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YEARS

THIS REPORT HAS BEEN DECLASSIFIED

Report of an Informal Discussion Between Dr. Clarke Millikan and Officers of the Bureau of Aeronautics on 7 July 1945.

Note: Since Dr. Millikan departed before the transcription of the conference was written it has been impracticable to correct all errors resulting from the transcribing process. Because of the broad scope of the discussion, the transcription is now being made available to Naval contractors and other interested activities without further correction in order to ensure timely dissemination of the information.

AC Form No. 1
(17 Oct 44)

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SUBJECT: Report of Trip to Germany by Dr. Clarke Millikan

TO: ~~Col. Kemmer~~ ~~Col. Smith~~ ~~Col. Rebey~~ Col. Dent ~~Col. George Price~~

FROM: TSENG

DATE: 15 Apr 46

COMMENT NO. 1

1. The attached report of a conference held in Bureau of Aeronautics, at which Dr. Clarke Millikan gave a preliminary report on his trip to Germany, is rather old but has a lot of good information in it.

L. C. CRAIGIE
Brig. General, USA
Chief, Engineering Division

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3-0151

Incl. Subj. Report

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CONFIDENTIAL

BuAer board room July 7, 1945 at 1600.

Gentlemen:

We are holding a meeting here this afternoon and are very glad to have the pleasure of having Dr. Millikan who just returned from Europe after a period of five weeks in which he's been able to look into the developments and research going on in Germany that we've been investigating. I want to hold this meeting most informally this afternoon. Dr. Millikan has kindly consented to come here and give us some of his impressions and for your information also, we have the room wired up with a microphone and Dr. Millikans remarks and his answers to questions will be recorded and we'll have them transcribed so that you people may have the benefit of reviewing them later on. In case you wish to ask any other questions we will be glad to obtain the answers for you. I'm going to ask Dr. Millikan that when questions are asked that just for the purpose of recording that you will merely repeat the question so that the mike will pick it up and in that case we will have the full recording, and particularily since the meeting is informal I'm also going to insist that Dr. Millikan sit down and in that way be close to the microphone too. I'll just turn the meeting over to Dr. Millikan.

Dr. Millikan:

Thank-you, Capt. Halpine. Gentlemen, this is a great and very unexpected pleasure and I wasn't prepared to give a talk to such a distinguished group of people as are here, and actually after a short and in some respects as hectic a trip as this has been, one's ideas, I find as I sit down and try to put a few ideas together, are not very well coordinated and synthesized as yet so that, what I thought I might do was just make a few comments on certain specific activities and developments which I happened to run into in Germany and England. I should first say that my comments are apt to be very limited in scope. I was primarily interested in Aerodynamics as applied to aircraft and to missiles, and also very much interested in the techniques that have been developed for obtaining research information on those subjects. I am going to mention one or two things in my comments here that lie outside my field of Aerodynamics and I'll perhaps make special apologies when I do that to the people in whose field they do lie. I thought perhaps you may be interested in the rather elaborate, in fact, the extremely elaborate research setup which has been in effect in Germany for the past ten years or so, there have been very numerous research establishments upon quite a large scale under the auspices of the aircraft ministry, which is called, abbreviated for short as the RLM, Riechs Luftfahrt Ministerium. I thought I might list a few of the major ones and describe a few of the facilities that are in some of these establishments so that you can see the magnitude and the scale on which the Germans have this Aeronautical research set-up. The chief Laboratory, which I presume would be called the DVL, was located in Berlin and was a sort of central laboratory of the RLM. It might correspond to a sort of combination of our NACA Laboratory and Wright Field and the Navy's establishments sort of rolled into one, for Aeronautical research. First I'll just list these 4 or 5 major laboratories and then discuss them a little. The first in importance is probably the famous Herman Goering Institute at Volkenrode just outside

Brunswick. Then there is the so-called AVA (Aerodynamische Versuchs-Anstalt) t Gottingen which was sponsored by the Aircraft Ministry and adjacent actually on the same grounds, is the entirely independent laboratory under Professor Prandtl, the so-called Kaiser Wilhelm Institute which has been a separate institution for many years. It now looky physically as if it were more or less absorbed, but Prandtl insists that it is essentially independent agency and has nothing to do with the AVA, which is under Dr. Betts direction. Then there's a very ambitious project, which was in the construction stage which I'll describe a little more later, at Munich. Finally the sail-plane institute under Dr. Georgii which was originally at Darmstadt and has been successfully evacuated and finally wound up in Ainring over near the Austrian Tyrol.

