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[full name of interviewee]

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[main focus of interview]

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Topics - new Systems Evaluation & Dev. Div at NSC; plans for Space Environment Simulation Lab; test chambers; evaluation of GE test facility at Valley Forge; Thermochemical Test Area; Vibration Acoustic Facility; Anechoic Chamber; pre-flight Testing policy; agency-wide test facility duplication reduction; selection of White Sands for propulsive tests; vibration acoustics testing; noise-free communications testing; Flight Acceleration Facility (centrifuge); reaction to NASA selection by Corps of Engineers; Corps interface with engineers; problems w/ sub-contractors; dev. of Lunar Receiving ~~Laboratory~~ & handling policies; man-rating Chambers A & B;

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Interview with Aleck Bond
October 10, 1967

In the Space Task Group I worked as an Assistant Division Chief to Max Faget in the Flight Systems Division. My responsibilities were primarily associated with managing the Division's support for Mercury. During the summer of 1961, Ray Zevaske of the Director's Office was asked to do a survey of test facility requirements for STG. A number of people involved in this exercise were drawn from our Division and other parts of STG. I was not involved in this exercise, as in June or July of 1961 I had been assigned by Dr. Gilruth to Headquarters' duty as a member of the Golovan Large Launch Vehicle Planning Group. Until about November 1961, I commuted between Langley and Washington, staying in Washington during the weekdays and returning to Langley on weekends. I spent a day or so a couple of weeks out of the month back at the Space Task Group. This is how I learned of the activity that was going on in the planning of new test facilities.

Sometime around October 1961, while I was in Washington, I received a call from Max telling me that I had been selected to head up a new division of the newly formed Manned Spacecraft Center. He didn't know exactly what the name would be but he said that it would involve structures, electronics, power systems, pyrotechnics, explosives, etc., and would include several of the former elements of the old Flight Systems Division. Through recruiting we would be expected to become a full strength division. He also mentioned that Mr. Joe Kotanchik had approached Dr. Gilruth and asked to be considered

for a position in the Manned Spacecraft Center, and had been selected to be my Assistant Division Chief. I accepted the position and the appointment of Kotanchik. I had known Joe for a long time, respected his technical ability, and had no reservations whatsoever about having him work for me as an assistant.

After I returned from the Headquarters assignment sometime around the first of December we began in earnest to plan the organization of the Division and selected a name for it-- the Systems Evaluation and Development Division. Joe and I also began to give our major attention to the planning of new test facilities. At that time the only major new facility on which there was agreement that it should be established at the Center was a large vacuum chamber. In addition, what later was called the Thermochemical Test Area was being planned by Dick Ferguson and several of his people. The present IESD Anechoic Chamber was also being planned about the same time, or at least the requirements had been outlined. A Vibration-Acoustic Facility was likewise conceived and planning on it began. That was about the extent of the test facilities planning for the new Center except for the requirement for a structures test facility within SEDD. Both Joe and I agreed that we ought to adhere to the basic concepts that had been developed and proved in the Structures Research Division at Langley and began to give considerable thought to the requirements of a Space Environment Laboratory. We heard presentations and discussions by a number of

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interested contractors. RCA had been involved in doing the design for the Mark I chamber at Tellahoma and offered many ideas for a similar chamber or chambers at the Manned Spacecraft Center.

Around December of 1962 we outlined, as I recall, that there would be requirements for about four fairly large chambers. One of them would be an extremely large chamber in which the entire Apollo vehicle could be installed and tested in the simulated environment of space. A second chamber, (now Chamber B) was conceived as a systems test and development type facility for development of environmental control systems components and assembled systems, and for performing space suit development qualification tests. The third chamber was to enable us to do mechanical systems component testing. It would be smaller than chamber No. 2, and would allow us to test mechanical systems with moving parts that would have to perform such as in the hard vacuum expected on the lunar surface. A fourth chamber was also conceived, which was actually never built. We designated it as Chamber C. It was intended to be medium in size and similar to Chamber B in that it was for environmental systems testing. Chamber C was intended as a separate chamber for the test and evaluation of spacecraft modules and major mechanical components that couldn't fit into the smaller chamber, Chamber D, was supposed to have solar simulation.

Now during this activity of deciding what kind of facilities we needed, we of course, looked at facilities that were being built

around the country and also those in the planning stages. We knew
148 that Tellahoma was constructing the Mark I Chamber. We considered using it for the Apollo Program; however, we reasoned that our requirements were such that the Tellahoma facility would not be able to adequately handle all of the requirements for the Apollo Program by itself. Also, we understood that the Air Force had built this facility for its own programs and uses, and there was no indication that it could be made available for the extended periods of time that would be required for the execution of the Apollo Test Program. Likewise, we were aware that a large chamber was being built up at Valley Forge, Pennsylvania for GE. Later on, General Electric did approach our management and attempted to convince it that this chamber could be made available and could do all the things that were necessary to run environmental tests for the Apollo Program. Around the end of 1962, Dr. Gilruth was contacted by Mr. Hilliary Paige who, I believe, was the President of the GE organization element having cognizance over this chamber. He invited Dr. Gilruth to come to Valley Forge and see this chamber.
170 Dr. Gilruth asked me to accompany him on this trip, and we spent a day at the GE facility at Valley Forge hearing briefings and having a tour of the chamber. The GE facility could have been used for some of the testing that was planned for the Apollo Program; however, it was not totally adequate, plus, we had already committed ourselves and had a facility being planned that would meet all of the requirements of the Apollo Program. The GE chamber did have some shortcomings--it could not contain the total vehicle

envisioned for tests, and we were not sure that the solar simulation system could be proved. Our design had considerable capability beyond that of the GE facility. There were no other facilities in the country that could be expected to do the job.

