all of the conditions that are normally looked at.

MR. SCHUELER: I think that actually applies to more than Level B.

MR. BAILLIE: Yes.

MR. SCHUELER: C and D, the same comment applies. Matching just deviation is nice but that doesn't necessarily provide you the required--the benefit that you really want.

MR. RAY: I think it's a reasonable alternative as long as the end result is whatever is reasonable. When I do in fact cut at V_{MCG} and I have a Gerry Baker in the seat, do the maneuver, do a fuel cut, the results should come out reasonably the same as the aircraft.

MR. BAILLIE: What's the repeatability on center line deviation for a given certification program?

MR. BAKER: Probably five feet.

MR. BAILLIE: You are always within five feet?

MR. BAKER: If they are the same number, same speed every time, I don't know if there is a big variable, if the guy in the right seat hits the throttle when you are coming down a runway at a good pace, how fast you input. I mean you've got a lot of variables, it's not a matter of losing the airplane one time and not deviating at all. I have never seen anything to that extreme.

MR. WILLMOTT: One of the things I think we notice when looking at some of these results, is that at the time the engine fails, depending on who has done the test, he has the airplane actually pointing in and traveling in a useful direction. In other words, there is some variation in maximum deviation if you extrapolate the ground track that existed prior to the engine failure and use it as the datum, instead of the runway centerline. We have this situation right now on our Gulfstream IV job.

MR. BAKER: We just did V_{MCG} a couple weeks ago on a 35, I hadn't been in a 35 for five years, and we got the data pretty darn close. What would you say?

MR. SCHUELER: Five feet is a reasonable number. But--it's within the conditions, I mean.

MR. BAKER: We had ideal conditions.

MR. SCHUELER: Given the test conditions, it's a repeatable maneuver, but the conditions have to be defined and I think what you are trying to say more than anything else, and I agree with you, the tolerance requirement that's specified here does not seem to be the most logical or does not cover all of the information that you would like to get out of it. Maybe that's the basis for going to a requirement where a time history of lateral deviation is another way of saying that your yaw rate and control inputs have to be--that that's important. It's important how you got there, not just where you ended up.

MR. BAKER: I agree.

MR. SMITH: Because when you do the simulation just mathematically, if you have a time history and you've got the exact engine cut time and the rudder response, and now Tom [Davis] would agree, and you can match that thing pretty close, then what you have done, you have assured yourself you have the right response of the aircraft on engine cut, the right response to the rudder, therefore when the pilot goes in and he can cut the engine and kick the rudder within reason, within the same, you know, plus-minus four, five seconds or whatever, and actually then the math model will respond close to the airplane.

MR. HEFFLEY: I have a question here. Are we trying to set up the entry conditions or does the validation include not only the initial yawing moment, forces, but is it also a matter of matching the pilot input, too, so that we have to play the actual pilot input from the test into the math model? And then how far time-wise do you go at that point? It could be a very difficult thing to match if you have to, if you have to proceed very far time-wise into this maneuver.

MR. BOOTHE: If you have to match the control inputs, you are talking a closed loop case here.

MR. HEFFLEY: Yes.

MR. BOOTHE: It's pretty difficult, as we found out on some other tests.

MR. BAILLIE: The important thing is, it's less difficult if you don't worry about center line deviation, because runway center line deviation is two integrations further down the stream and a small error times two integrations is a huge error. I don't think the pilot really sees five feet of center line deviation so much as he sees the yaw rate.

MR. SMITH: No, that's not the point. The point is by just matching that, that's just a matter of validating the simulation. If you get that right, the yaw rate has to be close, perhaps it would be better--it would be good for somebody to do some tests to prove it might be a better verification of simulation to match yaw rate, I don't know.

Right, Ed [Boothe]?

MR. BOOTHE: Well, I have a couple of questions here. One with the V_{MCG}, I think by definition that's a fuel cut, is it not? V_{MCG} is a fuel cut? The engine is stopping somehow?

MR. BAKER: Let me clarify. If that's the critical failure.

MR. BOOTHE: Yes. Here we have rapid throttle reductions which would bring the engine to idle but would we get then the same dynamic response that we would get with fuel cut?

MR. BAILLIE: I put it back as do you need it.

MR. BOOTHE: Or do we get good enough substitution for validating a model? That's really what I'm after here.

MR. BAKER: That's a variable in itself. Depending on the engine, I think we touched on it earlier, depending on the failure, you know, it's a lot of fixed turbo props, it's more critical to put into idle than to fuel cut to get a bigger deviation, because of the way they set up the flight idle blade angles, you can get a lot more drag out of the situation.

MR. BOOTHE: So it may be a more critical case than actual engine failure?

MR. BAKER: Could be. Depends on the engine.

MR. BAILLIE: It's easy to do a chop and difficult to do a fuel cutoff that doesn't damage the engine.

MR. BOOTHE: The objective is to validate the model, so not just at single points but to validate the model so that across the board we feel we can support whatever training events are to be accomplished. And I don't have any problems with this as long as I still can get the correct response when an engine fails as per whatever reason an engine fails. Bob [Heffley]?

MR. HEFFLEY: I guess that I envision a problem here. I think I agree with this approach in terms of worrying about the basic response and inducing the right response in the pilot. What concerns me is having to match that with a closed loop pilot response into the math model. That gets nasty. What's important here, though, are the conditions just after this happens and the amount of control the pilot has to put in immediately following this.

But if you keep putting the pilot in a few more seconds down the line, then you get something really weird here. It's trying to reproduce a closed loop response, and that's an awful tough thing to do. You really want to take and extract the open loop part of this maneuver in this response. You want to worry about that initial second or so of response and show that the same amount of rudder and aerodynamic controls are being applied initially, but you don't want to follow that maneuver too far.

MR. KOHLMAN: All of our time history matches for simulators are the results of steps or doublets, then it's over with. Then you have an open loop response.

MR. HEFFLEY: That's right.

MR. KOHLMAN: It's fairly complex input and you are integrating an accelerometer twice, it's just going to lead to, I think, almost an impossible situation, and one that doesn't count as much as the initial two- or three-second response, which is what the pilot needs to make the proper reaction from a training standpoint.

MR. BOOTHE: Within the limits of staying on the runway, maybe the open loop for a second or two, whatever the pilot can tolerate, might be the thing to be measuring before he or she applies recovery controls. Then it's open loop and the rest is just recovery. We don't measure that.

Is that a reasonable alternative?

MR. KOHLMAN: I think it is.

MR. BOOTHE: It's not much time, but you get the initial response.

MR. KOHLMAN: I think it is. And the longer term closed loop response is what is checked by the pilot evaluation. If the long-term response doesn't recover or doesn't recover properly or goes into some kind of an oscillation, then we have a problem that has to be corrected. But we don't try to match it at the outset.

MR. BOOTHE: All right. Well, help me fix this up, Stuart [Willmott]. Oh, I'm sorry.

MR. WILLMOTT: The way we currently run what we call the low speed engine out, what do we call it, low speed engine inoperative ground speed control characteristic--I don't think it was you that came up with that name--when we didn't have a V_{MCG} test. We have tests which have been performed in the airplane, with the engine failure and often with the nosewheel working properly, the pilot puts in the appropriate response to that.

Sometimes we have center line deviations, sometimes we just have a comment from the pilot that the deviation is about ten foot, what we do in the simulator is just repeat that test and play back the rudder pedal and/or rudder surface input and usually stop the test as soon as you start coming back towards the runway center line.

MR. HEFFLEY: That's the idea. About how much time is the question.

MR. WILLMOTT: That's, I think, what they are doing.

MR. DAVIS: Is what you are saying not truly V_{MCG}? It is in terms of certification? No, it is not a true V_{MCG}, it is from my perspective V_{MCG} like.

MR. WILLMOTT: You can have, you know, what is it, 13 sims that have the test devices you described that were qualified back in '83. I'm sorry, '84, '85.

MR. BAILLIE: Do those include time history matches of things like yaw rate?

MR. WILLMOTT: Not yaw rate, but heading. Heading, some of them sideslip, but not all.

MR. BOOTHE: Is there a recommendation for an alteration for this language here?

MR. WILLMOTT: I'm not sure what the difference is between what Stewart [Baillie] is recommending and what is currently allowed, other than maybe you were going to get rid of runway center line deviation.

MR. BAILLIE: That was one of them. And concentrate on, make sure yaw rate is matched very good. But not concentrate on being away from the center line.

MR. SMITH: Somehow wouldn't we have to track that, know when to stop or just watch yaw rate?

MR. BAILLIE: What's that?

MR. SMITH: You want to stop when it starts cutting back, so you just--

MR. DAVIS: With this proposal do you see the engine out takeoff, as being a case you could present to show they are complying with this requirement, the yaw rate, rudder input, there has to be more to it than that. It has to be V_{MCG} plus five knots, we need to quantify what we are talking about a little more than matching yaw rate and center line deviation. We know he comes with a piece of data, he says yes, this is compliant with the requirement.

MR. NEVILLE: I don't think you can substitute the engine failure in V_1 for a V_{MCG} type maneuver. It's really a test of the airplane's response on the ground. For the engine-out takeoff, you fail the engine, you tend to rotate almost immediately.

MR. DAVIS: I agree. I want to clarify, we are still going to do V_{MCG} and do center line deviation--

MR. BOOTHE: I think what Stewart [Baillie] is recommending here is a yaw rate response to a thrust change.

That's pretty much all you are recommending, is it?

MR. NEVILLE: And the response to rudder control, too.

MR. BAILLIE: Yes.

MR. BOOTHE: But we wanted to get away from the closed loop of trying to input the control. We have to cover that someplace.

MR. WILLMOTT: Yes, but you are not going to have more than the tiniest fraction of a second of uncontrolled anything if you are cutting an engine close to V_{MCG}.

MR. BOOTHE: That's true. You are absolutely right. How do we get around that? Unless the requirement were to input full rudder. And then it would just be a matter of time rather than a matter of pilot manipulation of the control. That may not work either.

MR. HEFFLEY: I'd like to suggest something. That what you are looking for are the yawing moments and the build-up of those yawing moments with the engine cut. You would like to know what those quantities are in the absence of the pilot. You can't do that. So what would give you an answer to this is to look at the first one second or two seconds following this engine cut and ensure that there is a match, that is, some tolerance in the applied rudder versus the amount of yaw rate response that you get. You are just looking for that basic balance in terms of the applied pilot rudder versus the motion that you are getting from the aircraft. You are not looking for the long-term closed loop response because we know that gets complicated. You are looking for that first one to two seconds.

MR. BOOTHE: So if I were to do this, I would move a throttle to a lesser thrust position, perhaps idle, like you are suggesting doing it at several different thrusts, degradations, are you not?

MR. BAILLIE: I would say idle is the most important.

MR. BOOTHE: But let me say I reduce the throttle to idle stop, and what do I do, wait as long as I can stand it and then put full rudder? How would we do this?

MR. HEFFLEY: Let the pilot apply the appropriate amount of rudder to counter the yaw and record the net response by recording the rudder. Apply that, it should be approximately the same in the simulator to some given tolerance.

MR. BOOTHE: I agree with that, I'm just thinking about having to manually repeat this test in a simulator. Or even in an airplane.

MR. HEFFLEY: For the application of response in the simulator you generally play in the flight test input. If it's a step input, you play back the actual step from flight test into the simulator. In this case you would play back the actual application of rudder from flight into the simulator and that should closely balance the upset in yaw moment.

MR. BOOTHE: In an ordinary test, yes. But I'm thinking, too, of the permission for manual testing where somebody has to--the person has to make this input, then the repeatability is going to be quite different.

MR. HEFFLEY: But if you take it approximately as a step input--initially that's what we are looking at, a step input for all practical purposes--you are looking at about the same amount of rudder input to this power cut.

MR. STOCKING: We have run this as a constant heading test before where they didn't want to do it at the V_{MCG}. We did it at five knots above V_{MCG} and it was not an unexpected test, in other words he pulled the power off and he put in the rudder to maintain center line, then we played back both throttle and rudder to see how closely it maintained center line. That worked out quite well.

MR. HEFFLEY: It seems to me that gets the essential nature of what you are looking for here. It's a simple test.

MR. BAILLIE: That coupled with taxi response at high speed gets you the right answer.

MR. STOCKING: Yes.

MR. LONGRIDGE: Okay. Ready? Do we have what we need?

MR. BOOTHE: I think what you are telling me is leave it as is, as an alternative I would not want to remove the privilege of using V_{MC} ground because we use that throughout the whole range of simulators and if the person happens to have that, I think they could use it, but I think an alternative, published alternative is certainly acceptable.

Unless I hear objections, I really don't see why this wouldn't work. You guys see any reason?

MR. SCHUELER: As I understand it, the difference is what you would match. I mean, the procedure is really no different, it's a difference in whether you are going to match deviation or you are going to match rate and acceleration.

MR. BOOTHE: You are still looking at an ability to correct a rapid change with the same controls, so we are still looking at the ability to control the loss of thrust on one engine with the rudder, so whether or not you would do this with a nosewheel engaged or not is the next question we need to ask here.

MR. BAILLIE: I suppose it depends on what the operating procedure for the aircraft is. If he does a takeoff with--if he is allowed to do takeoff with a castering nosewheel, it becomes a valid maneuver to do this with a caster nosewheel. Whether it's a requirement or not is--

MR. BOOTHE: In that case we are not looking at rudder power, we are looking at nosewheel friction.

MR. BAKER: That's not a V_{MCG} test.

MR. BOOTHE: No. I would say we need to use rudder, and permit the rudder to correct the situation, because otherwise you are not going to know which is correct.

MR. BAILLIE: But if the response to the aircraft is significantly different with the castering nosewheel than a non-castering nosewheel, if the pilots are always doing a takeoff with a non-castering nosewheel you better get that one right, to heck with the castering nosewheel case.

MR. BOOTHE: But we also use these things to do takeoffs on runways that are less than standard friction. So we really need to have the rudder power tested here.

MR. BAKER: That's the reason for doing the test, contaminated runway conditions.

MR. BOOTHE: That's part of a training scenario. So if we want to validate the model to cover the entire training scenario, we have to look at the situations where the non-castering nosewheel would be happy to go sideways as well as forward. So I think we would have to adhere and the nosewheel would have to have at least castering to make it useful.

MR. NEVILLE: Another requirement for that is if you don't match a case where you have a normal non-castered nose gear, you don't know how to fix the model. You have the wrong yaw moment somewhere.

MR. BAILLIE: Right.

MR. BOOTHE: I will add caster nosewheel, but Chuck [Stocking]--

MR. STOCKING: You answered it.

MR. SMITH: I would like to mention a point. Academically it would be nice, and I don't know how we would do this, something like this, you know, come about. In the first couple of tests that were conducted to obtain data that we ask for center line deviation, but in order to correlate the center line deviation with yaw rate, even if we had to somehow or other do--that would be worthwhile data.

MR. RAY: With the cost dropping for GPS, is it a player?

MR. BAILLIE: If the aircraft has the installation already. Otherwise it is a major cost factor.

MR. RAY: To strap a--

MR. BAILLIE: To get an STC for the antenna. That's the cost. We just went through it for a Challenger CL-601.