Now these are all essentially aircraft ministry establishments and as you will see when I describe briefly some of them, each is on a fairly large scale. In addition to that, there are the establishments which are under the auspices of the War Dept., and the SS had a few of them, there was quite a number of other agencies, the only one I'll mention is the Peenamunde establishment which developed the V2, or A4 rocket as the Germans call it and which was evacuated from Peenamunde down thru Germany and finally wound up at Garmisch and Kochel down in the Tyrol and was independent from the aircraft Ministry. Now I thought I might describe very briefly a few of these establishments and give you an idea of their magnitude, the DVL I know very little about and I think very few people this side of the water know much about it because that, being in Berlin, was taken over by the Russians and as far as I know has not been visited by any of our technical people at all. We do know the names of the people who were there. Several of the good ones actually got out of the Russian zone and are somewhere in the American zone now and it's possible that some of them may be actually brought to the States. In any case, it was a very large and very well equipped laboratory but I shall not describe it since I haven't actually seen it. The Herman Goering Establishment at Volkenrode, Brunswich, is an enormous place.

Apparently it was kept from the Allies knowledge almost completely although the Germans said the Russians did know something about it. It was built in a woods, in three woods as a matter of fact, and covers an enormous area, with the most elaborate camouflaging I've ever seen. As a matter of fact, the camouflaging goes so far or perhaps it's just the nature of the woods, that as you walk around you can come within a hundred yards of a building before you see that it's there at all. Even though the sides of the buildings aren't camouflaged the woods are very thick on top, and on one of the wind tunnels they have 3 feet of sod all planted with a forest growing on top. I've seen the bombing of the reconnaissance photographs and apparently we never knew it was there at all. In any case it was never bombed although it is right adjacent to an airport. The airport was bombed but the experimental establishment was completely untouched. It has employed several thousand people. There are 7 or 8 large wind tunnels up to about 20 feet in diameter, the working section of the largest one was a little over 20 feet in diameter. There were 4 very good supersonic wind tunnels. There is a very elaborate and complete engine test installation

off in a separate woods by itself, with perhaps half a dozen buildings for the engine division, completely separate from the aerodynamic and wind tunnel. There is another division in a separate woods which deals only with Armament problems, which has I suppose the most elaborate ballistic ranges of anywhere in the world, underground tunnels that are very long, a good many thousand feet long with very elaborate ballistic recording apparatus in them, and with little wind tunnels blowing sideways across the ballistic range to give the effect of side winds and yaw on bullets. That's an enormous and elaborate place that I just didn't get to because there was so much to see there. In addition to that, there is a Rocket research establishment which is separate under Dr. Busemann and some miles away, with large mathematics and theoretical section.

It's a really tremendous place and they told us that they had all the money that they could possibly spend, and were asked to come in with recommendation with more to spend which they couldn't use. They said they couldn't use their appropriations up even in the last couple of years. They were apparently very elaborately supported. The establishment at Göttingen does not have nearly the physical equipment of the Brunswick tunnels. It has one big 20 foot tunnel, but then a very large number of small special purpose experimental tunnels and other facilities that are set up to investigate special problems. There are 3 or 4 tunnels in which they are doing a lot of work on non-stationary motion. They are doing a lot of flutter work by oscillating heavy metal airfoils in water, and they get very good reproduction of the normal airplane characteristics. They are apparently using that technique a great deal. They have a lot of supersonic tunnels, small supersonic tunnels, 2 or 3 of them pretty good size. They have a cavitation tunnel which I will mention a little later in connection with a high speed research project which they're doing there. They have a very complete installation for testing turbine and compressor blades and all sorts of thermodynamic and heat transfer problems are investigated, and probably the best collection of scientific brains that there was in Germany, if you take both the people under Betts' direction in the AVA and Prof. Prandtl's group in the Kaiser Wilhelm Institute. So, although it isn't on so grandiose a scale as Brunswick it was certainly one of the very effective institutions in Germany. Munich was the brain child of Däumke's I understand. Däumke was the director of the aircraft ministry until the last year or so, and he felt that there should be in the South of Germany an elaborate installation set-up analogous to the Hermann Goering one in the North, and consequently they established this very elaborate one in Munich. It was only under construction at the time of American occupation. They have one 9' in diameter wind tunnel which reached mock number 1, with about 12000 horse power. They had 3 or 4 supersonic tunnels that were under construction, one of them perhaps the most advanced supersonic tunnels in Germany, which actually, a Navy Lieutenant and I discovered and tagged and the last I know it still had Navy tags on it but maybe the Army's taken them off by now. In any case, it was sitting on the cars and had never been assembled. The compressor and all the equipment was furnished by Brown-Bavaria, Switzerland. So there is a continuous-operation supersonic tunnel that's just waiting there for somebody to pick it up, ship it off and put it together somewhere else. It had never been used. They also have very elaborate engine and rocket motor tests installations planned. The buildings were about half up. They had in the motor laboratory as I

remember, 10 test stands and in the rocket laboratory another 10 test stands, so that they could carry on 10 simultaneous tests on either rocket motors or jet propulsion or gas turbine type of motors. That was a very elaborate installation but not completed as yet. The most fabulous of the developments was the largest wind tunnel, I suppose the most powerful in the world, which was being built under the auspices of the Munich Institute but down in the Tyrol just close to the Italian border, in a place called Oztal. It was known as the Oztal tunnel, it had a working section diameter of about 20' reached a mock number of 1, was driven by a 100,000 horse power which was obtained from two 50,000 horse power pelton wheels. They put in an enormous hydraulic project for 500,000 kilowatts, even put in a dam which was under construction and 400,000 of the kilowatts would go for electric power and about 100,000 were to be taken to drive this pelton wheel to drive the wind tunnel. That wind tunnel had been under construction for several years. It's usually called 70% complete although the actual steel structure is somewhat less than 70% complete, but apparently all the machinery was finished. The two pelton wheels are setting there. The steel structure of the thing is pretty well up. The buildings are largely up and apparently it would have been ready to operate within another 6 months or so. It, by the way, was equipped for handling complete jet power plants up to at least 4000 lbs. thrust with full power and running at a mock number as close to 1 as you could run without having the tunnel choke. It's a really gargantuan undertaking. The only other one that I want to mention is the Army one, which at the time that we were there was in Kochel having been evacuated from Peenamunde, which was primarily a ballistic research establishment. As I say, all of the work, practically all of the work on the German V-2 was done by this Peenamunde group, It was a very extraordinary group. They had no geniuses as far as I could discover among them but a large number of highly competent and qualified engineers and scientists. But as I say, none of them being outstanding, they turned out what to my mind was the greatest volume and the finest supersonic wind tunnel work of any place in the world. I think the material that they turned out during the course of this V-2 Aerodynamic research is simply remarkable and we are fortunately going to have a complete record of it. The Army had Dr. Zwicky as a Technician and he got them to work at 8:00 in the morning and cracked the whip and made them all finish up all the reports they were writing. They had buried most of their documents and he made them dig them up, put the photographs back in. We're going to have 183 reports out of Kochel and a nice volume when Zwicky gets through with it, which is about now. That project actually was handled better I think than any of the establishments we moved in on. We will have a complete documentary record of everything they did. The tunnels are still there. There was no fighting in that area. Actually I think your Lt. Cdr. Biot from here shanghied a tank company and went in and took over Kochel before the combat troops had gotten in and put a guard on it so that nothing was disturbed there. They had by the way, two supersonic wind tunnels about 15" by 15" cross-section working sections which ran intermittently. They evacuate a great big sphere down to very low pressure, and then let the air rush through the tunnel into the sphere and they can run for about 20 seconds during which time they get their observations. They have the highest mock numbers of any tunnels actually running in Germany going up to nearly 4½ times the speed of sound and actually have done a simply enormous amount of work on projectile shapes, thin, small wings on projectiles. These proposed

again, which has been pretty well dropped out of the catagory of things that we were interested in in America but it does seem that with sweepback you've practically got to have tipslots and they've got to be very carefully designed, so that you can maintain the lift of the wing tips and not have lateral instability. Another thing is that the normal high lift devices on sweepback don't work very well.

Conventional flaps don't show up very well with high sweepback and the Germans have developed, especially for these, very thin pointed wings which are necessary at high speeds; it's a new kind of flap which is a nose flap with a little piece of the leading edge simply flipping down from the leading edge of the wing and sticks out like this. It is the damnest looking thing you ever saw in your life, but the lift actually goes up to quite high values and it works with sweepback, that is a development which as far as I know had not been used in flight yet. Cdr. Sweeney may correct me in that but I don't believe that it appears on any airplanes, but it certainly is going on them in the immediate future. Well, that's one of the fields where we have a lot to do and we've spent a lot of time and gotten a lot of effect in reading all the reports the Germans have written, because there are a lot of them on this whole sweepback technique. Another one which to me is very interesting, which is a little further off, is the development of ram-jets, or jet-power plants without compressors. There were a lot of people working on that, but there were two developments which I think were outstanding; one was by the Folkewolk Co., a young fellow named Pabst was responsible for it. He had first gotten a new conception of how ram-jet works, which I think was a very fruitful conception. Perhaps it might interest you if I describe it in just a second. The ordinary calculations for ram-jets are usually done by calculating the momentum coming in the momentum coming out and the thrust is the difference, the excess of the momentum going out over the momentum coming in, and that has always been somewhat unsatisfactory to some of us and apparently it was entirely unsatisfactory to Pabst because Pabst had said you don't ever get a thrust except when it is the result of some pressures acting over a surface and he wasn't satisfied just calculating these overall momentum exchanges. He said where does the pressure act, and where does the actual force exist on the ram-jet, and what he discovered was a thing that one would think of if he thought hard enough and clear enough, immediately, is that it is the pressure, the suction, over the leading edge of the ram-jet. It is exactly like an NACA cowl, and the effect of the combustion inside is primarily to put a blocking effect in, which gives you a stagnation point on the inside of the cowl with a very high velocity over the nose and he calculates the pressure distribution and gets the resultant forward force, the thrust, and his ram-jets are very reasonable, sensible looking things. They look very much like well designed NACA cowls, they're short and fat instead of these great long things that everybody else was working on for the ram-jets. That was one very important development and another is that he became entirely convinced because the internal shape of the ram-jet is so important that you couldn't have these terribly long things and therefore it was necessary that the combustion chamber be shortened, so he completely abandoned the idea of combustion of liquid fuels. He uses only gaseous fuels and when he uses gasoline he uses a separate little combustion chamber and vaporizes and preheats the gasoline before he feeds it into his