MR. BOOTHE: In the experimental category you don't need STC.

MR. BAILLIE: You need an experimental test permit or something. But it's a big expense.

MR. BOOTHE: Big deal, yes.

MR. WILLMOTT: Two things, Ed [Boothe]. Sometimes the nose of the aircraft is pulled up in the air and off the ground before you do the engine cuts, so nosewheel castering or equivalent.

And secondly, I was going to mention a test that Boeing came up with on the 747 for checking V_{MCG}, and I don't know whether this is relevant here, but what they would do is take off with power on all the engines, start to take off with power on all engines and then pull the critical engines slowly back putting in rudder to compensate for it while it was under control, and sometime a little before V_{MCG} the engine would be cut and a small turn rate into the dead engine would result, but because it's accelerating that quickly passes and then you are turning back to the runway center line.

The point at which the turn rate goes to zero matched the V_{MCG} on the 747 in the early days. That was for the 100s. And that's a very simple way of doing the test in the simulator, very repeatable way, it matched the airplane V_{MCG} number. It's like a quasi steady yaw moment.

MR. BAILLIE: Perhaps.

MR. WILLMOTT: I don't know how people would feel about doing that test in an airplane to see if it was close to the actual recorded V_{MCG}.

MR. BAILLIE: Stuart's [Willmott] comment has opened this up a bit to point where we say the simulator company must demonstrate the yawing moment caused by asymmetric power and the yawing moment caused by rudder on the runway, but if they can come up with that test versus a V_{MCG} test, and if the FAA is involved in the acceptance of the plan before the data is collected, it should be immaterial just so long as the concept of the test is matched well with the actual procedure.

MR. RAY: I was thinking in the extreme you talk about C-130. Is the potential of doing a three engine takeoff, somewhat exactly what you described, to prove the rudder effectiveness on the ground with a castering nosewheel--can it be done in a number of ways other than a classic V_{MCG}? The answer is yes. The issue is to put forth your rationale for alternative testing before the testing is accomplished.

Coming up with one single line saying that's the only answer, that's like an ostrich sticking his head in the sand.

MR. BOOTHE: I think I would prefer to take the position of adding a statement similar to what you just said, simulator operator, applicant, must demonstrate yawing moment versus asymmetric thrust and rudder yawing moment required to compensate, and then just add that as--leave yours pretty much as it was as an alternative and we have got enough covered there to last us, I think, if that's acceptable.

I don't know how we are going to play this table out, but I will get those notes in. We spent a bunch of time on that one, but that's always a sticky one. The next one is sticky.

I don't want to cut that one off, but I think we have got enough input there to make a good case. Minimum unstick, as I understand, and I need to have Gerry's [Baker] and Daryl's [Schueler] help here, that's a required Part 25 test, I couldn't find anything in commuter category but yet it still seemed that some similar speed needs to be identified.

MR. BAKER: There is no V_{MU} required for Part 23.

MR. WILLMOTT: Do you do a minimum rotate test?

MR. BAKER: No. Part 23 commuter simply factored the speeds up to fairly high number that whoever in their wisdom generated that initially felt that that would suffice, and not having a V_{MU} or a V_{MCG}, so far it's proved successful, it's not been a real issue.

We have actually had one applicant who has a special condition that wanted to do a V_{MCG} on a commuter category airplane and actually lowered their takeoff runs by using a V_{MCG} and V_{MU}s. Which tells us it's pretty conservative what's in the rule right now.

MR. BOOTHE: Well, Gerry [Baker], what's going to happen to the commuter rule, is it going, will it stay or go on to [Part] 25?

MR. BAKER: The commuter rule will stay as a commuter rule. There won't be any commuters using it anymore, if they are used in scheduled passenger service.

MR. BOOTHE: So any user in a Part 21, any--

MR. BAKER: Any new airplane. Derivative airplanes can go on forever.

MR. BOOTHE: Has there ever been an airplane certified under 23 commuter category?

MR. BAKER: A lot. Beech, Beech 300, Beech 1900D.

MR. BOOTHE: Under the commuter rule, not one of the old appendices.

MR. BAKER: Yes. A couple versions of the Fairchild Metro and somebody else has one, Embraer or somebody.

MR. BOOTHE: So if they operate under Part 121, they can retain that certification under grandfather rights and press on?

MR. BAKER: Well, of all the airplanes I mentioned, the only Beech airplane would be the 1900D. The rest of them are not passenger hauling airplanes for scheduled passengers. 121 is only for scheduled passenger service over ten passengers.

MR. BOOTHE: What happens to the regional, is it just scheduled airplanes?

MR. TOULA: Scheduled, yes.

MR. BOOTHE: So that leaves us with a minimum unstick for Part 25 and nothing defined for commuter category. I guess the question is, then, that part but "a similar speed must be identified," you can scratch. I think I said that erroneously.

MR. BAKER: That was meaningless.

MR. BOOTHE: So we can scratch that. Again Stewart Baillie represented an alternative here which may, even if we don't apply to larger planes, we might apply to commuter category airplanes. Stewart [Baillie]?

MR. BAILLIE: I took the maneuver to try to demonstrate pitching authority on the runway. And so the primary case would just be an early rotate.

And perhaps--I see Stuart [Willmott] is disagreeing, what is the philosophy?

MR. WILLMOTT: We used to have both tests in the Advisory Circular. We used to have minimum rotate and minimum unstick. The minimum rotate is to check pitch and the minimum unstick is to check lift. It was felt in later revisions that the minimum unstick test also proved enough of the large pitching that we didn't really need to do the minimum rotate.

MR. BAILLIE: In general experience, when we are getting data other than for--from the manufacturers, we are not doing the V_{MU} because we are not getting tail contact.

MR. BAKER: That has nothing to do with it, you don't have to get tail contact for V_{MU}.

MR. BAILLIE: But we are not necessarily getting to the minimum unstick, we are getting lower than normal takeoff, lift-off speed, but we are not getting V_{MU}. And--

MR. BAKER: Depends on the definition of V_{MU}. There is two V_{MU}s.

MR. BAILLIE: The important thing here is not what the definition of V_{MU} is, but what are we trying to validate for this test? And pitching authority is one and lift is the other.

MR. WILLMOTT: And lift is the other. Unstick has always really been lift.

MR. LEISTER: Also with some aircraft, the Legacy 130 you have so much lift from the fans out there some pilots claim they can make an entire takeoff with the nose off ground. You may have to design some special tests for the specific type of aircraft.

MR. BOOTHE: What were you recommending, simply do a rotation at less than recommended to check the elevator authority?

MR. BAILLIE: And hold the pitch attitude till lift-off.

MR. BOOTHE: And hold till lift-off, which gives both conditions, the control power requirement as well as the lift requirement.

Wouldn't we have to be somewhat specific about that? How would we know what speed? As long as it's below V_R, is that good enough?

MR. BAILLIE: I would think so.

MR. BOOTHE: So would we say at a speed below V_R? Would we use full elevator? I would, but I don't know if you would.

MR. BAILLIE: Our pilots are typically pulling the column back to chest when the aircraft rotates [to] capture a pitch attitude and hold till lift-off.

MR. BOOTHE: They hold till lift-off and record--

MR. BAILLIE: We also, remember, have the second case, which is the normal takeoff, which is a normal rotate. So you have two points of rotation and two points of lift versus attitude on the runway.

MR. BOOTHE: One of the things we are doing here is putting ourselves in a position of measuring such things as when did we lift off. And I don't think I have accounted for that in any of the instrumentation requirements here.

MR. BAKER: That's not easy to do, either.

MR. BOOTHE: I guess we could always put--no, it's not--Gerry [Baker]?

MR. BAKER: That's one reason Part 23 did not instigate V_{MU}, because you have to go through a process of actually determining when the airplane is actually off the ground. There is a possible alternative solution you could use. And there is several ways you can do V_{MU}. And the Boeing airplanes traditionally use geometry limited V_{MU} type thing. Most light planes don't geometry limit but determine a V_{MU} based on lift-off attitude.

There is some guidance in FAA advisory material that talks about V_{MU}s for limited control airplanes and the biggest, what that amounts to is a lot of airplanes you cannot achieve a V_{MU} attitude at forward because you don't have adequate elevator, they allow you to use more stabilizer trim, or allow you to go to more forward CG to actually run the test.

Then you have to come back and show you can produce the required rotations at your normal rotate speed at forward CG at a speed of five knots less than required. It's possible you could just use a similar situation to that. Go to your--go in the airplane at a simulator at forward CG, most forward CG, and show you can rotate and achieve speeds or actually speeds minus five knots.

That is an alternate method you can use on the actual airplane. All you are really trying to do on most modern airplanes is show you can meet performance. It used to be a big factor. The comments were you will never get off the ground, you will drag forever. I don't think that's been a big problem for years now.

I have never seen anybody encounter the problem in most of the airplanes we are talking about.

MR. BOOTHE: What you are suggesting still measures elevator control power?

MR. BAKER: The ability to achieve scheduled takeoff numbers. I'm not sure how valuable that is to a simulator, I will be honest with you.

MR. BAILLIE: That's what I was going to ask. Is measurement of the distance to takeoff that important to the training environment? Could we do that with checking off the runway markers like we are doing for the ground acceleration?

MR. RAY: This particular test?

MR. BAILLIE: On this particular test. Or do we need--

MR. RAY: We never used distance.

MR. SCHUELER: Distance isn't a requirement.

MR. BAKER: Distance isn't a requirement.

MR. BAILLIE: Well, it isn't, but measuring takeoff time is, so it's effectively the same measurement.

MR. RAY: It's a separate test. The other test. It's not inherent with this particular test.

MR. KOHLMAN: This is just elevator authority, not the distance down the runway when you are lifting the nosewheel, seems to me.

MR. BAKER: That's correct.

MR. BAILLIE: But you are going to have a condition where the aircraft is at pitch attitude and lifting off the runway. You want to determine what speed the aircraft was at that point.

MR. SCHUELER: Speed, not distance.

MR. BAILLIE: Okay. Speed, not distance. Well, your question is, can you use another measure other than oleo deflection as the primary one to give you lift-off position? I don't have an answer here. I'm just raising the question.

But do--the other question is, do we have to match this to get the commuter recurrent training goal of takeoff performance?

MR. WILLMOTT: I think the original reasoning as to why that was in the Advisory Circular was that if a V_{MU} test is important for the aircraft, it should be for a simulator, too.

MR. BAILLIE: Why?

MR. WILLMOTT: To check that the lift simulation in ground effect is like the airplane.

MR. BAILLIE: If you want to do lift and ground effect there are other ways to do it as well.

MR. BOOTHE: So the subject I think has come around to do we need to do this?

MR. WILLMOTT: The other thing I was going to say, too, was almost every aircraft that I know has a squat switch which works from a deflection of the oleo, is there no way of just recording what that is? Whenever that--

MR. BAKER: It won't always tell you you are off the ground.

MR. WILLMOTT: Perhaps that's the nearest thing to tell you you are damn close.

MR. BAKER: I have seen them break and you roll another 500 feet down the runway.

MR. WILLMOTT: If that's all you have got, if you match that on a simulator--

MR. BAKER: I tell you better than that, use a radio altitude trace. I have seen that work. Take a radio altitude trace when the airplane starts flying.

MR. WILLMOTT: We used to do something similar to that with the minimum rotate where again it was hard to find when the nosewheel was off the ground. We used a pitch attitude of two degrees or something.

MR. BAKER: Let me read a couple of paragraphs out of the [Part] 25 Advisory Circular regarding a limited pitch control V_{MU} test. Something like this might work. It says, “one acceptable test technique is to hold full nose up control column as the airplane accelerates. As pitch attitude is achieved to establish the minimum lift speed, pitch control may be adjusted to prevent over-rotation,” which is typically what you would see, “but the lift-off attitude should be maintained as the airplane flies off the ground and out of ground effect.”

You use normal attitudes, resulting lift-off speeds do not affect AFM speed schedules. If the test proves successful and the resulting lift-off speed is at least five knots below the normally scheduled lift-off speed, that's a test that you, using starting full back the airplane starts rotating, you lift off, if it lifts off five knots less you are done.

MR. BOOTHE: Where does the five knots less come in?

MR. BAKER: That was a number that somebody created. A policy.

MR. BOOTHE: If I hold a normal takeoff attitude why would I get five knots less?

MR. BAKER: You have to back up. I didn't read it all. But it's just a number to give some pad, somebody came up with five knot pads that said the five knots provides leeway for a mistrim, CG errors and so forth.

MR. BOOTHE: So does this mean it really should be hold an attitude that would cause lift-off five knots prematurely?

MR. BAKER: No.

MR. BOOTHE: I guess I have to read the whole thing.

MR. BAKER: You have got to go back to how V_{MU} relates to your speed schedule. Your takeoff speed schedule is dictated on V_{MU}. It's a percentage. So they are related to each other by factoring. That's where it gets into the picture. So it's V_{MU} is not just a number that's done and thrown away your takeoff speed schedule--your V_{LOF} is based on V_{MU}. And one reason Boeing uses geometry limits is because they can get by with lower speeds by geometry limiting than you can by attitude number by about two percent.

MR. BOOTHE: I don't see anything wrong with using that procedure that's outlined in the Part 25 AC if we can do it with reasonable--what I get back to is lower cost, less instrumentation and I don't know whether we satisfy that requirement, I don't think so.

I see Daryl [Schueler] shaking his head no. But as far as the procedure is concerned, it sounds like a good one, that it would certainly be applicable and would address the V_{MU} for non-Part 25 airplanes, although call it by a different name.

MR. BAKER: The goal is make sure you can achieve rotate schedules. If you can meet the numbers, that's the bottom line. You don't--this is related to a pitch limited airplane, because what they allow this airplane to do is V_{MU} at some stabilizer position, now come back and validate it and make sure you can achieve those takeoff schedules, that's the bottom line it comes out to. And you don't get into any over-rotation issues.

MR. BOOTHE: For the simulator, when we compare it to that, there would be two goals. One that we demonstrate the same elevator power, so that we attain rotation at same speed, and further, then, that we lift off at the right speed so that it gets us both the elevator and the minimum C_L, I guess.

MR. BAKER: There are a lot of airplanes that have been certified that way, I can tell you that.

MR. BOOTHE: If there are airplanes certified that way it would make sense to try to do the simulator tests that way. The only problem you have is then how do we instrument to accomplish this? Does that put another double asterisk? I don't really think so.

What it means is we have to have something to measure when we lift off, that's what we are missing.

MR. BAKER: I think you could use radio altimeter.

You could try a squat switch, but they really have never worked for me.

MR. BOOTHE: I have heard stories like that myself.

MR. BAKER: You start trying those tests, you can extend the main struts--unless you had a nose strut, the main struts, you can get them fully extended and keep the wheels rolling a long time.

MR. HEFFLEY: There should be an acceleration at that point that's identifiable.

MR. BOOTHE: If installed, Bob [Heffley]. If you have that package in there, I would rather not require that.

Does this meet your scheme, Stewart [Baillie]?

MR. BAILLIE: It does, and you are right, we really don't have an improvement in instrumentation. We--our experience with trying to wire in for squat switches is that the aircraft in general has so much other electronics associated with their, you know what I mean, squat, that the signal is unusable. Oleos are easy but they are mechanically complicated.

MR. BOOTHE: How much lag is there in a radio altimeter? I don't know anything about those things.

MR. BAKER: Not much.

MR. BOOTHE: Is that sufficient accuracy?

MR. WILLMOTT: None. It just depends on how accurate, how you want to use it exactly, how accurately--

MR. BOOTHE: I want to use it when I lift off the ground, that's pretty precise.

MR. WILLMOTT: You probably won't be able to tell. It will be a real asymptotic type.

MR. BOOTHE: Maybe 19 guys looking at it, like this *(indicating)*.

MR. WILLMOTT: Some of them with magnifying glasses, too, Ed [Boothe].

MR. BAKER: The ones I have, ones I have seen are a pretty clean break.

MR. BOOTHE: I wouldn't rule it out.

MR. BAILLIE: It depends where the radio altimeter antenna is, too. If it's on the nose and you get any pitch rate at all--

MR. BAKER: The thing is--when you run these tests you are holding constant pitch, keep in mind. You are going to hold that pitch attitude.

MR. BOOTHE: It's a change we would be looking for.

MR. BAILLIE: How are we going to determine pitch attitude unless we have the inertial system on board?

MR. WILLMOTT: Hopefully we will be able to get this TIR test and the manufacture support--this is always a test that's done in the airplane.

MR. SMITH: Time history of pitch?

MR. STOCKING: If you have accelerometers you can have the same information. You don't have to have an--

MR. BAILLIE: You have accelerometers and rate gyros--

MR. KOHLMAN: If you have just a standard inertial box, you will have three gyros, three rate accelerometers and a vertical gyro. Isn't that what we have in--

MR. SCHUELER: That's what is typically referred to as inertial data independent of what the transducers are. Whether you apply inertial--

MR. BAILLIE: This would then be the first test that then needs an inertial system.

MR. BOOTHE: All right. So you are saying here that you need to add the requirement for inertial system, we can do the required test as in Part 25 for those airplanes that have complied with that and for which there is data available, we can do the test that is defined in the Advisory Circular for compliance with Part 23. Gerry [Baker]?

MR. BAKER: 25.

MR. BOOTHE: 25. So that applies to either large--

MR. BAKER: That is 25.

MR. BOOTHE: We can still do the same test for commuters.

MR. BAKER: I don't see the need for commuters.

MR. BOOTHE: You still have the need for elevator power.

MR. BAKER: Unless you want to do distance and power elevator, if that's what you want.

MR. BOOTHE: So I think with that combination of those two tests what we have done is actually increased the extra instrumentation requirement here, unless you know a way out.

MR. KOHLMAN: If you relax the resolution requirements you can read pitch off the artificial horizon.

MR. BOOTHE: If we are trying to maintain an attitude to match lift-off speed, I don't know, Dave [Kohlman].

MR. SMITH: It's a real critical parameter. As a matter of fact, I was going to say normally we have a one and one-half degree tolerance on pitch, again we don't worry about it on V_{MU} normally because you are geometry limited, so in some ways it matches the airplane, but here you may not want to allow one and a half degree tolerance, that would make a big difference.

And you have got tolerance, you will have tolerance on the V_{MU}.

MR. RAY: If you match input, the input ends up being attitude.

MR. SMITH: Whichever way you do it. If you match elevator--

MR. DAVIS: You just mentioned elevator. The present requirements explicitly state you have to use exact elevator to maintain the pitch. Do we have to measure that surface now?

MR. BOOTHE: What we would be doing, if I understand the test correctly, is using full elevator until the airplane rotates, or simulator, at which time you relax control input to match pitch attitude, which you hold constant till you lift off.

MR. DAVIS: Right.

MR. BOOTHE: I don't see there is any inconsistency there with having to measure the surface deflection, because once you have rotated, we have got the confirmation of elevator control power at full elevator. And I think once you relax the elevator to maintain pitch attitude, then we can measure how we would have measured it before. Is that not true?

MR. DAVIS: We measured it before by instrumenting that surface, that's what we are trying to get away from.

MR. BOOTHE: Before today, as we discussed this morning. By measuring pilot controller position and having a relationship then to the elevator, like we were talking about this morning. Now that may not be in the data package from the manufacturer if this is data we used from a manufacturer; but we are talking about if you have data from a manufacturer, then this discussion is really not germane, anyway.

MR. DAVIS: Still, so I'm clear, the requirements right now say that you must match elevator exactly. Your elevator must precisely match aircraft data. Are we sticking by that? Do we still have to measure that parameter if it's not readily available or forego that and maintain pitch attitude as required, whether it's 12 degrees or whatever?

MR. LEISTER: That's pilot input.

MR. WILLMOTT: For Level B you were suggesting earlier on, that we do not use surface.

MR. LEISTER: That's pilot input.

MR. BAILLIE: Do you need to match the pilot input at this point?

MR. HEFFLEY: No.

MR. DAVIS: I'm just saying it's on the books right now.

MR. BAILLIE: Ground effect elsewhere, in this case you may just want to match aircraft attitude and rotation given full elevator on the takeoff roll. So you don't care about pilot input for this test.

MR. LEISTER: I think you do, too, the elevator power is very nonlinear in that area. And by matching pilot input for V_{MU} and then for normal takeoff will cover that.

MR. HEFFLEY: Where you are interested in elevator power is where you have full aft elevator. At that point when you release full aft elevator and go to constant attitude, elevator doesn't have very much to do with where you lift off.

MR. LEISTER: Yes, it will.

MR. HEFFLEY: Well, within the tolerance of the model here, what really matters here at that point is pitch attitude.

MR. LEISTER: The elevator power is different in that area.

MR. BAKER: The way this is going to happen, the elevator will make a lot of difference because what you are going to find at forward CG, this thing is going to--you are going to be full aft elevator about the time you come up to the speed you are going, you are supposed to rotate, you are going to go forward to hold attitude, if you don't have the elevator for the right speed you are going to go through. Keep in mind you don't have an over-abundance of elevator here. You are not going to pop the nose off at 35 knots of most of these airplanes. I have seen some airplanes go to 140 knots before they lift off.

MR. BOOTHE: So elevator is important or some measure of longitudinal control.

MR. BAKER: Unless you have an exceptional airplane that's overloaded with elevator power.

MR. WILLMOTT: From the standpoint of the next phase of discussion, math models having an elevator time history is very, very useful, but for this particular thing it's not. You can get the minimum rotate speed matching because there is a variety of pitching moments involved.

One of them is the elevator, but the other one is also very important because it's a very low speed, is the pitch from the engines. And as you proceed to a higher speed than that, what happens to the pitch due to the engine is indicated to quite an extent by what happens to the elevator as you are proceeding higher up in speed.

So I don't think it's necessarily required for this test, but, you know, if we discuss later on what we really would like to have for the purposes of modeling that helps us in determining the pitch due to the engines at very low speeds which isn't checked anywhere else--

MR. SMITH: There's also ground effect on elevator effectiveness.

MR. WILLMOTT: It's a very complicated area, pitch due to basic airplane, pitch due to ground effect, pitch due to the engines--

MR. BOOTHE: What I hear--

MR. WILLMOTT: --and engine pitch particularly changes quite a lot of very low speeds.

MR. BOOTHE: What I hear you saying and disagreeing with yourself, is we need to measure something that correlates elevator effectiveness.

MR. WILLMOTT: What I said for this phase of our discussion, the validation data, you don't really need it. But when you get to our next phase of discussion, which is modeling, I think you do need it.

MR. LEISTER: You do, I don't. I can deal with that.

MR. BAILLIE: Ed [Boothe]?

MR. BOOTHE: Yes, sir.

MR. BAILLIE: I have one other comment.

Gerry [Baker] brought up a remark which makes a big difference, which is center of gravity and weight of the aircraft. We have yet to say whether we are going to require these at a variety of center of gravities or one, a variety of weights or one. And one consideration is that every commuter driver can take his own aircraft, fly it at a nominal CG, nominal weight in after hours non-revenue time and do these tests. So the simulator to meet what the guy does in the actual aircraft doesn't necessarily need the worst CG and the worst weight, given though it would be better to have the critical condition in each case.

MR. BOOTHE: Well, yes, I hear you.

MR. BAILLIE: It costs.

MR. BOOTHE: It does, but I think that that's one place I think we have not done a good job in training. We go out and train in simulators as though they were airplanes, so we use a training configuration, so when people train in airplanes they have medium weight and a mid CG, but I think to do that training in simulators we are missing the boat. We ought to be training more critical conditions that people encounter on heavy weight takeoffs and those kind of operational environments.

Why don't we use the simulator to really duplicate the operational environment? If we are going to do that, I mean go out and train in a simulator at mid CG and light weight, and then you tell me to take off in a 7--let me get back down to small airplanes. At maximum gross weight and perhaps an extreme CG with a full load of people, it's not typical of what I just did in the simulator. We need to look at some more critical airplane configurations and loading here. So I don't think we should just do everything at mid CG.

MR. BAILLIE: The important thing is not doing it at mid CG and nominal weight adds cost. That cost is probably well worth it if there's training and then the trainee uses it. But to add the cost and have training regulations not require critical configurations is a waste of money.

MR. BOOTHE: Tom [Toula] can take care of that.

MR. TOULA: This Tom.

MR. LONGRIDGE: We already do that in AQP, we actually specify the conditions to a much greater level of detail--winds, contaminated runways, all these things are spelled out in the qualification standards for a given approved AQP program. It will be aircraft specific.

MR. RAY: Ed's [Boothe] comment is absolutely right on target with what happens in the training world versus real world. There is the old story, I don't know if anyone heard it. The old pilot was being trained at 2:00 in the morning with light loads and full power takeoffs, and the airplane naturally jumps off the ground and accelerates. To compensate for the pitch forces, he starts running in nose down trim before takeoff.

MR. BOOTHE: You can tell where he is from.

MR. RAY: Run in a number of units of forward trim to avoid forces after lift off. Nobody caught what he was doing, he went out on the line, nothing abnormal. He finally gets heavy weight forward CG takeoff. Guess what he did? Same technique. He wanted to again avoid the anticipated forces after takeoff. Fortunately the copilot happened to notice what he had done. The copilot ran the trim back out when the aircraft wouldn't rotate and finally lifted off at the runway end. The story simply supports training at extreme CGs, absolutely right.

MR. BOOTHE: I more or less arrived at the opinion we need a measure of elevator input, direct or indirect to make this a useful test. If you really strongly disagree with that, I'm subject to being persuaded, but from all I've heard it sounds to me if we don't have some measure of longitudinal control input we are missing half the test.

MR. HEFFLEY: Ed [Boothe]? Aren't we trying to do two things here. We are trying first of all to validate that there is the right amount of pitch attitude control and the right amount of elevator power, if you will, for a given air speed. And the second thing is that there is the right amount of lift for a given attitude and air speed.

And they are two separate things, they both can be considered separately and they can both be considered at two different air speeds, in fact two different tests. One is driving down the runway at full aft elevator to measure where you start to get elevator effectiveness, i.e., some pitching motion. And number two, you are trying to measure where you achieve enough lift to fly, and that's most easily done at a constant pitch attitude, which represents a constant angle of attack as you are rolling along the ground.

Why does this have to be done as some sort of dynamic maneuver other than to just vary the air speed enough to measure your pitching moment and your lift at two convenient conditions? I mean, it's--we keep coming back to the minimum unstick label for this, but that's a certification maneuver and we are trying to validate simulator characteristics here.

MR. BOOTHE: So you are saying we could do two pieces, one at low speed and the other--

MR. HEFFLEY: We have two different characteristics we want to keep separate in the simulator, the simulator has a valid elevator control power and the simulator has a valid amount of lift in ground effect at a given angle of attack. Two separate points, and we--you can probably get those two separate points in the various ways.

MR. BOOTHE: They don't care what the elevator is at that second point, the lift-off point?

MR. HEFFLEY: No. Not especially, it's not--it's going to be the small stuff in your simulator math model, it could vary quite a bit and it's not going to change that answer of whether the thing starts flying very much. The amount of elevator contribution to lift is not--is not huge.

MR. BOOTHE: Especially when the wheels are on the ground.

MR. NEVILLE: I guess a question I have is how much does this alternate test V_{MU} or equivalent V_{MU} add to the normal takeoff? Normal takeoff tests pitching moment due to elevator, it certainly tests lift if you match the time history. It has to lift off at the same speed and so on. What additional information do you really get from a V_{MU}? Is it necessary for a Level B simulator?

MR. BOOTHE: So you are saying really all we need to do is something to measure elevator effectiveness at low speed, or are you saying that?

MR. NEVILLE: Just a normal takeoff.

MR. BOOTHE: Because normal takeoff normally doesn't apply elevator until V_R, slightly before.

MR. BAKER: I understand what he is saying. I think he has a point. It was mentioned earlier V_{MU} is a certification issue, the pilot never sees the V_{MU}. It's--and the important thing is you can--that's the purpose of that test, that you can rotate, you can meet your performance numbers.

In a simulator, I think there is some truth to that, you are not trying to be a test pilot, you are trying to show that you have adequate elevator authority to rotate at the proper speeds and lift off at proper speeds. I think that's all you are trying to do. At the most extreme CG, though, you have to go to a forward CG to validate that, obviously.

MR. KOHLMAN: I think that adds to inflight measure of elevator power, which will certainly be done is what Stewart [Baillie] was saying. You get an in ground effect at high power.

MR. SMITH: You get full elevator, it's not linear for normal takeoff, you don't get in the linear range necessarily at V_{MU}, you are at the limit.

MR. NEVILLE: Maybe you need a minimum nosewheel lift-off, which used to be a requirement and went away. It's a very simple test to perform, if you need an additional test, it's at lower speed, requires full elevator.

MR. RAY: It appears to be one of those where if you have classic V_{MU} data, that's acceptable. As an alternative, what I heard Gerry [Baker] say seems like a reasonable test of a number of items. It fits right in.

MR. BAKER: Pretty close to what he is saying.

MR. SMITH: Covers both areas.

MR. BAKER: Not much difference.

MR. RAY: It's a fairly mundane test to do.

MR. BOOTHE: All right. I think we beat this to death. I still don't know whether to measure elevator deflection or not. Where I have it is we either do a V_{MU}, because that's what was done in the airplane for Part 25 airplanes and that measures the things we need to measure; or we do the tests Gerry [Baker] described, which we can get a hold of the Advisory Circular or refer to the Advisory Circular for that.

So the only other remaining question I have is do we need to measure directly or indirectly the elevator input in a continuous fashion or do we just need to measure pitch attitude and lift-off speed? That's the question I need answered.

MR. WILLMOTT: If you want the opinion from me, I would say no. And the reason--

MR. BOOTHE: No what?

MR. WILLMOTT: We do not use elevator time history. For the normal takeoff you will have, I guess, control column, because we are replacing that by elevator for a normal takeoff with a lower value of elevator. That will enable you to check that the pitch is correct in that condition. You don't need this continual time history.