combustion chamber as a gas and when he does that his total combustion chamber is only about that long and it's independent of scale. He builds his models with the same size actual combustion units as full scale and the whole combustion chamber about that long and that's all you need. He gets 100% combustion in some 20 centimeters. Those things are very remarkable and that has been tested in the high speed wind tunnels up to a mach number of 9/10's and gives a fuel consumption as far as I can discover, although I don't have the figures very accurately on the intermittent motor*figures that I've seen. It's a very, very remarkable development that was not in flight either, but they had thought that Focke-Wulfe was working on planes to use this ram-jet as a power plant. The other is a still more fascinating development, which is the high mach number supersonic ram-jet which Oswatuch from Goettingen had been working on, and he said the essential problem here was to get a supersonic defuser that will give you large pressure recovery and he had actually developed a supersonic defuser at a mach number of 3 which gave him twice the impact pressure that you would get with an ordinary Pitostatic tube stuck up there, out in the free stream. He caused a series of oblique shocks to occur so that you got the velocity successively stepped down until just before the entrance to the actual closed defuser the velocity was only slightly above the speed of sound and then had a normal shock with a relatively small entropy increase and got this very efficient supersonic defuser, he had calculated. They had not made any actual burning models of his defuser, his were designed primarily for missiles for the War Department not for the aircraft people, but he had made calculations on the basis of his actual experimental data and at a mach number of 3 he got overall thermodynamic efficiency for his ram-jet of between 40 and 50% which is a perfectly fantastic figure. The compression ratio that he gets in a mach number 3 is 19 to 1, which makes the high thermodynamic efficiency not unreasonable. That's something that I think very definitely is going to be pushed very, very rapidly and we have his complete reports and designs and I think we can go right ahead and work on it.

Another development which is out of my line but which I will take just a minute to describe, or rather two developments in the gas turbine field which apparently are not very well known by the power plant people yet, one was done at Goettingen and was a ceramic heat exchanger for gas turbines whereby the heat of the exhaust gases from the turbine is taken out and fed into the air coming from the compressor before the combustion chambers so that you get a regenerative turbine cycle. The weight of this installation is very light. The weight is about 3/10 of a pound per horse power which is fairly heavy for a jet engine but the thermodynamic efficiency is up around 40 or 45%. A 5000 kilowatt shaft power turbine had been developed to power the ME-264. The ME-264 was that long range bomber that they were talking about coming over and bombing New York with, and the turbine for that which was to deliver 5000 kilowatts shaft power was to have the Ritz heat exchanger on it and the fuel consumption calculated on the basis of his experiments for that was .31 lbs. per horse power hour which I think is thrust horse power per horse power hour because the comparable figure for 4-cycle Otto engine and propeller that he gives is .48 which the fuel consumption is cut down to not very much over, well, it's about 2/3 of what our present fuel consumption is with this device. Ritz is a first class scientist, he is not as practical an engineer as the next man that I'll