MR. BOOTHE: I will scratch elevator deflection here and we will defer that to normal takeoff.

MR. BAKER: Let me ask, I would assume when you go out and you conduct tests on these airplanes, that you do validate that the elevator is correct, don't you? I would hope so, we wouldn't go through a certification process without assuring the airplane is in conformity.

MR. WILLMOTT: The basic reading.

MR. BAKER: Yes. The airplane you are flying. I hope you don't pull the airplane off the line and validate the test.

MR. BOOTHE: I think that's been done, Gerry [Baker], but it gave us some problems.

MR. BAKER: You have critical stabilizer angles, you have critical elevator angles, you have to be at least at the critical tolerance as a minimum. For stall recovery you want the least nose down elevator. For stall speeds, you want the least nose up, I don't think you need to go that far but you at least need to be within nominal tolerances on all surfaces of the airframe.

MR. BOOTHE: I firmly agree, any airplane that's going to be used for testing, to acquire data for simulator validation, certainly needs itself to be validated before one begins gathering data, otherwise you are just measuring garbage.

MR. BAKER: It's not unusual to get an airplane off the line--

MR. BOOTHE: I'm going to leave that one. I thought that was going to be an easy one. And we may revisit as things go on.

Let's go on to normal takeoff. Really I don't see any difference there except what we are really doing now, although Dave Kohlman planted some words on us about reconstructing flight paths, I'm not quite sure what that means, but the thing that I have really changed here is not measuring angle of attack as we currently do in--across the board, according to the Advisory Circular. Otherwise I don't see how to do that without strap-down instrumentation.

There are some things you could do, video of the airplane instruments, but you could probably get by with that for takeoff because it's not really a--it's not steady state, but it's not really a quickly varying situation.

But since you have to have an inertial system anyway, I don't see a whole lot of difference from where we are from all simulators or how to do better than that, so I think your input--

MR. HEFFLEY: I have a question. In this particular case, suppose someone proposed to measure flight path and attitude from an external video and did the appropriate reconstruction of flight path from looking at the aircraft externally and avoided instrumentation of anything.

MR. DAVIS: I think you could get certain things that way, but there is other information you can't measure, like the control force or something, and how are you going to correlate this information off line? You may be able to get a good vertical speed or good altitude that way, but certain things, control forces as an example, you can't get that way.

You have to correlate it with these two, separately collected information, that may be a problem. Aside from the accuracy of that technique, which would be questionable.

MR. BOOTHE: Stewart [Baillie]?

MR. BAILLIE: I would think in any case the technique has to be put forward to the FAA, and you guys judge whether it's accurate or not.

MR. RAY: Before the fact?

MR. BAILLIE: Before the fact. As an example, we have done a certification program on a simulator where we did not measure angle of attack, and that was fully accepted. But before the fact we proved the technique was accurate enough. So I can come up with any other measure--

MR. BOOTHE: As long as you can prove it, I don't know why not.

MR. LEISTER: If we don't measure surface deflection, you need inertial system or some system to measure the pitch attitude, pitch heading and all those things, because you can't really derive a good model without surface deflection, if you don't have the other additional information, acceleration.

MR. BOOTHE: I have included that here.

MR. LEISTER: I know, I keep hearing, I think I keep hearing that maybe we won't have the inertial system on some tests but I think you have it strapped in on all the tests, really. So you do need all the attitudes and acceleration to derive a good model.

MR. BOOTHE: You know, I think it's reasonable to assume that if you have to put an inertial system in the airplane for those tests that require it, chances are very good you are going to use it for other tests. And that only makes good sense. So consequently, when building this table I have--could have just included it in all tests and we could all go home. But in the interest of trying to look at the minimum case, I chose to do it this way.

But if it were installed, I mean surely people would use it. But you could also consider the situation where maybe you had a partial data set, as Bob [Heffley] had mentioned earlier, and wanted to supplement it, in which case you may need not to do inertial measurements and do other tests by different means.

MR. LEISTER: But my memory was you were talking about attitudes--I built a simulator once using just video data reading pitch attitude and I don't ever want to do that again. It's not accurate, not a good way to do it.

MR. BOOTHE: I think, to answer Bob's [Heffley] question, I don't think it's something we ought to write in here, but I think that needs to be referred to these guys, but if you were to come forth in the plan that you would present prior to collecting data, here is how I plan to do it, here is what works, I think you would find that--

MR. HEFFLEY: One reason I ask that question is we have a case here in this normal takeoff where for the most part we are going to have validation of the math model in most all respects from other tests. And this is one of those tests that is kind of a, you know, it's--it lumps everything into it. It's more--I guess I'm not sure exactly what the real purpose is, what's unique about this one particular test that isn't covered by others. Other than it just represents a normal takeoff on this, you would like to see a normal takeoff being made in a simulator.

MR. BOOTHE: Good point.

MR. HEFFLEY: It's a closed loop maneuver of sorts. And it's a complex test.

MR. BOOTHE: If you don't have a means of automating the test you almost cannot accomplish it.

MR. HEFFLEY: Yes.

MR. WILLMOTT: I think there is a number of things that normal takeoff checks. The principal things being the ground effects with the nose on the ground and the ground effects once you are at the takeoff attitude or angle of attack. Particularly at the higher angles of attack with the right takeoff flap settings.

MR. HEFFLEY: We had that with the previous test, though.

MR. WILLMOTT: Maybe, maybe not.

MR. DAVIS: One thing that is unique to this test, reversible controls and a requirement to match stick force.

MR. WILLMOTT: One of the effects that you get for the normal takeoff if you haven't modeled the correct ground effects as far as the change of pitching moment ground effect with angle of attack, is over-rotation, and it's a good test to check that. This is a normal maneuver that the pilot is using for taking off in the simulator and in fact if you don't have that pitching ground effect correct you get over-rotation, and that's a common problem in simulators in that area. This helps to check that.

MR. STOCKING: Or under-rotation.

MR. WILLMOTT: Or the other way, too. You have the right slope of pitching moment versus angle of attack and ground effect at those angles and the minimum unstick doesn't necessarily check the changing effect at these attitudes.

MR. STOCKING: The number one training value I would say for a takeoff is the force required to rotate the aircraft under a number of conditions. That's really what you are aiming for. Forward CG, aft CG, gross weights, power settings, all those things affect the force to rotate. Pilots are very sensitive to that.

MR. BAKER: One of the biggest items is the stabilizer position.

MR. STOCKING: That's part of the longitudinal stability of the aircraft.

MR. BAKER: A lot of simulators don't do a very good job on that one. The positions aren't anywhere close to the airplane's, I have seen that on a lot of them.

MR. NEVILLE: Takeoff characteristics are something we found really important to get right. Because especially a pilot during recurrent testing familiar with the airplane is very familiar with what a takeoff feels like. And if the simulator doesn't feel right, he will squawk it.

MR. WILLMOTT: Take a 747, for example, during its rotate phase, it has a hesitation at about seven degrees of pitch attitude, and further application of control column is required to enable rotation through this attitude--

MR. BOOTHE: That's Boeing.

MR. NEVILLE: Not just the 747.

MR. WILLMOTT: --in order to get it to go through that particular pitch attitude to simulate that.

MR. BOOTHE: Haven't you guys managed to engineer that in every paper?

MR. SMITH: It's a wrinkle in the paper, Ed [Boothe].

MR. BOOTHE: I think--I'm sorry.

MR. STOCKING: I was going to say for a turbo prop aircraft it's more critical because you have the lift induced by the big fans out there that are really going to have an effect on this problem.

MR. BOOTHE: Are there any reasons to change anything here for normal takeoff? Other than what we--Stewart [Baillie]?

MR. BAILLIE: You are suggesting we don't measure angle of attack, which I would agree with. But what about touch or lift-off? Do we measure oleos, do we measure squat switch?

MR. BOOTHE: I have a radio altimeter in there--

MR. BAILLIE: That's going to be sufficient.

MR. BOOTHE: --which I would assume would be measuring lift-off and climb profile to 200 feet.

MR. BAILLIE: I wanted to clarify that.

MR. BOOTHE: Whether or not that's really precise or not to determine the moment of lift-off, I don't know. But then I don't know that the exact moment of lift-off is that important, either.

MR. NEVILLE: The radio altimeter.

MR. WILLMOTT: If we match pitch attitude and radio attitude tolerance, it pretty much indicates lift-off at the right place.

MR. NEVILLE: Radio altitude is a much cleaner measure of lift-off than it is for a V_{MU}, which is a very gradual takeoff, which is asymptotic, but for a normal takeoff it's pretty easy to spot.

MR. BOOTHE: Critical engine failure on takeoff, this is the one that traps us all and keeps us from doing things we might do otherwise. We need the aircraft dynamic response to the engine failure, we need correct control inputs, it is a test, everybody talks about V_1 cuts, that's the things that always keeps certain requirements in simulators that otherwise might not be so critical.

But I think a way to think about V_1 cuts is that nobody gets to do them in airplanes anymore and even when they did they didn't really do them, so the only person that does this is the company test pilot or Gerry Baker. But no person in training for operational flying ever does this anymore, to my knowledge, in an airplane, and if they do it's not a true representation. So I think it's a maneuver where proper simulation is very important because while engine failures are rare, fortunately, it's the only place where a pilot will see engine failure.

So I have left that to say that we, the subject matter experts here, need to identify the critical parameters, and I thank Dave Kohlman for putting this notion before me when we visited you, if we could identify critical parameters, then maybe we could simplify that somewhat.

I just wanted to introduce it with those thoughts, because I think that proper simulation here is as critical as that--

MR. KOHLMAN: I wanted to add that there are operators that are still doing V_1 engine cuts on takeoff in the airplane. That's why we need to do it in the simulator, because it works out not happily, occasionally.

MR. BOOTHE: True. But they don't really because they don't fail the engine--

MR. TOULA: They come close.

MR. KOHLMAN: That's right. They are coming back to a torque measurement that the manufacturer says matches zero thrust. It's a very realistic engine cut.

MR. BOOTHE: We don't want them to do that. I don't have data or statistics with me, but I think if you were to look at the past ten years of training accidents, most of which seem to occur in turbo propeller airplanes, a good number of them occur with engine failures at takeoff. And some other dumb things people did.

But the whole objective here is to get people out of the airplane and not do these things in airplanes. All the more important why the simulator has to.

MR. WILLMOTT: We are starting off by asking for parameters needed; is it useful to use what we have for tolerances? Air speed, pitch, we have angle of attack, altitude, bank, slip, column force, pedal force and wheel force. This test also helps to define an additional parameter for the prop type aircraft; the first part of the takeoff run indicates the amount of rudder pedal that is needed to offset the slip stream "turning" effect from symmetric engine power application--on some of these aircraft it's quite large.

MR. BOOTHE: I guess the next question is is there anything we need to do differently? Obviously we need the inertial measurement system for this. I don't see any relief for that. And we need control measurements, maybe not at the surface but someplace like in the cockpit.

MR. WILLMOTT: We do have the pilot forces here, which under Stewart's [Baillie] category is very difficult.

MR. BAILLIE: But probably required.

MR. WILLMOTT: But I think they are very important for V_1 cut.

MR. BOOTHE: The things we don't have are sideslip angle and angle of attack. What does that do to us? Or they are things we were recommending not having?

So sideslip, if I have inertia I can measure lateral acceleration?

MR. LEISTER: Yes.

MR. HEFFLEY: And heading.

MR. BOOTHE: Does that get me home free on this?

MR. KOHLMAN: I think it does. You can derive angle of attack and sideslip angle, they are not as accurate as direct measurements. What Stewart [Baillie] is saying, I agree with him, are the more critical parameters are control forces, bank angle and control deflections.

MR. BAILLIE: The important question is would there be a requirement to make a derived sideslip to the aircraft or the simulator model? Or is heading and lateral acceleration sufficient?

MR. BOOTHE: I think if you met--the dynamics are really lateral acceleration.

MR. HEFFLEY: That works, yes.

MR. BOOTHE: I think that's more important.

MR. HEFFLEY: Yes.

MR. BAILLIE: Me, too.

MR. HEFFLEY: They are observable and the angle of attack and sideslip are not observable.

MR. WILLMOTT: If you have the inertial platform on there, with an altimeter and heading, doesn't that enable you to get sideslip?

MR. BAILLIE: It does. But as you know, we don't do it that way anymore because it's far too much manpower.

MR. WILLMOTT: Manpower? Don't you use a computer program?

MR. BAILLIE: No. It's not something that is easily automated. And tremendously manpower intensive for a given V_1 cut on a certain simulator, it probably took a week's computing effort by somebody sitting in the terminal and tweaking to get it right.

MR. WILLMOTT: Really?

MR. BAILLIE: Whereas lateral acceleration and heading, measured directly or close to it, is a lot easier.

MR. BOOTHE: So if I add to this, this sort of description here, measure heading and lateral acceleration, and omit angle of attack and sideslip, we end up doing the same thing we are doing, we just look at a couple of different parameters that are easier to measure. Is that okay? Does that get us home? I'm sorry, Bob [Heffley].

MR. HEFFLEY: I was just going to say you want to look at angle of attack and sideslip in this particular situation as being redundant, really. That you have got sufficient information from acceleration and angular rates to see that the motion is reasonably close.

MR. BOOTHE: Now I have got testing in free air. I think that's for people like us who are going out and trying to develop some airplane responses but ultimately it seems it's going to have to be done on an in ground effect, too. Maybe I better strike that and leave that to people's own ingenuity rather than try to dictate something. I'm going to scratch the test in free air and let that be just test with strap-down inertial system, and leave that to the ingenuity of the people designing the test and presenting them for concurrence before doing them.

MR. BAILLIE: Another question I have, Ed [Boothe], is typically we have talked about V_1 cuts, but in the test environment do we necessarily need it exactly V_1? Or do we need it somewhere close to V_1 to just validate the dynamics in that regime?

And then the other question is, is a rapid throttle chop sufficient or do you need the fuel cut? Both of which cost a lot more in effort.

MR. LEISTER: You may need to ask another question, do you want to cut the engine when it's rotating a turbo prop, that's a lot more than V_1, do you want to do that?

MR. BOOTHE: I didn't understand, Dave [Leister].

MR. LEISTER: Cut the engine when it's rotating, takeoff rotation, you cut the engine there, that's more critical than V_1, or at least it's a lot hairier in a prop job. Do you want to do that?

MR. KOHLMAN: For many turbo props that's where V_1 is.

MR. LEISTER: True.

MR. KOHLMAN: Very close to rotation.

MR. LEISTER: That's a very critical area with prop jobs. I guess jets not so much.

MR. BOOTHE: Well, personally I don't see that there is anything that is so magic about the exact number V_1, I think we need to know--

MR. LEISTER: Just on takeoff?

MR. BOOTHE: I think we need to know the response of the airplane to an engine failure at speeds close to V_1, but I don't see anything magic about V_1 itself. I do think, though, that we need to find out what's more critical, throttle to idle or the engine being stopped or cut off?

MR. BAILLIE: Does it matter?

MR. BOOTHE: Yes.

MR. BAILLIE: Assuming that the engine model can do both in the simulator and will provide the thrust that is appropriate for each of those conditions, if you have the thrust for one condition that you match, can you accept the extrapolation to that more critical case?

MR. BOOTHE: Well, if you model and we test it at a point which may be a throttle, a rapid throttle chop to idle cutoff and validates, one could take the position well, if the model is good it will also validate at the other point.

So I don't know, any thoughts on that?

MR. WILLMOTT: Modeling of these propeller driven aircraft is not easy. I've only really been involved in one, which was the King Air, and I know that there are even problems with the analog simulation equations, when you look at them in detail they don't really work. And things were done so as to represent the forces and the conditions and, you know, the speed at which they feather, things like that, don't automatically come out on any models, you have to engineer something. Usually from specific flight tests.

The answer is, you know, it depends on how good that engine simulation is and that is not anywhere near as straightforward as [with] a turbo jet. Maybe Dave [Leister] can say something on this, he has done it more than I have.

MR. LEISTER: Yes. I guess the worry is that these airplanes that have negative torque sensing systems, like an MU-2, if you fail an engine on an MU-2 on takeoff and your sensor doesn't work, you are going to go on your back in a second and a half. What do you do in a simulator to do that? We can get real complicated on takeoff.

MR. BAILLIE: Do you have to--

MR. LEISTER: Do you have negative torque sensing, is that assumed on this engine at takeoff that you do in a simulator? Do you have to prove that it actually--

MR. BOOTHE: I have taken a position in the past that not everybody agrees with, but--so that's not unusual, that if the airplane were certified with a negative torque sensing system and somebody showed the reliability of that system was good enough to certify the airplane, why should I worry about it not working in a simulator? I mean, is that a reasonable--

MR. BAKER: Depends on whether it's required or not.

MR. BOOTHE: I have often said let's look at what's required sometimes for airplane certification, we certainly don't need to make simulations any more complicated. And if an NTS was good enough for the airplane and that's what's considered an engine failure, either autofeather or NTS, that's good enough for the simulator. I don't see why we need to go beyond that.

MR. LEISTER: What brought that to mind is the comment about engine dynamics on takeoff when you have an engine failure. And that test is very sensitive. Whether the--you have the negative torque sensing or the autofeather properly monitored.

MR. BAKER: Some of the King Air series, the autofeather was optional. Some had them, some didn't, so you needed to model those. Most of these airplanes you are talking about in this category have some type of autofeather. In fact, you know a Part 25 airplane basically says that pilot on engine failure, shall do nothing other than fly the airplane, it forces them to go to autofeather, the rule clearly says that if you don't have autofeather you have to let the prop windmill. Most of them can't tolerate that.

MR. BOOTHE: Not without a bigger engine, even with bigger engines.

MR. BAKER: So most of them are going to have autofeather, I don't see a fuel cut being a big deal on an airplane with autofeather.

MR. BOOTHE: I agree.

MR. BAILLIE: A fuel cut is a big deal when you get in an aircraft from an airline and you need to get the aircraft capable of doing a safe fuel cut, you have to get in the fuel system, you need an experimental or type certified valve in there. It's a big installation. It effectively adds a week.

MR. BAKER: You don't have a fuel shut-off valve anywhere?

MR. BAILLIE: In some cases, if you use a fuel shut-off valve when the engine is at high power, you have to overhaul the engine.

MR. BAKER: Most airplanes that's not true. Maybe for some airplanes, but I have never seen an airplane that there--

MR. BAILLIE: My understanding is that in these cases the fuel cut puts an unbalanced load on the fuel controller.

MR. WILLMOTT: I would suggest that the tests performed be the one that's safest for the aircraft and you rely on the proper simulation to give you the effects of the other types of failure in simulation. And sometimes it would seem that just pulling the throttle back is not necessarily the safest way of doing it.

MR. BOOTHE: If the airplane has an autofeather system and you pull the throttle back at takeoff, it's going to autofeather, isn't it? Isn't that usually--

MR. BAKER: No. A lot of them won't. A lot of them won't autofeather unless it's on at takeoff position, in King Air airplanes.

MR. BOOTHE: If the autofeather is on and if at takeoff power I reduce one engine, won't that engine autofeather?

MR. BAKER: No.

MR. BOOTHE: It won't?

MR. BAKER: A lot of them don't. You have to, in fact you take an airplane again like King Air 1900, if you lose an engine you have to leave the power levers forward, if you actually lose an engine, to get the autofeather to work.

MR. BAILLIE: During the certification flight test, the manufacturer typically gives a procedure to simulate an engine failure for training.

MR. BAKER: That's true.

MR. BAILLIE: What throttle to pull back to.

MR. BAKER: That is if you go out every day and train in the airplane.

MR. BAILLIE: Is that an appropriate match for the simulator plus knowing the engine models have the other characteristics?

MR. BAKER: I don't know. I guess I have this thing, the simulator ought to be built to represent the airplane. And when you go through the certification process in a real airplane you make fuel cuts, I don't know why you guys do it any different. You are big boys, too, the guy gets out and gets hazardous duty pay for flying these tests, so pay him. You are talking about expensive simulators here, they darn well ought to represent the airplane.

MR. BAILLIE: We are trying to reduce cost. I agree if we are trying to go Level D, if we are trying to keep the $15 million, $20 million simulator, that's no problem.

MR. BAKER: If you can rationalize the critical malfunction without making fuel cut, that's fine. We have trouble doing that on original cert on airplanes, most of them end up with fuel cut. I have never seen a full fuel cut damage an engine. So we have gone around the pattern 20 times and made fuel cuts on airplanes. Restart, come back around, do another one. Time after time after time. I have never seen an engine damaged from it.

Maybe there are certain fuel controls on certain engines that can happen. I can understand that. Some of the big huge engines do have those problems. Most of the smaller engines that's not a factor, to my knowledge.

MR. RAY: I'll start using the word “preamble paragraph,” the lead-in to this, the assumption that the engine and prop model is correct. If it's not, you may not have sufficient data to validate exactly how it should perform.

But if you go in and check it and put a Gerry Baker in the seat and it doesn’t perform correctly, I don’t really care what the objective says, it doesn't work. A two function evaluation of this device that Mr. Baker or his coworker, one of the fellows out of Wichita or Seattle, goes in and checks the device and does the fuel cut, then we have a problem to resolve.

MR. BAILLIE: That presupposes the guy that's going to do the subjective testing has done the fuel cut on the real aircraft and is fully familiar with it.

MR. RAY: That is the goal that we have in trying to get someone like that. We can't always do that. It may be in some cases we have found that it's two or three evaluations down the road before we actually get that person in there. So that word “assume” jumps up and bites us again when we assume that it passes the first test that it's good forever, that's not the case. We can't assume that that model is correct. If it's not correct, it has to be corrected.

MR. BAKER: If you can rationalize it by calculations or whatever, that's fine. As long as you know you are correct. That's the point.

MR. STOCKING: To save time we might want to talk min control air.

MR. BOOTHE: We will get to that. It's break time. A quick summary, I think we leave this pretty much as it is with the added addition of heading and linear acceleration based on data from the airplane. I know we did not resolve how we would test the airplane, we may have to revisit that.

For now, let's take a break for 15 minutes and be back here at--let's make it 16 minutes--20 after.

(Break taken.)

MR. LONGRIDGE: Before we get started again I think we need to examine our rate of progress and consider whether or not we want to reprioritize or redirect our current discussion. I think the discussion so far has been outstanding, it's exactly what we are looking for. And especially the part about lack of consensus.

But I think this discussion is important because this is going to potentially impact what the FAA does with respect to its validation requirements. On the other hand, I think we are all aware we are not likely to have a dramatic impact on costs with any of these things that we are talking about. We might be able to reduce costs ten percent, perhaps, perhaps not. It's entirely possible that we could end up increasing cost as a function of this discussion.

In light of our overall goal to reduce cost, the question is do we want to continue, given the amount of time that we have before we adjourn tomorrow, with a discussion of proposed alternatives for the FAA validation requirements, or do we feel the opportunity to impact costs might be greater by virtue of moving the discussion to the aerodynamic modeling? Which is an area that is already not constrained by the FAA, but is a big cost driver with respect to creating a flight simulator that actually handles like the aircraft.

I would like to kind of solicit the input of the group. Where do you think the biggest pay-off would be? Which would you rather do, continue the discussion of the validation tables or move on, defer that and move on to a discussion of aerodynamic modeling requirements, data requirements associated with that?

MR. HEFFLEY: Tom [Longridge], so far as the cost impact, I think that the validation requirements are the bottom line. That's where you have to do certain things to satisfy the FAA. As for math modeling, you are a little bit more left to your devices on how you solve things and how you accomplish modeling. And of course both of them kind of go hand in hand if you are working on a problem. I'm not sure that you can really split them apart that easily.

I think they are still both requiring the same sort of engineering, but certainly validation is what's required. If you are going to spend money, that's what you have to spend money on for sure.

MR. LONGRIDGE: Okay. Any other input on this issue? Yes?

MR. BAILLIE: Looking at it from a different perspective, perhaps, if we are requiring the same quality of simulation as we currently have, knowing that the people that are building these simulators are trying to get that quality at the cheapest cost already, and that you put no regulations on how they build the model, I don't think you are going to get any reduction in the modeling end of it. If you need a measure of the oleo deflections to make a good model, you are going to measure those deflections.

MR. DAVIS: In the interest of being as economical as possible with respect to building a model, you guys aren't telling us how to do it to date. What we need to do to validate, again I don't think we will be able to do much, reiterating what Stewart [Baillie] says, we can't do much to reduce cost without reducing fidelity.

MR. LONGRIDGE: There again, the more data that you have strictly for the math modeling part of it, I would think that the less of an effort you have to try to tweak, the math modeling sort of matches the aircraft.

MR. DAVIS: Say that again? Sorry.

MR. LONGRIDGE: The more data that you have to support the math modeling the better off you are with respect to handling characteristics.

MR. DAVIS: Yes.

MR. LONGRIDGE: You need that data and need to examine how to most economically get that data for that part of it, just as you do for what we are talking about with the validation side of it. Is that not true?

MR. STOCKING: There is different approaches to modeling, though. I was explaining earlier we are developing foundation models, they are models that are based on the laws of physics and whatnot. In the case of the strut model, I can model a strut and all the struts on the aircraft. I can model the tires on the aircraft using the laws of physics, if you will. And then we say for this particular aircraft tire it has this stretch because it has so many plies, it's such and such a diameter, it has so much air pressure in it.

Now we are talking about engineering data you can get out of a maintenance manual. We have developed the foundation models that uses data out of a maintenance manual, which is a real cheap source. And it guarantees, in this specific model, a level of fidelity. And meets a training requirement.

We used these models in the--for our commercial division that were built specifically to the Level C and D device machines. The only data required is nitrogen strut precharge pressure, the area of the strut, the stroke travel, things that you can measure on the aircraft. It resulted in good, high fidelity models. Total time for ground reaction was three weeks, all we did was test the output that we were plotting, check that the slalom steering was correct, when it went from understeer to oversteer at a certain speed, those things that the customer doesn't even see, right?

But they are basic engineering disciplines, if you will, right? And if you develop those models, then you can spread that cost over a number of machines. You have got something that is really inexpensive to do. So you have got--these models are a company philosophy, if you will, methodology that allows you to produce this cheaply and at the same time maintain the quality of the product.

MR. DAVIS: I think the point is, you can build a high fidelity model that people like but if you go and make precise measurements and compare some database line it may expose, I won't call them flaws, but areas that aren't as close as some engineer would expect. We can build a good model that will fly well.

We spend a lot of our time trying to make these lines close, but does the pilot perceive that? I don't know. In many instances he doesn't. That's probably a bigger cost driver than anything.

MR. BOOTHE: What was the last thing you said?

MR. DAVIS: The time we spend getting these lines, whatever the tolerance is, has minimal effect on simulator fidelity or at least the pilot's perception, but it has a big effect on cost.

MR. LONGRIDGE: So now you are talking about the data required for FAA validation?

MR. DAVIS: Right.

MR. LONGRIDGE: As opposed to strictly the math model.

Is there any other input with respect to which direction we should proceed here?

MR. RAY: I guess my question goes back to the word I won't use again as far as the preamble, if you will, the lead-in to this. Are there certain assumptions the FAA should make if you assume a reduced set of validation data, are there assumptions the FAA should assume that someone is going to go through to get to the starting point or have they gone to Microsoft and paid $39.95 for something and started from there? Or should we not assume anything?

MR. HEFFLEY: One thing that's not really covered very explicitly right now is the structure of the model from the standpoint of it being robust, being able to handle all flight conditions, all loadings, all environmental conditions. The way your documents are structured right now is from the standpoint of making spot checks. And that's fine.

But it does assume, it does assume that you have a good structural model that is going to obey the laws of physics and obey first principles. And if you are really trying to do the model right, of course, you start from a good first-principles model so that you do the sorts of things that Chuck [Stocking] was talking about.

MR. STOCKING: You design it to the training requirements.

MR. HEFFLEY: Yes. But you might not necessarily see somebody come in the door having already done that. Theoretically they could meet those spot checks very well and the in-between points not so well. So I'm not sure how you really specify the structural integrity of the model in a way that's really useful.

MR. RAY: And we wouldn't want to. We shouldn't get into how you do what you do, but there is some, I think, basic broad assumptions that we should be able to make along those lines that, if nothing else, serves the purpose of letting anyone who wants to come along and hopefully participate in this, so they don't get misdirected.

They put something together and it's not that robust model that you need. What could we or what should we do? Should we do anything? A statement like that, what I call an assume statement, as a lead-in to all this that could help on the front end.

MR. HEFFLEY: I guess I'd like to add one other thing, too. Besides that aspect we just mentioned here, there is also the context of where the aeromodel, per se, fits into the overall simulator, simulator fidelity. There are a lot of things in the simulator that are not associated with aeromodels, specifically, that have a huge impact on fidelity.

One is the quality of the cockpit manipulators. Another is the quality of the visual presentation, whether it's an outside visual scene or just simply cockpit instruments. Those things have nothing to do with aeromodel, per se, but probably have as much to do with perceived fidelity and usefulness of that system. And so there is a matter of putting all this in the right perspective.

MR. KOHLMAN: I have a question about what difference it really makes to the end goal, and I keep focusing on that, that's training pilots safely and effectively and economically. What the structure of the model is. And how many terms are in the equation. And how we got those terms, whether it was all with a very, very smart predictive program or a $39.95 Microsoft model.

But in the end when we do our checks, that's all we can do, and everything matches, and the pilot says this flies just like the airplane, and the training is effective, what difference does it make?

MR. RAY: If the Microsoft $39.95 works, then that's fine. If there is an assumption that goes along with that that it does in fact perform the full range, that it's not just these limited tests that we are doing. The fact that you need a given set of tests therefore you have a simulator, is not necessarily so.

MR. KOHLMAN: I know. That's an extreme example. But in the end when we all end up presenting the FAA with a simulator that we want to have validated, you really look at all of those, I don't know how many points, 20, 30, 100 points, and only those.