*but the fuel consumption is a little better than the best intermittent motor

mention, Dr. Schmidt, but I think certain development has processed far enough and looks as if it had enough promise to be worth very, very, careful investigation by experts who are more able to judge its value than I am. The other gas turbine development was done by Dr. Schmidt who was the director of the engine laboratory at Brunswick at the Herman Goering Institute. What he was trying to do was to get higher combustion temperature and in Germany they were apparently terribly limited on alloys. Everywhere you went they were struggling to make the cheapest kind of materials work for them and they apparently had no alloys to make high temperature resistant steels, so his problems was to get high temperatures without the special alloys and he did it by a very ingenious system of water cooling. He drills 3 little radial holes in each of the blades of his turbine and the water is forced in through the hollow shafts and as it gets into these little radial holes and the surface is hotter than the center of these little holes because of all of the heat coming from the combustion and so you get a slight difference in density of water on the edge which is heated and the water in the center which is not so heated and in the tremendous centrifugal force field due to the rotation, it gets up to 2000 g, you get a very intense circulation with the water coming out the sides of these holes and down the middle, and out near the outer edge of the blade where you need the cooling most, the conditions are such that with this tremendous pressure the water is actually about at the critical stage (doesn't know whether it's a gas or a liquid you get very, very high heat transfers) and he says that there was plenty of cooling to carry away the heat from the blades without any difficulty at all. Then the water is forced down into the middle and as it gets into the shaft the pressure is reduced and it is driven out the other end of the shaft as steam where it drives a little auxiliary turbine (little steam turbine) and is cooled down and goes back into the cycle. The Man Company, which is one of the largest rotating machinery companies in Germany, had contracted and was building a 10,000 kilowatt stationary power plant using these water-cooled blades in which they had guaranteed an overall thermal efficiency for the plant of 35%. They expected to get up close to 40 but it guaranteed 35. He was able to run his combustion chamber, his combustion gases, at 1200° centigrade which I think turns out about 2300 Fahrenheit, with ordinary mild steel blades. As far as I know the highest temperatures we can reach are the order of 1500 Fahrenheit so he's pushed the temperatures up 500 or 600 degrees with this thing, but it seems to me both of these are developments which are well worth some investigation by power plant people and may really cause considerable revolution in our power plants.

I think that I talked longer than I expected to now, I think perhaps I had one other item down here to mention which is research airplanes. There isn't very much to say about that except that both the Germans and also the British had very active programs on for developing airplanes to go up into this supersonic region. The Germans had one designed by Lippich which was under contract by Sieble designed to reach a mach number of 2 with 2 rocket motors of the type that power the ME-163. That was a very carefully laid out design with a lot of very interesting features on it. Junkers was developing an improved 163 which I think they hoped to get up to the speed of sound or a little through. Messerschmidt was doing a very elaborate series of research airplanes in an attempt to push the 262 up higher. They weren't hoping to get through the speed of sound. They were perhaps closer to technical airplanes than these others, but it's felt that people are very much interested in and a lot of work was being done in Germany and I myself

feel that a lot of work should be done here because I think the problem that we're running into as we get into these small supersonic velocities or high subsonic velocities are so difficult that we just won't solve them unless we get some airplanes up that actually fly at those speeds. I think that you only get these with airplanes specifically designed for that purpose and not designed for any immediate military operations. Well I've talked longer than I'd expected to, and I'd be very glad to discuss anything that you care to discuss.

Beginning of questions and answers:

Question: What's going to happen, Doctor, to the gear that is over there, wind tunnels and that sort of stuff, is there any plan made for the shipment?

Dr. Millikan: The question as to what's to happen to the wind tunnels is apparently still very much up in the air. I gather that a meeting is being held early next week which as far as I know is the first time that the various agencies interested have ever gotten around a table and there will be some table banging and deciding as to who's - - General Phillips is calling it, I think. I'm sure the Navy is represented and Ordnance, CNO, BuOrd, and I think Buaer, there are - - -/

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As far as I know plans for evacuation have gotten so far that everybody agrees that some German personnel are to be brought over here. Just what the mechanism or how they are to be treated and handled I don't believe anybody has faced yet or solved. It's a very difficult problem.

Someone else: That is being worked out by OP16, Naval Intelligence. We're going into that matter in order to bring it under proper control and expect that they will handle these people that are brought over and make them available to us as desired.

Dr. Millikan: Who's OP16?

Someone else: That the Navy Intelligence Center OP16PT received all information and captured enemy material and the scientists are considered no more and no less than captured enemy material and will be treated as such. They will look out for them, Sir.

Dr. Millikan: There is certainly a lot of material that is valuable, no question about it. We've had very active people both the Navy, the Air Force and Ordnance, have pulled out a lot of stuff and put it into good safe American territory for further distribution.

Someone else: Well, that's what I had in mind. While all the meetings are being held in Washington I think somebody over there ought to be trying to get a hold of some of this stuff.

Dr. Millikan: They have been getting a lot of it. As far as I know these Kochel win tunnels hadn't been moved when I last heard. We sent down just when I left, a team to work on this Munich wind tunnel. We got hold of the fellow who did the designing, he was a former MIT professor who was there and was very cooperative with inventorying the whole thing and telling us just what parts belonged together out of this terrible mess. That was one installation which was very seriously damaged, but not by fighting, it was the displaced persons and mostly GI's. They came in and were billeted there and there was nobody to protect the place, and it's a mess! Everything is dumped together and it's an awful mess. It will take weeks to straighten it out. We recommended that they get 10 or 12 German engineers that were setting around there doing nothing who had actually constructed this thing and put them in to clean up the mess, and they were very anxious to do it. They wanted to go to work to do something so I think that our team is now working on that tunnel, whether they've actually evacuated it or not I'm not sure.