And you have pilots who evaluate it essentially throughout the flight envelope from a qualitative point of view, and if those checks all work, then we don't or you don't go into the model to see how many terms we have in the equation.

MR. RAY: Nor do we want to, ever. There is an assumption there that whether you use a room full of models or a $39.95 model, there is an assumption there.

This goes across the entire spectrum. If you put Gerry [Baker] in the simulator, a true expert, and walk away with a textbook full of problems, somebody will likely scream foul because he met the 25 cases you are talking about. I'm trying to give someone fair, I shouldn't say warning, that's not a good word, but decent advice that this isn't the end. There is a perception that if I strictly pick up Appendix 2 of this and read it and exclude all the others, I have a simulator. That's not the case.

I'm trying to be as fair as I can in passing out information, good information, to those who might want to jump in the market. The manufacturers we are dealing with right now, that's not really a major problem at all. It will be those new entrants into the market that will try to serve those who are the primary motivation for this endeavor, the commuter world. I suspect other manufacturers would want to come into it and we want to be fair to them. That's my point.

MR. KOHLMAN: Are you saying, though, that if somebody matches all of these points and the tolerances required, they may not have an adequate simulator?

MR. RAY: Yes, sir. True statement.

MR. KOHLMAN: Does that say we don't have enough points?

MR. DAVIS: You never have enough points.

MR. RAY: You never have enough.

MR. KOHLMAN: I think there is a dilemma there.

MR. DAVIS: You want to leave the points alone and let the pilot fly.

MR. SCHUELER: Appendix 1 and Appendix 3 are also considered. Appendix 2 is a set of objectives, but Appendix 1 and Appendix 3 also play in the acceptance of a sim.

MR. DAVIS: If we look at the international standards now we have an increase in tests, I don't think simulators are any better, really. Matches more points, but keep in mind that at least for us the data that goes into building the sim package is far more than this matrix calls for. We are talking about hundreds of points.

The FAA doesn't want to see that, I don't want to show it to the FAA, really. If they are interested, I will. There is--it doesn't equal the pilot flying the machine.

MR. KOHLMAN: I think that's really the final exam, is after you have met what are always a finite number of points, somebody has to fly it to see if this behaves like the airplane. Do I feel like I'm getting an experience that's equivalent?

If that happens, it doesn't matter to me if it's a totally predictive model or you do real cheap or low cost validation test or if you have done a Level C and D flight test with parameter verification and all this. It doesn't matter. If you match these and you get pilot examination--

MR. RAY: Exactly right.

MR. LONGRIDGE: Stuart [Willmott], you had a comment?

MR. WILLMOTT: I guess I'm one of the oldest people here and remember the days of AC[120-]14 and maybe even before that, but maybe I can don a little reverie here.

The current situation in simulation as far as the Level D and higher echelon simulators, C and D, is I guess we go through, you know, the IATA data standards. Boeing came up with a beautiful mathematical model, they even give you all the data points on the curves, and the simulator manufacturer essentially implements that and he knows he is going to get a simulator that is based on a very good mathematical model that covers the complete flight envelope of the airplane.

And it's been proven to be like the airplane, they have a proof of match. And somebody that I know very well, used to describe that as "socialized simulation." What we are talking about here is, you know, business jet, regional jet type simulation, and a lot of these being built today by Flight Safety, by CAE, are being built on a program as near as these people can get to the big full commercial simulator.

You go out and do an extensive flight test program, and you define a whole series of equations, what lift coefficient is made up from, and pitching moment, and the aerodynamic control surface hinge moments. You define that as a series of equations which is what I define as the model, and I'm not sure whether everybody means that when they talk model.

And then, you know, there is a proof of match done on that. And a complete envelope coverage is required of that simulator, and for this and for the previous one, of course, there is a limited number of tests that are used to spot check that. And it's my understanding that particularly Ed [Boothe] and other people at the FAA have always said that with these higher level devices, this Advisory Circular is really just a spot check of that and there has to be a lot of other flight testing and definitions of the model done in order to ensure that you have got a complete simulator.

And that, you know, is where we are right here and now, particularly for the C and D devices. But if I go back 20 years, from people like Boeing, we did have relatively good models for the aerodynamics, but for the business jet community we did not. We tried flight test programs to come up with good data and good models, which helped the simulator manufacturer, but it was up to the simulator manufacturer to come up with models that in fact describe the aircraft as best as he knew how with available predicted data and flight test data and with resources like KSR and some others.

But we still would use things. I got a list here of supplementary type things that we would use, like type inspection reports. There was a time here 25 years ago, maybe less than that, where we didn't do any special flight testing for simulation at all. We would use what was available. There were about 35 tests, I think, in the old FAA AC[120-]14. Takeoff times, climbs, some static stabilities, a few tests like that which we were able to extract from type inspection reports.

There are things like production aircraft flight test procedures, each airplane that's built has to be flight tested and there is quite often some useful information in there. Airplane flight manuals, operations manuals, maintenance manuals, so on and so on.

And I guess the point that I'm making is two-fold, one is that I guess what we are trying to do here is to back off from the optimum of building a simulator, which is C and D, building these massive flight test programs which are very expensive and try to go back to something maybe like we had 20, 25 years ago. And you know, when you look at what training has to be done by these people that are doing initial, even recurrent training, some of it they can do on Level 3 devices, 4 devices, 5 devices, we are talking about another device that is sort of in between the optimum and some of these flight training devices.

So I think that there are other sources of data out there other than a full-fledged flight test program and it's left with the simulator manufacturer to use those available resources to his best ability, and to come up with models that fit all of the basic envelopes that he has to do. I guess that's about it.

MR. LONGRIDGE: So once again I gather that the consensus here is that we should continue the discussion on the validation tables and kind of leave it up to the manufacturers what they need to do to optimize the aerodynamic math models as best they can with whatever sources they can obtain to do that. Is that a fair conclusion?

Within the validation tables themselves, at the rate we are going I'm not at all confident we are even going to finish those. Are there particular tables that we think we would like to--yes?

MR. BAILLIE: Would it make sense in addressing the validation tables prior to going through the exact procedure to just get an agreement on each of them what are the fundamental issues you are trying to match? And if we just had a list of those, I think that that would be a fairly easy thing to do that's agreed upon, that gives at least the starting point, so that someone could come back and say I'm meeting that concept or intent but a different way, will you accept it? That's a suggestion.

MR. LONGRIDGE: Discussion?

MR. DAVIS: I think there is a lot of merit in that. If I understand correctly, what do you want to do with V_{MCG}? What is the objective with that? Anybody can come up with an alternative in representing these models? Let's narrow in on what we are trying to do with these tests and find ways perhaps to simplify it. If we don't agree on what the objective is, how can we talk about some of these things?

MR. BOOTHE: Could I ask Stewart [Baillie] to elaborate a little more? I'm not sure what you are asking.

MR. BAILLIE: As an example, in the V_{MU} test that we just finished discussing, for a while we all had the idea you have to match this minimum unstick time history, but eventually it came to prove what the pitching, maximum pitching authority while you are rolling down the runway by aft elevator and prove C_L versus alpha while you are on the runway. Those two things are much easier to comprehend than a case V_{MU}.

MR. BOOTHE: They are for you. But for the industry, particularly the operators who fly airplanes and use simulators for training, I'm not certain that's true.

MR. BAILLIE: But the people who are presenting approval test guides to the FAA, I assume, are more like people like me rather than operators.

MR. BOOTHE: They are people like you, yes. One of the things, it's probably a good time, I didn't mean to take your--

MR. LONGRIDGE: Go ahead.

MR. BOOTHE: It's probably a good time to mention, it is one of the things we try very hard to avoid and get away from, is the attitude within the training community that often exists is we have got a training, let's just test for that, forget all the other stuff. And I think that's a mistake and I totally disagree with it.

The reason that this bunch of tests were chosen was, as has been said here earlier, and Stu Willmott just said it, we have a simulator that needs to represent an airplane over some operational environment and we should be able to validate such a simulator at some select small number of points, really. To say that it's good enough to do whatever training you want to do, represents the airplane good enough to do the event in a typical training program. And that's what this attempt is about, we never attempted to take a test like V_{MU} and say well, we are testing for elevator control power and lift-off speed or is proper lift generated at the lift-off speed of the airplane, I think that's for people doing the work to build a simulator validated to know, but we have to write this for a much wider community than us.

MR. DAVIS: But to facilitate discussion it may be good to focus on what the intent is, for us to focus our discussion on what are we really after here.

MR. BOOTHE: I agree.

MR. HEFFLEY: Why do you have to write it for a larger community now?

MR. BOOTHE: It's--that's hard to explain, but in writing this thing we have dealt with people like us in engineering, we have dealt with people in flight operations, we have dealt with people in the training community. We have to try to write something that all of them can partially at least understand, and use. That's sometimes--if this were strictly for us engineers, we might do it differently.

MR. BAILLIE: The thing which doesn't show up until you are starting to brief pilots, I find, is that when you say okay, we are going to do a V_{MCG} maneuver, the flags go up because that's a certification maneuver, very difficult, we have got to do a huge work-up for it. Then if you say no, we are just going to cut the engines at speeds on the safe side of V_{MCG}, it's a completely different environment. And so the--sometimes using the terms that are understood by everybody causes more problems in the engineering environment than understanding.

MR. NEVILLE: Isn't it true that tests like V_{MCG} and V_{MU} and a number of others were originally included in the list of tests just basically because they are there, they are done anyway for certification? That in itself is a potential cost saving if those tests are available, if there is enough information that you can use them, and that's fine, I think that the situation that Stewart [Baillie] is concerned about is where those tests are not available or there is not information to make them useful, but you need something equivalent to that. Let's look for something that provides the right kind of information but is maybe easier, less costly to obtain than going out and doing strictly a V_{MCG} or V_{MU}.

MR. BOOTHE: I don't have a problem with that, in fact, but I don't answer to that anymore, so.

MR. RAY: That's where the alternative wording, I believe, Ken [Neville], is appropriate. Where certainly a number of the tests in here we can come up with alternative language to that, a lead-in comment, if you have alternative testing you would like to submit, then we are certainly open to look at what alternative testing you want to use. Stewart [Baillie], you used the case if you have other tests and you come in with your case and present it. That's certainly reasonable.

The standard wording, you are absolutely right, is the assumption that you acquired it in certification as a test and it's transferred directly. To change that would probably create more confusion. Could create more confusion.

MR. BOOTHE: Yes, but if I could follow-up with Stewart's [Baillie] comment, are you suggesting that it might be a good idea where we list the test, you know, if we are going to do something different from Level B it still has to fit in the overall scheme of things, but are you suggesting it would be useful where we say V_{MU} to have another column to say what's the objective of doing this?

MR. HEFFLEY: Yes.

MR. BAILLIE: Exactly.

MR. BOOTHE: That way if you know the objective of doing this, what is it supposed to show? What things is it supposed to measure? Then perhaps you could develop alternative means more easily because you know what these guys are after.

MR. HEFFLEY: There is a real benefit to knowing what the objective of these things are. Because you may come up with better, even more effective ways of demonstrating these things.

MR. BOOTHE: Well, I think that's a good idea. It's more work for somebody to figure that out, but I also think it would cause some critical thinking to be applied to this whole set of tests to have somebody or some bodies sit and say why are we doing this? What is the real aerodynamic in this case, objective? I don't know if that's for today.

MR. LONGRIDGE: I think that's a good suggestion, but I think it's also incumbent on us to suggest one way that would be acceptable to the FAA with the proviso that other ways will be entertained.

MR. BAILLIE: The clarification of the intent then leads to the decision that is now possibly be made formally, which is, does a Level B simulator require that match? Right now we have all of these lists, many of you--as an example, we are not really sure until we break it down to the intent that we require that time history or snapshot to be matched. And this way you might be able to highlight some cases that you don't necessarily require for a Level B simulator.

MR. WILLMOTT: I was going to say, Ed [Boothe], that the handbook that was developed to go along with the international standards to some extent highlights the purpose of the tests that are in the international standards and each test in here is covered by international standards. I'm not sure if you are familiar with that document. I don't have a copy of it here.

MR. NEVILLE: I brought a copy.

MR. WILLMOTT: Maybe you could look at that.

MR. BAILLIE: We should make sure we all agree that is the intent.

MR. HEFFLEY: Ed [Boothe], also certainly the intent here of these individual tests is something that really has been falling out of each of our discussions of each of these items. I think that that's ultimately what's happening here, is we are in some cases really discovering what the intent maybe really is.

MR. WILLMOTT: I thought that one of our ground rules at the start, given ground rules given by Tom [Longridge], we wanted to stick with the current Advisory Circular for Level B simulators. Is that a ground rule?

MR. LONGRIDGE: I think that's a ground rule but I don't see anything that necessarily precludes identifying the objectives that are currently specified for the Level B, that's why we are asking for the information we are asking for the Level B.

MR. BOOTHE: That's a big job, to really do that. I guess that leaves us, shall we proceed with what we were doing, keeping that in mind? We probably are going to do that anyway, but it will take additional efforts to get that on paper. If we were to preclude that, we need to produce such a piece of paper.

MR. HEFFLEY: I think this will come out a little bit more naturally here if we have this idea in mind.

MR. LONGRIDGE: We will give it a try. Of course that will mean we will only get through about half the table. So we are going to proceed with these tables.

MR. BOOTHE: All right. We were about to finish critical engine failure on takeoff. I hope we finished that. Because I was hoping to go to crosswind and say no change.

If we have done one of those we have probably done the other, really. But are measuring those same things for crosswinds adding heading and lateral acceleration good enough?

MR. HEFFLEY: In a case like that, is precise knowledge of the crosswind, precise measure of the crosswind, is it necessary or is that something that can be regarded as basically derived data?

MR. BOOTHE: Well, we are talking about validation stuff here. I think we have said in the international standard, which is not what we are doing here, that a wind profile has to be provided so that's a good question of what do we do about that here? Should we--can we just generate a wind profile and use it?

But if we did that, how would we know what the airplane did for the same wind profile? I don't know how to answer your question, Bob [Heffley].

MR. BAILLIE: Is the intent only to deal with the dynamics of the aircraft in the first 50 feet of altitude? Or higher? Because if it's the first 50 feet, you might be able to just use tower measured wind, whereas if it's higher you need to develop a profile.

MR. BOOTHE: I think--Chuck [Stocking]?

MR. STOCKING: For Level C and D devices we use the one-seventh law profile, which is what they use to certify the airplane. They certify the airplane at a 25 knot crosswinds, at 50 feet, it's probably 16 feet, whatever it is above the ground, above the ground level. The friction of the earth's surface changes at wind speeds.

MR. BAKER: It's ten meters now. The international standard is ten meters.

MR. STOCKING: But that is always a given, that is a steady state wind at one-seventh profile.

MR. HEFFLEY: If it's steady.

MR. WILLMOTT: The big problem--

MR. STOCKING: That's right, if it's steady.

MR. WILLMOTT: --with crosswind and any wind is that it never stays the same, it is always gusting, and normally what we use in simulation is just the tower reported wind and do the best we can in the simulation with that, and there is always gusting on top of it.

You can't measure sideslip or even the control surface, we use some sort of boundary layer, the one over seven law is the standard boundary layer whether you are at Wichita with flat ground or Chicago with buildings all around. That's the standard we use. Usually after the aircraft leaves the ground, the controls are centered, you know, the crosswind component using the rudder, you normally let the rudder go, so you are not so interested in it once you decrab the aircraft, and it's mainly the ground run and initial decrabbing that you are interested in.

MR. BOOTHE: I think an important part is the transition from the ground to the steady state condition. And beyond that it's just flying in the wind, it doesn't make any difference.

So that's really what this is about, and I think we would be measuring the same stuff we would be measuring in previous takeoffs. So I don't know that there is anything really different here except we might have a little more interest in lateral acceleration and heading.

What I have to tell you, I have seen simulators put before the FAA that automatically corrected for crosswind, I don't know how they did that, I don't know how they ever got such an idea.

MR. RAY: I can tell you why. The engineer said he saw an airplane take off one day, turn into the wind, therefore he made the simulator do it.

MR. KOHLMAN: I think Ed [Boothe] is right. If it's right within a few seconds after lift-off, it's no longer a crosswind event. And so it's that transition that's really important. Along the ground until you take out the sideslip.

MR. BOOTHE: So maybe we don't need to do it to 200 feet. Just like all takeoffs are to 200 feet. I want to tell you this is relief. It used to be 500 feet. But do we need to do a crosswind takeoff in a Level B simulator? Do we need to record a time history to 200 feet or do we need to record it to off the ground or something? I don't know.

What do we need to do?

MR. DAVIS: I don't think it makes much difference, frankly, probably best leave it alone. As you have already said, there is not much happening once you get rid of sideslip. I don't think you would cut costs by 100 feet, leave it.

MR. BOOTHE: Sideslip, heading, lateral acceleration, otherwise we are left where we were. We need the inertial system anyway.

MR. WILLMOTT: The thing that would be real nice to get is the actual wind where the airplane is.

MR. KOHLMAN: That would help.

MR. WILLMOTT: That gives us the biggest problem.

MR. DAVIS: Remember we are talking cutting costs.

MR. WILLMOTT: One of the simulators that we recently had, I had enough data that theoretically enabled me to extract the wind and when I did that I got something that you would normally find in a round container. For whatever reason, it didn't work out.

MR. HEFFLEY: That's what you find when you do estimate what the actual winds are in situations like that, is that they are nothing like you were really assuming. And the only way you get it is extracting the stuff from the flight data, deriving it from the flight data.

MR. BAILLIE: The important thing to remember, too, there are aircraft that accurately do measure the wind in the short-term high frequency range, and that process takes a tremendous amount of calibration of an aircraft to do it. Much more so than what we are doing for any of these tests.

MR. WILLMOTT: I think you have to actually be in the air for that to do it. You can't do it on the ground.

MR. STOCKING: When Mr. Kohlman has his radar gun in there to give me ground speed, I can tell the tower what the wind was. I mean, it was that accurate between correlation with your sideslip and your side forces on the aircraft, and your ground speed versus air speed, it was quite accurate.

MR. BAILLIE: I would say to do that--

MR. STOCKING: That's the only source I had for ground speed that was accurate enough to do that with.

MR. BOOTHE: Okay. That's interesting, but we need to go on.

MR. STOCKING: I wanted to get that in.

MR. KOHLMAN: Thanks, Chuck [Stocking].

MR. BOOTHE: What do you call the things you put in wind tunnels? Straits? You can build a 30 meter wind tunnel strait and put all the--

MR. WILLMOTT: I guess when people like Boeing are testing it they have anemometers in places down the runway; is that right?

MR. SMITH: A rake. R-A-K-E.

MR. BOOTHE: Rejected takeoff, I don't know if it's worth talking about separately, I don't see that it's anything more than an acceleration and stopping. We are doing both of those things somewhere else. I question why it's in here except that in the international standards it seemed to be necessary, so it fed over. Because the reason it got in there is because at that time, and I really haven't heard of any since, but there had not been a successful rejected takeoff almost in history without running off the end of the runway or some other at least incident in airplanes.

So the idea was to get something in simulators that was checked and no matter--no amount of argument would work to say well, we already measure acceleration and we already measure stopping distance, what more do you want? So we put it in. I would just as soon pass it by and say it's already covered, if that's all right with you. In fact, do we need that for Level B at all? That's the question I should ask.

MR. BAILLIE: What was the intent?

MR. WILLMOTT: Do you need to do a rejected takeoff in the training curriculum?

MR. TOULA: Yes. Unless you change the training program.

MR. BOOTHE: But we are measuring acceleration, time and distance, we are measuring stopping time and distance, the rest is pilot technique in between. Transitioning from acceleration to stopping, which is a variable that's not really that well controlled anyway. Why do we need to measure the total maneuver?

MR. BAKER: There are differences.

MR. WILLMOTT: Flap deflection.

MR. BAKER: Flap deflection.

MR. BOOTHE: You have takeoff flaps instead of landing flaps.

MR. BAKER: Usually you are rejecting a takeoff from a higher speed, so deceleration rates could be substantially different. They are usually due to braking differences. You can probably compute it.

MR. RAY: You can change the test, instead of a rejected takeoff you can do a deceleration with takeoff flaps.

MR. BAILLIE: The other question might be what is the accuracy requirement for that maneuver in the training?

MR. BAKER: You could possibly compute it. I would agree with that. I'm saying they are not exactly the same.

MR. BOOTHE: I realize that. But going back to objectives, if we are measuring an acceleration in the simulator, and comparing that to an airplane, and we are measuring a stopping time and distance or deceleration in a simulator, and comparing that to the airplane, even though there is perhaps a difference in flap setting, we still have the calibration of those two events.

Is that sufficient, or do we need to have it an exact duplication of that condition, is what I'm asking?

MR. KOHLMAN: By "exact" you mean a time history match as opposed to a--

MR. BOOTHE: I mean a total rejected takeoff from brake release to full stop, with all that happens in between with takeoff configuration

MR. HEFFLEY: You are not measuring anything different as far as the simulator math model characteristics would be; right?

MR. BOOTHE: I don't see that you are. Gerry [Baker] points out a different flap setting, that's true, and maybe decelerating from a higher speed, and that's true.

MR. STOCKING: Also with a turbo prop aircraft, you are planting it back down, I don't know whether you test to make sure that you had that effect.

MR. BOOTHE: I didn't hear you.

MR. STOCKING: On a turbo prop aircraft when you go in reverse thrust you are really planting the airplane again because you are losing all the lift on the wing. It's one aspect that you want to make sure you have modeled.

MR. BOOTHE: True.

MR. BAKER: On a turbo prop it would be different. I keep thinking jet. A normal landing is going to be a symmetrical event, too. On RTOs it's probably going to be an asymmetric event.

MR. BOOTHE: Okay. Seems it's good reason for leaving it in, but I don't see it makes any difference on how we measure it. We would measure them the same way the way we measure them for acceleration and deceleration, just under different conditions.

Okay. Gets us over to climb, which is all steady state stuff, as I see it. There should be information available in the type inspection report if that were available in the airplane flight manual, you can just as well do all these climbs with a calibrated altimeter and air speed indicator, stopwatch, which is what I've tried to indicate.

Is there any reason to discuss that? I don't know of a simple test one could come up with.

MR. BAKER: Why don't you use published data?

MR. BOOTHE: I don't know.

MR. WILLMOTT: Airplane flight manual?

MR. BAKER: Why would you need to repeat the climb data? Some of the data is not in the flight manual, perhaps the higher altitude, usually you have an operator's manual that gives that kind of data. Anything below 1500 feet, first segment, second segment, final segment, that's all in the flight data.

MR. BOOTHE: Gerry [Baker], is that data in any way factored? Is there something we would need to deal with there to remove any factors applied so we can get back to the--

MR. BAKER: It has a net factor, you can get the numbers out of the FAR.

MR. SMITH: If we match thrust with torque it ought to match up.

MR. HEFFLEY: Here is what happens sometimes. You think you have the flight manual but then you get some flight data that are different. And those flight data that are different are going to be consistent with everything else that you are measuring. So when you get that model finished it winds up maybe not matching the flight manual.

MR. LEISTER: It very rarely does.

MR. SMITH: We checked simulators on evaluations against flight manuals and we always found, and we always ensure that the simulator actually did better than the flight manual, because that's what we expected.

MR. BAKER: That's probably because--

MR. SMITH: They use conservative data.

MR. BAKER: The flight data is a min spec data. You can correct all that. Frankly, that's what you should be putting in the simulator, is a min spec engine.

MR. HEFFLEY: It's known what the conditions are.

MR. SMITH: You have to match the rest of the data package, I guess. Aeromodelers probably--

MR. BAKER: I will believe a flight manual data any day before you get any airplane off the line.

MR. LEISTER: The problem I have run into is that some of the flap transients are functions, not some but all the flap transients are functions of lift and drag and pitching on the course, if you fiddle the lift and drag to make those times come out correctly, well, then your dynamic tests will not be so easy to come by, if you can even come by them.

I have never yet found flight test data that matched the simulator. Maybe a couple of jets, but not prop airplanes.

MR. BOOTHE: But if that flight manual data were corrected to a spec engine, then would you have a better chance of matching it?

MR. LEISTER: Probably so, yes.

MR. BOOTHE: I think what we are doing here again is just calibrating the simulator, or validating the simulator, so as I see it if we are simulating the same powers the airplane had, then we should get the same climb. And I don't really care where that data comes from as long as it's a valid data source.

MR. LEISTER: If you make the simulator match that data, then the simulator is not going to match other data, mostly your dynamic data at some other point in the sky unless you have flight test data that are way off--

MR. BOOTHE: I'm not suggesting that. We should find out how the flight manual data got to be what it is and correct it back. And use that.

MR. LEISTER: It's so obvious it's just an average. I used to work at flight manuals years ago at GD.

MR. BAKER: GD flight manuals are not FAA approved.

MR. LEISTER: You are right.

MR. BAKER: This is FAA required standards.

MR. WILLMOTT: To my knowledge they are usually produced with 0.8 and 1.1 percent gradient in hand depending on which flight condition it is, they use the minimum engine and humidity effects on the engine. If those things were taken out to represent the true aircraft with an average engine, I would have thought we could have used them.

MR. BAKER: Sometimes you have bleed extractions, if the bleed is on, the heat is on, typically anti-ice are included in approach data. If you ask the right people, you can find out what's there.

I have had good luck producing climb data on Part 25 aircraft in particular. I'm just saying if you could cut out doing a lot of climbs, why not cut it out? Sounds like everybody wants to go climb.

MR. KOHLMAN: I agree. In all cases I have been involved with we are validating the simulator to a specific serial number airplane, the one we did all of our flight testing in. If it has a real good engine in it, it's not going to match the flight manual data. So let's correct the flight manual data, but then I hear other people saying well, we still don't usually match the flight manual but what are the tolerances, how much is that mismatch, and can that be taken care of by having reasonable tolerances on the rate of climb? If it can't, I agree with Gerry [Baker], let's get rid of any test we can reasonably get rid of.

MR. BAILLIE: To corroborate what you just said, if you can measure an aircraft from the line that has 300 feet per minute higher rate of climb than the flight manual, you shouldn't be matching flight rate of climb to 50 feet per minute, you should be rating it to the amount of variation that's up there. And maybe it's opening up that tolerance is the important thing.

MR. KOHLMAN: That's a good guideline for tolerances.

MR. BOOTHE: How you find out what that is is another question.

MR. BAILLIE: I'm just asking questions here.

MR. WILLMOTT: I thought the position of the FAA was always as far as the performance and handling is concerned you pick an airplane, and you match it.

MR. BOOTHE: Yes and no. I never took that position. I took the position that if you are going to model a cockpit, you have to have some cockpit, there is a variation in what's permitted in type certification, not every cockpit is the same, you can't model them all, so you have to pick one.

I never applied that to performance and handling because I don't think that one airplane is a good sample, necessarily. But if you only test one airplane, that's all you got. So you can't reject it, either.

MR. WILLMOTT: I remember the days of the 747 where we had problems with column friction, and somehow we get results from about half a dozen different aircraft that showed that the basic static control force varied considerably. And we were going to use the average, but I guess we were told at that time to select an aircraft and match it.

MR. BOOTHE: Well, at that time I hope I didn't tell you that. I wasn't there, I hope.

MR. WILLMOTT: I think it was before you, Ed [Boothe].

MR. BOOTHE: All right. Well, we have got here in climb two data sources, actually certification data and TIR, about the same thing. And AFM. And I think if there is a way that those things can be used without flying the airplane, then we ought to do that. If for some reason that's a problem, and one has to do tests, then that becomes your problem.

But do we need to change this? I mean, it's a simple test technique. I would certainly look for data sources that may be available and go from there.

MR. BAKER: I would trust flight manual data any day over somebody who does two check climbs, which is probably what anybody is going to do at the most.

MR. BOOTHE: You are absolutely right. I have seen results of that by some very reputable organizations and it was just to fill a square. Say here, here is a climb thing, and I have seen climb schedules that bent in the middle, they were really screwed up and had to go use the flight manual data anyway. So I'm with you.

MR. BAKER: You have--it's just like any other flight test, you have to have good atmospheric conditions, proper lapse rates to get the--

MR. BOOTHE: So if we have to do it we can do it with a stopwatch and some calibrated instruments. And hopefully we don't have to do it, we can use existing data, and in order to get an airplane certified that's one of the requirements of the flight manual is performance data.

That gets us over to--we are all the way up to page four. Which is really stopping deceleration time and distance with wheel brakes and deceleration time and distance with reverse thrust. Two different tests. Level B doesn't require any contaminated runway stopping. Again, if you can get it from certification data, great.

Do you now do certification tests with reverse thrust, or reverse thrust only or is there credit given?

MR. BAKER: It's--you can do it, but it's difficult. There is some new standards coming in, it's a mess in itself, in Part 25 it's going to allow the use of reverse thrust as long as you have accountability. There is a bunch of things coming in, all new requirements, most of those are not in the older airplanes.

The answer is yes, they are going to allow the use of reverse thrust, but you have to go through other things with that. In 23 they allow it but hardly nobody has used it. I think maybe one of the Jetstreams used it, the 23 Jetstreams, that's the only one I'm aware of.

MR. BOOTHE: So to get reverse thrust stopping distance we almost have to do some sort of testing within the airplane before this change comes. After that comes, maybe there is a way to look at that. But for wheel brakes, certainly landing distance tests have to be done and that data, again if we can get a hold of the type inspection report, that data should be available.

Now I said that there is no additional testing required, but if there were, I would suggest the same techniques that we would use for acceleration. I don't see any difference.

MR. WILLMOTT: The only thing is with the reverser you are operating the engine in, if I pronounce this properly, the beta range, and am I right in saying that is variable?

MR. BAKER: It can be.

MR. WILLMOTT: So, you know, with a regular jet pull the reverser up and go with whatever, with these it's more complicated. And I'm not sure what it is that you could record to determine exactly where the reverse thrust is with a prop plane.