Question: Doctor, from your observation over there in regard to the larger pieces of equipment, etc., which would be impractical to transport over here, what would your opinion be in regard to the possibility of our establishing a unit in order to operate and see the value which can be obtained, until we could duplicate them in this country?

Dr. Millikan: The British are talking about doing that in Volkenrode. You see, that is in British territory. We had it, then the British moved in and took over and there is talk about their operating it as a British establishment. I myself am inclined to think it a little dangerous. I think we just don't want such big research centers left in Germany and I think we ought to pull them out or blow them up, probably that's a pretty tough thing to say to the poor German scientists, but on the other hand, I don't see any assurance that the things won't be misused again. But that is a purely personal thing and this is obviously something that's got to be settled on very high levels, promising determination.

Question: That would be after we had had an opportunity to study and reproduce them ourselves. I was thinking of using them up until that time and destroying them later. I just wondered if you had a chance to observe what might be practical billeting?

Dr. Millikan: Some of them could certainly be used. There's no question that Kochel could be run today and all of Brunswich and all of Goettingen could be used, they could start right in, local staff ready for action.

Capt. Halpine: What is the attitude in general of the German scientists toward the cooperation in that way?

Dr. Millikan: All the experience I had, with two or three exceptions, were most cooperative. They are primarily interested, I think, in science, technology and they don't care much who they work for. I don't think there were many ardent Nazis among these technical groups. There probably were a few, but I don't believe there were very many of them. On the other hand, and I find

the same thing true with the best of the airplane designers we talked to, I find a great difference between the awareness of the situation on the part of the professor and the fellows in the research institutions, and the men in the aircraft factories. The men in the aircraft factories say, we know we're through, there'll be no more airplane built in Germany, and they would like to come to the States to do anything they can so that they can go on working on airplanes. People in the the research institutions are kind of thinking, well pretty soon this is going to be over and we'll last out 6 months and then we'll go back to work again. Prandtl for one I know. Col. Dane is in charge there in Goettingen, and Prandtl comes every day and wants to know when he can start to work again, in other words, the scientists just don't see that chances are they are not even going to get to work again in those same establishments, but almost all of them were very cooperative. Apparently during the early days there was some non-cooperation and a few tough fellows like Tony Diot put guns at them and they got pretty cooperative but by the time we got there they were all very cooperative. They are all just scared stiff of the Russians, that's one thing. They're just scared stiff of the Russians and they say they want to work with us against the Russians.

Question: How far along were they toward plans of landing the rockets and buzz bombs?

Dr. Millikan: I heard, of course, about the tales about rockets and buzz bombs that were to cross the Atlantic, and Lindbergh who was over also on NavTecMisEu auspices about the time I was and spent about two days talking to Messerschmidt himself, Willy Messerschmidt and Messersmitz spent all the time talking to him about long-range rockets. I think it was a cover up myself, I never was able to find that they really had these long-range rockets where they were close enough to be imitated. I think Messerschmidt thought he would rather talk about long-range rockets than about 800 m.p.h. airplanes. Probably, but I don't know. Lindbergh didn't think so, he thought Messerschmidt was being honest with him. I'm a little dubious. They certainly were working on it but I don't believe they were as far along as the scare headlines lead us to believe.

Question not clear.

Dr. Millikan: That is very hard to tell because we do have I know, extensive plans and in some cases the construction has begun on supersonic tunnels, but that material has been so terrifically classified and so difficult to find just what was going on that I don't know just what supersonic tunnels we've got under, I know what ones I've been working with but I don't know any of the NACA tunnels, I know that they have a lot of them, it's very hard for me to tell, I could say how much you would have to expand what is actually now existing and running but how much you'd have to expand, what is under construction I just don't know. I'm inclined to think that our supersonic, no I'd say our transonic equipment, the wind tunnels to go to the speed of sound, say 9 or 10 foot throw, that sort of thing, is probably as good and perhaps better than German's now. The supersonic tunnels, they have a lot of them,

and I think we should have a lot of them, they're not enormously expensive things so I think that duplication in that field is awfully hard to do. There is so much work to be done that it's pretty hard to get the many facilities and to begin duplicating.

Question: Do you think the rapid strive in methods used by the Germans is partly due to the large scale programs they had or is it due to their education, to their system of educating people?