MR. LEISTER: You use torque or something like that. It's nebulous.

MR. WILLMOTT: Even if you have a given torque, you get a variable amount of reverse thrust.

MR. LEISTER: It hasn't been that variable, it's been variable in the beta range as you would range. I know you didn't want to say it that way.

MR. BOOTHE: You sound Australian and he sounds Scottish.

MR. WILLMOTT: I'm mid-Atlantic. When I go back to England they think I'm American. Here they think I'm English.

MR. BOOTHE: You must have been to Australia, too.

MR. WILLMOTT: Yes.

MR. BOOTHE: I know you picked it up somewhere.

MR. SMITH: Got that outback.

MR. WILLMOTT: They call me a POME, P-O-M-E.

THE REPORTER: Thank you.

MR. WILLMOTT: Prisoner of Mother England, that's where it comes from.

MR. RAY: The other was beta.

MR. BOOTHE: Yes, it was beta.

MR. WILLMOTT: So we are able to tell the reverse thrust by--

MR. HEFFLEY: Torque and axial acceleration.

MR. LEISTER: Yes.

MR. BAILLIE: Although most prop models I have seen don't work well in dynamic cases. So you really don't have a good measure or good model of the prop in that regime.

MR. LEISTER: Yes, you are right.

MR. RAY: I'm sorry, what regime?

MR. BAILLIE: A transient regime.

MR. BOOTHE: But if we measure stopping distance we would be measuring--

MR. HEFFLEY: Overall, yes.

MR. BOOTHE: You are not going to measure the transients once you have established the reverse thrust setting, then you measure acceleration from that point.

MR. BAILLIE: It's a transient because the advance ratio on the props is changing all the time.

MR. HEFFLEY: But your prop model ought to be able to take care of that.

MR. BAILLIE: No.

MR. HEFFLEY: It ought to be able to take care of it to the extent it gives you the right answer in the end.

MR. BAILLIE: Exactly.

MR. BOOTHE: Well, is there anything we add to take away from this stopping thing? I don't know of any way to simplify it. I guess that's the question I have.

MR. BAILLIE: The only thing might be that whoever runs the test has to somehow document what the throttle or the pilot control was doing.

MR. WILLMOTT: Right.

MR. BOOTHE: Yes, but that's a given.

MR. BAILLIE: It's not written down.

MR. WILLMOTT: In other words, if you are running the test manually you have to know where to put the control.

MR. BOOTHE: Well, give me something to write down.

MR. BAILLIE: I'm not sure what to write down, other than the thrust reverse control must be documented.

MR. KOHLMAN: We have video down here.

MR. BOOTHE: Yes.

MR. KOHLMAN: If we have a proper field of view we will get that.

MR. BAILLIE: Perhaps.

MR. BOOTHE: I'll just say thrust control and engine output must be measured, or something like that.

MR. WILLMOTT: Must be noted.

MR. BAILLIE: Documented, something.

MR. WILLMOTT: The engine which also operates the propeller and the fuel control, normally the prop would be somewhere.

MR. BOOTHE: The next block addresses engines, and all we really do about engines is measure an acceleration and a deceleration, under [AC120-]40B it says acceleration approach or landing, I guess that was for--if that's the airplane configuration or the flight condition. I thought we would just--you didn't accept just a static acceleration--

MR. KOHLMAN: Our training device includes both air and ground accels and decels.

MR. WILLMOTT: The acceleration was supposed to be for the go-around situation.

MR. HEFFLEY: Question. On this, though, acceleration of what? I mean, we have three or four indicators there, all of which have different time constants and really all of which ought to be about right. Torque, N_1, ...

MR. SMITH: Primary condition of pilot--

MR. HEFFLEY: Fuel flow.

MR. SMITH: Torque.

MR. BAKER: Torque and rpm in most turbo props.

MR. BOOTHE: If it were left strictly for me, I would use for a given throttle change propeller speed, because all the other stuff is in between. And if the torque is not there I won't get the rpm built up in the proper time.

MR. HEFFLEY: I guess I was worried about those distinctions and you all are saying you don't really have to worry about the distinctions in the individual cases?

MR. BOOTHE: I wouldn't say we don't need to worry about them, because they need to be presented correctly to the pilot, but I would be reluctant to say we want to measure all of those things because I just don't see that that really gains us that much. If we take an end-to-end engine simplified performance measurement, which is all this really is, that's sort of--that includes all those things but it doesn't mean they are correct.

I mean, they could be compensating for one another. But then the other part of that equation is I think those have to be cockpit instruments, and if the simulator is wrong it should be noticed during some subjective test in that respect. So I think an end-to-end measurement is good enough here. That's what we have accepted. In fact pretty much across the whole spectrum of simulators.

MR. BAILLIE: The intent of this may be twofold. One is thrust transient as in how fast the aircraft accelerates, and there are probably other tests to do that. And the second is when a pilot is making abrupt movements on the throttles or condition levers he has to track a little to make sure it doesn't go on limits.

Perhaps the best approach would be to define for a given type what the parameter is, whether it's torque, temperature, rpm, that's the one that has to match, and the others are subjectively similar.

MR. WILLMOTT: I think the international simulator standards spell that out, I think it's either N_1 or torque in that order for the engine acceleration. And the other thing is fuel flow, ITT, and the other engine parameters are normally checked by the qualitative, subjective evaluation, there is nothing in the requirements for the regular jet for this, subjectively evaluating, start, shutdowns, climbs and chops, looking at all engine parameters.

MR. BOOTHE: Well, that's exactly right, it does say what you said. This is not the international standard, but 40B says the same thing in that respect. I guess what we need to do is leave that as it is, it already says what can be measured, and see if we are content to do it with something as simple as a stopwatch and calibrated aircraft instruments. That's the issue here.

Can we? Is that something that is within the time frame we could do that or does it happen too quickly?

MR. LEISTER: It happens too quickly, you could do it with a video camera then transcribe it. It's too quick to do it. I can't see that fast. Most of them are too quick.

MR. SCHUELER: Too dynamic.

MR. BOOTHE: We have video in the block, so it's there.

MR. BAILLIE: Do you need to document the input?

MR. LEISTER: Yes.

MR. SMITH: Yes.

MR. LEISTER: You better.

MR. BAILLIE: Okay.

MR. RAY: Absolutely.

MR. LEISTER: And video is a real good way to do it. You just can't do it really otherwise.

MR. BOOTHE: Also there is a reference I have put in there to AC120-45A, which is the training Advisory Circular which simplifies that somewhat, I think. The point being is that all we need for Level B? [AC120-]45A gives a plus or minus one second for Levels 2, 3 and 5. Otherwise it just says ten percent of time. Whereas for a simulator we say we establish a time initial and a time final and time total. Which you almost have to do anyway, but I was looking at some simplification.

Giving it a second look now I don't think it works. Because at a recent training device case we had to go to 40B and come up with an initial and total time to make this work, anyway, so just scratch the 45A bit off of there. It doesn't work. And the Advisory Circular already gives you the latitude of using whatever engine parameter that is here called critical, so I don't think there is much more to say about that really.

MR. LONGRIDGE: Good.

MR. BOOTHE: I think we have closed down.

MR. LONGRIDGE: Keep going, you are on a roll.

MR. BOOTHE: This gets us over to handling qualities area, so we are about half through here, static control checks, and I couldn't find a lot to do to simplify this. You notice there is a single asterisk, which means there is some test instrumentation required, and in this case it's a force and position measurement system.

The thing that I have changed is that perhaps as we began discussing earlier today, the surface position measurements could be simplified by doing some on ground calibrations, and Chuck [Stocking], you said you did that in one case.

MR. STOCKING: Established the control laws, right? And as long as those hold when you are airborne, there is no reason you can't use the control position to develop your surface position.

MR. BOOTHE: I said here surface position could be measured from the flight data recorder sensor, or if there is no flight data recorder sensor at selected column position using a control surface protractor. There are such things, I don't know if that's the proper name for them these days. Which would do what I think you said you were doing.

MR. STOCKING: If you are going to record the control positions continuously when you are doing a flight test, off line, you can generate what the elevator position is to go with that by knowing what the control laws are.

MR. ELLIS: How much do you have to get into cable stretch and things like that?

MR. STOCKING: Well, I measured it in the aircraft. For that aircraft, I put in gust locks and I looked to see where the cable stretch was. In that aircraft it was in a T bar in the front of the cockpit, and that's what we used in the simulator, so our model didn't have stretch in it, it was already part of the simulator hardware. And--

MR. LEISTER: Works quite well.

MR. STOCKING: Go ahead.

MR. BAILLIE: How do you take into account things like dynamic pressure caused by engine slip stream over the tail and its effects on trim tab, string tab, all these tabs into that model?

MR. STOCKING: I can calculate those.

MR. BAILLIE: All based on approximated dynamics?

MR. STOCKING: Yes.

MR. DAVIS: You are going to calculate them and use that, this is my calculated elevator position, that's probably used in your simulation.

MR. STOCKING: It's not elevator position, it's the force you are generating.

MR. DAVIS: I'm sorry, I thought we were talking about the--

MR. STOCKING: As long as it's still connected by the control to your control position you are just talking about the generation of forces, and if you are recording the forces and the positions, you have got everything. If you want to back out what those are, your power effect on that surface, you have to include that in your aerodynamics. That gives you the force that represents it. Otherwise you won't get the correct force. It's a reversible control system that's being reflected back.

MR. BOOTHE: I don't hear much objection to what I have said here. In fact what I hear it's already been similarly done.

MR. STOCKING: Yes.

MR. LEISTER: Hundreds of times.

MR. BOOTHE: Hundreds of times. Then Stewart [Baillie] suggests small control sweeps in the air. Could I ask you to describe that for us?

MR. BAILLIE: I wasn't sure what I meant by that other than perhaps--

MR. STOCKING: To get a control system inertia, things like that. We do a test, you start off very slowly and just keep increasing frequency with it, but you need really fine test equipment in the aircraft to record the aircraft response to that to get the proper--see where the flight control system rolls off, that type of thing. That's really a high fidelity simulator that we do that kind of work.

MR. BAILLIE: That is certainly something for the modeling side, but whether it wants to be a validation--

MR. STOCKING: Yes.

MR. LEISTER: I think it should replace the control force dynamics test strength, they degrade a simulator worse than anything after you put them in the simulator. If you make the simulator work. Because the control force dynamics test, rapid control, let it go. I think most [of] the time you are meeting the dynamics response of the stream, whatever you are measuring the position with into the data.

I never have seen a simulator that flew better after those things were tuned into it. I think the small inputs like that would be much, much superior.

MR. BOOTHE: What do we have to do to instrument for it?

MR. BAILLIE: We are just comparing control applied force versus column, as an example, position. We are not instrumenting anything further back.

MR. LEISTER: Yes.

MR. BAILLIE: But we are getting the effect if I have inertia of the whole control system as seen by the pilot.

MR. LEISTER: That's what you really care about.

MR. BOOTHE: So we could instrument to do this on an airplane in flight?

MR. HEFFLEY: But you have to use a string gauge.

MR. BAILLIE: You have to measure applied force at the column wheel, pedals and column position, wheel position.

MR. BOOTHE: But you have to instrument for that, anyway.

MR. BAILLIE: Unfortunately.

MR. HEFFLEY: In this case, yes.

MR. BOOTHE: So am I hearing that it would be better to do a frequency sweep than it would to be doing a control dynamics?

MR. SMITH: They aren't required for [Level] B.

MR. BOOTHE: That's right. For B they aren't required anyway. Thank you.

MR. SMITH: But that's an interesting subject, because Ken [Neville] could explain what they did for CFDs on the 777, they used a method of, it was--essentially eliminated hooking the wire up.

MR. LEISTER: CFDs are okay if you use a laser, but if you put a string in there--

MR. BOOTHE: Thanks, Hilton [Smith], I sort of overlooked that. Do we need to even mention the frequency sweep in that case? Since for Level B we are not doing a dynamic case anyway.

MR. KOHLMAN: If it's not required, let's not add requirements.

MR. BOOTHE: All right.

MR. KOHLMAN: We are going the wrong direction.

MR. BOOTHE: I'm going to scratch it here.

MR. WILLMOTT: I have made a note to myself that the maintenance manual gives you good data for the ground surface to pilot control reading, as Gerry [Baker] said, you normally check that the aircraft that you are testing meets those standards before you go and test it anyway. So it's another source of data for surface position versus control column.

MR. STOCKING: As a matter of fact, that's where you start, with the maintenance manual.

MR. BOOTHE: Well, we can enter at column four, maintenance manual, if you want to as a data source. For surface to controller calibration or something like that.

MR. STOCKING: Yes.

MR. WILLMOTT: Surface to pilot.

MR. BOOTHE: Okay. I don't see anything that should be different for the wheel or the rudder pedal.

MR. BAILLIE: One point I would like to make, that if in a Level B simulator if we are not looking at the dynamic force versus position characteristics of the controller, we should reduce the requirement for matching control force applied on maneuvers such as V_{MCG} and those type of maneuvers because we are not requiring to match them dynamically. It's sort of if you have reduced the requirement to match the dynamic cases separately, then why should you have to match them in a dynamic maneuver, which is harder to match?

MR. RAY: There is a bigger question, though, in a training scenario the accuracy of what you are giving to the pilot can't degrade one area that you've set no tolerance for, no standard for it and negate the training implications, the potential there of avoiding the test will have a big impact on training.

MR. WILLMOTT: I think the biggest influence on those forces, too, is the static friction more than it is the viscous friction.

MR. BAILLIE: It would have to be an inertia.

MR. STOCKING: I was going to say if your controls people need an inertial, you can do that on the ground, you can do oscillations on the ground and measure just the inertia of the control itself.

MR. HEFFLEY: You also have downspring and bob weight. All the things need to be in there in the right way. Then you add the air loads to them after you get them off the ground.

MR. STOCKING: I can disconnect a downspring.

MR. WILLMOTT: All of that has to be simulated and normally what you do to get the force deflection curve is put a Fokker unit on it. If you have a Fokker unit on it you can get inertia or mass out of it.

MR. BAILLIE: The comment I was trying to make is we have just said that a Level B simulator you don't have to look at the dynamic force, which is position, and yet the essential part of making some of the other matches we have already agreed upon.

MR. SMITH: Maybe we ought to say we don't require a validation test for the dynamic control characteristics, we trust you to model the control system properly.

MR. BAILLIE: Effectively it means that regardless of whether it's in the ATG or not, the simulator guys are going to have to measure it anyway. So the fact that we are not putting it in the test doesn't reduce any cost to the simulator company. Or to the owner.

MR. DAVIS: I think to be fair, V_{MCG}, steady sideslip, they are more interested in the static force required to hold a pedal position, not within five pounds dynamically. My experience is they are generally practical about that, how much pedal force is what they are focusing on. They don't say that, but when it comes down to it, they are not worried about dynamic, oh, a small shift in time, they don't seem to get hung up on that.

MR. LONGRIDGE: Okay.

On that note I think we will adjourn for the day. Unless you would like to keep going.

MR. BOOTHE: Thank you.

(Time Noted: 5:00 p.m.)