Dr. Millikan: Well, I think it is due to both. I think their system of training engineers has been better than ours. I think we're improving, and have been steadily improving for the last 10 or 15 years, but I don't think we are quite caught up to them as yet, and I think this procedure which they followed of setting up considerable numbers of semi-independent organizations pretty well scattered throughout, coordinated by a central supervisory group, is an excellent system, and I think the decentralization of setting up a number of establishments when working on this type of a problem is a very important element. I think the Germans were not as good as we, in the direct contact between the people doing the research work and the users. It is one of the great surprises, always is, that you look at this tremendous amount of material and then you compare aerodynamically the actual combat airplanes that the Germans were flying with our combat airplanes and until the Jets came out I think our airplanes were better and I think the difficulty was that they did fight through this Reichs Luftfahrt Ministerium which was a sort of a buffer. There wasn't a direct contact between the agencies like the desks of a Bureau and the people who were doing the development, and it certainly harmed the putting into actual practice of these developments. There is no question about it. There were apparently considerable changes about 2 years ago. I think another of the reasons why the Germans went ahead further, in their fighters for example, was this dictate that came down from top-side apparently in about 40 or so that were going to concentrate on production, they let the development go ahead, but they didn't let it get into the airplanes that were being built. They said that they would freeze designs and turn out lots of airplanes. They woke up about a year and a half ago to the fact that that wouldn't work. Since that time there has been a tremendous spurt, for example the ME-262, the designer told us was flying and in the air in 1939. The phototype (they couldn't get anybody in the air ministry interested in it) was dropped until 1942. Thank God for that.

Question: What about preflight research, that is full scale and model?

Dr. Millikan: There was a good deal of that, I didn't have very much contact with it, there was one group at Goettingen working on it. They did have small groups scattered around, one at Goettingen, there was an extensive one under this sailplane institute which was at Darmstadt but that had moved to Ainring and I didn't get to Ainring. The main center of their flight test research was in the neighborhood of Berlin, which is Russian territory so we didn't get in there at all. It may be that some other members of our Navy team over there will have more information than I've got, on preflight research. They did do a lot of it, a great deal.

Question: Did they have anything in this program -- preflight models? For example, mach number of about 103 - - 1F6 model - - -

Dr. Millikan: Their kilometering, I think, was not perhaps as far along as ours, their whole radar technique, so I am told, was definitely behind ours. We had the jump on them and the kilometering goes along with that. They were working on kilometer but I'm inclined to believe that we were perhaps ahead of them. Kilometer strains, I think, right now to certain within 10% or about 3% - - -. They were getting started very elaborately on ballistic measurements, that is, photophilous light and differentiating the projectories and getting the forces in that way. That's a pretty complexed technique and takes a long time, they were doing that largely with the guided missiles, and I don't believe they had much on actual measuring forces and kilometering them back.

Question: What means did they use in confirming their tunnel corrections and --

Dr. Millikan: They were in a state on tunnel corrections like anybody else.

Question: That's one of the objections?

Dr. Millikan: Yes.

Question: Doctor, you spoke of the supersonic tunnel that is all crated and ready to go, ready to come over here, labeled, did you get any impression that we're not on the ball, enough in getting this material, insuring that we get it, do you think we need to examine our system for procedure for getting that material over here?

Dr. Millikan: I'm afraid that I'm just not familar enough with that system of transmitting material to have an answer, I, myself, didn't get any out. I think we ought to be getting documents back faster, reports, etc., but that is probably a function of a lack of simple clerical assistance in Paris.

Someone else: I received one piece of equipment already from one of my enterprises in this field ---.

Dr. Millikan: I think that system is probably set up and working pretty well, don't we use largely the Army's facilities in the field?

Capt. Halpine: Yes, everything is under shape ---. Dr. would you give us some idea, what I think would be of interest to the people in general, as to how you think this data will be handled, how much there is of it, and what kind of a job we are going to have as a result of what our mission has been doing over there in Germany?

Dr. Millikan: You mean this whole data situation, well, that's an enormous problem, there are literally thousands, I don't know how many thousands of tons, of documents and material that has collected over there and it is a perfectly terrific problem how to get it back and to get it distributed. To my mind the most essential feature of the whole thing is time. It's not going to do us any good in two years. We've got to have it now if it's to do us some good. I've been having some conversations with the AAF, which has a set-up

which looks to me as though it was going to function. I think some coordination between the Navy, AAF, and the Ordnance Department of the Army can result in getting that material back here in pretty complete form. I don't think any one of the three agencies has a complete enough file to warrant doing it by themselves. I think they've got to be pooled because the file has got to be complete if it's to be useful.

Capt. Halpine: You mean you think it's got to be set up in some kind of joint Army-Navy agency or something?

Dr. Millikan: I think in effect we'd better jump aboard the AAF bandwagon, they've got it setup, I think they've got the facilities.

Capt. Halpine: The facilities of NACA might be expanded in that direction too and act as a central agency.

Dr. Millikan: I'm inclined to think that the way they've got it setup probably the best thing to do is to use and amplify the facilities which the AAF is setting up for it, both in Europe and in this country.

Capt. Halpine: To be fed from the Allies document center which is established in London --- or then to joint Army-Navy activity over here.

Someone else: I see, Sir.

Dr. Millikan: One thing that I would like to make a very strong plea for is that all this material be classified just as low as possible; it's now secret or top secret over there. There just hasn't been a determination, and it seems to me to be useful, it's got to have the maximum possible distribution among our people, and I think it should be classified down just as soon as possible to as low a level as is consistent.

Capt. Halpine: The Germans already know all about it, otherwise we wouldn't have it here, the question in that case is how much do the Japanese have and how much we need to keep away from them.

Dr. Millikan: Certainly, the things we know the Japs have. How much I don't know.

Capt. Halpine: We don't want to keep Dr. Millikan here too late, very glad to have you ask any further questions that you'd like to have Dr. Millikan answer. Dr. Millikan is going to have to catch a 7 o'clock plane tonight for Wright Field, appreciate very much his coming over and talking to us. There may be some other questions, however, that we might ask in the next few mintues.

Question: I wonder if you ran across anything along the lines of using atomic energy?

Dr. Millikan: No, Alsos, I presume is handling all that. Alsos mission which has been over there a long time, is supposed to handle scientific developments other than aeronautical, I think.

Capt. Halpine: That is being handled too?

Dr. Millikan: Yes, sir, I'm sure it is.

Question: What would you say is the comparable size of their combined - - -?

Dr. Millikan: Well, it is certainly larger per capita, considerably larger, whether it is larger in numbers of persons employed, that is the case here, I would guess it somewhat larger but I would hate to be asked to justify that in black and white. Certainly, relative to the size of the country, it is considerably larger.

Capt. Halpine: Relatively, they have many more people involved in research than we have.

Question: Which one of these plants say for example was comparable in size or larger than Langley Field?

Dr. Millikan: I don't think any one of them was larger, but there were quite a large number of them and as I say, I think the DVL would be the most analogous and that I don't have any late information on.

Question: Would several compare in size?

Dr. Millikan: Yes.

Question: Doctor, did you run across any of the Delvus series of aircraft?

Dr. Millikan: Yes, that's the Lippish development, I didn't spend any time on that particular development myself. I was concentrating more on the research lab, I did spend a little time with the Yonkers people interrogating, and a couple days with Dr. Folk of Messerschmidt, who is a very, very brilliant and capable engineer and I understand arrangements are being made to bring him over here. I think he can be extremely valuable. I think he is responsible for the Messerschmidt developments. He's a young fellow about 38, but I didn't actually have close contact with the Lippich, Delo developments.

Question - - - -

Dr. Millikan: As far as I know none of our technicians of any description have been into Berlin as yet. For the information of everybody I'd say that inasmuch as we are here on a confidential level, it is not expected that we will ask for any blanket permission of any kind to go into and get any information out of the Russian areas because of the plants and establishment which they hold. The reasons for that being that if we did we would have to no doubt, grant a free exchange and area which we hold happen to have about 90% of all the really valuable research and technical information in it and only about 10% in what the Russians hold. The Russians would probably be very glad to grant us permission to go over there and say "Yes, that's perfectly all right, let us come over and see what you've got." It would be a 90-10 exchange probably and in their favor. Therefore, we are not at present making any great efforts. If we find things already taken over by the Russians we're

not making a great deal of effort to go into it now, later on, we may be able to put things on an exchange basis, you give me information on this piece of material and I'll give you information on that. The same way that we usually do in exchange of foreign information during peace times, but the other way would be decidedly too hard to balance that system. - - -

Question: Do the U.S. and Britain interchange information on captured equipment?

Dr. Millikan: The United States and Britain are interchanging everything very freely, there's no question about that, our people come and go into the establishments the British have and the British into our places, but the Russians have been pretty ticklish about it and we have decided pretty much to lay off and we've profitted pretty well by doing do.

Question: - - -

Capt. Halpine: Yes, from the information found in Germany, in documents, etc., going into places.

Dr. Millikan: My guess is that the big German establishment at DVL is probably pretty well banged up. The reason that this 90% figure that the Captain mentioned is almost certainly true is because most of these research establishments were not fought over, the damage was done largely by GI's billeting in them, not by battles. And our advance was so fast through this region that there wasn't much fighting and there was very little destruction due to fighting.

Capt. Halpine: Do we have any other questions? If not, sir, I'm sure we all appreciate very much Dr. Millikan's talk. Thank-you.