We went through a conceptual design study with the Bechtel Corporation and analyzed all of the requirements and the capabilities that had to be included. We considered the requirements for test chambers, and at this time we eliminated Chamber C. We built chambers A and B which are the large test facilities, and a Chamber D which is an unmanned small mechanical systems test facility but with a high capability for producing solar and vacuum environments. At the same time we were proceeding with the design of the Thermochemical Test Area, the Vibration Acoustic Facility and the Anechoic Chamber.

I recall one conversation I had with Dr. Gilruth while coming back from a trip to Washington. He told me, "Aleck, one of the things that I want to make sure of is that we don't create any white elephants in our big building program. I have a real concern about creating any facilities that we may not need or that might be so far out that we really don't know if they are going to be useful or not." I also had had considerable concern about this problem, and was going to do everything in my power to assure that whatever we did produce was going to be useful and practical. I personally feel that this standard has been achieved--all of the test facilities that we have created here have proven their usefulness. Every one of them has played a major role in Center's development programs

since they were activated. Another general guideline that we observed was that every practical and feasible means of ground testing was to be employed for evaluating and validating spacecraft and their systems in ground facilities prior to their being subjected to flight tests. We wanted to make sure that we understood our spacecraft systems--how they worked, why they failed, and how we could make them work in a fool-proof way. And that is one of the reasons that we have such a large number of test facilities. This kind of philosophy was also insisted on by NASA Headquarters. As I recall, Dr. Seamans used very similar words that the Apollo Program was to do all of those things that are necessary on the ground to prove out its hardware and systems prior to getting into flight tests. The reason for this kind of policy is quite obvious when one considers such factors as the tremendous cost of development flights, the practical limitations of instrumentation and data transmission of flight test vehicles, and of course, the need for assuring that the spacecraft is safe and reliable in order to minimize the risks of the life of the spacecraft's human occupants.

In the planning of the test facilities for the Center we have also attempted to prevent the needless duplication of particularly costly facilities which may be in existence at other NASA Centers or DOD sites. The major facilities which we now have at the Center possess capabilities and features which were not found in test facilities in other locations. We have also attempted to prevent the creation of such major and costly test facilities at our prime contractor's plants, in order that these facilities would be readily available to the

Government for use in our future development programs. We have allowed establishment of some conventional type test facilities such as chemical, meteorological, and structural laboratories which are found at other locations in the country, with the justification being that quick response is required. A number of these smaller laboratories were also included in the Center's plans.

The White Sands Test Facilities have a history that is slightly different. At one time we considered the creation, at the MSC site, of requisite large scale propulsive test facilities. It wasn't long before we decided that this wasn't possible because of the proximity of surrounding residential communities. Therefore, we had to take a look at other areas and we set up a site selection team in which personnel of the SEDD participated. The North American Company tried to promote their plant in McGregor, Texas as the site. We preferred not to establish facilities of this type on company-owned property for the obvious reason that we wanted to avoid entanglements with a specific company. The site selection committee surveyed Egland Field, Florida, and Matagorda Island.

There were a number of distinct advantages of the selection of White Sands over the other areas. Availability of logistics support, access, availability of schools, and many things made it advantageous to locate the facility at White Sands. Now here again, the kind of facilities that were to be located at White Sands did not then exist at other locations. There were special tests required for the service module engine and the ascent and descent engines such as tests under high

altitude conditions. There was also a need for our direct management of the flight test of the Little Joe Program, which made it doubly advantageous to locate our test facility at the White Sands site.

The design of thermochemical test area at Clear Lake was the responsibility of SEDD. Jesse Jones, with a very small staff, developed detailed requirements and design features that we desired in this facility and conveyed them to Brown and Root Corp., the architect-engineers of the facility. One of the factors that we considered in establishing this facility was the safety requirement. There was a question whether we should go into a single major building that would contain all the various kinds of activities involved in the thermochemical test area, or to split the facility into individual test laboratories, separated to minimize the possible hazard that could be involved in test operations. Because of the somewhat hazardous nature of all of the activities that were conceived for the thermochemical test area, we decided to separate the facility into 6 distinct elements--a Central Control Laboratory and adjoining office space and 5 individual test facilities each designed with a specific test discipline in mind. All are tied together to a single control room. Nominally we would conduct only a single test in any one of the test chambers at any one time. However, by controlling all of these chambers from a central unit, it gives us a great deal of flexibility and enables us to carry out a number of activities almost simultaneously. We have a separate environmental test chamber that was designed specifically for environmental testing on systems that have some hazard connected with their operations, such as the fuel cells, which require hydrogen and oxygen. We have a separate pyrotechnics test facility

capable of doing all types of environmental testing on explosive and pyrotechnic devices that are used onboard the spacecraft.

One of the concerns at the time of the conceptual layout of the thermochemical test area involved deciding the levels of thrust, and thereby the amount of propellant that would be stored within the facility at any point in time. Because of the proximity of the surrounding community areas, it was necessary that we design the facility so that we would stay within our own boundaries in the event we had any kind of spill of toxic materials. Therefore, we designed the facility to contain any kind of explosion and not be a menace to the surrounding communities. We also made sure that we were able to closely control runoff fluids--spills of toxic materials and spent gases and fluids, etc., that are used in a propulsion facility. We made sure that we neutralized these materials to prevent contamination of surrounding water areas. Of all the test facilities that I have been responsible for here at MSC, the thermochemical test area proved to be the least troublesome and the most problem free in its design, construction, and operation.

The budget package that included the Vibration Acoustic Facility included with it the anechoic chamber. This was all conceived initially as a single facility that would study not only the laboratory and acoustic launch environment but would also study simultaneously the problems of electromagnetic radiations and interferences. However, after an initial study, it was decided that it was more practical to break it up into two separate facilities --a facility for studying separately the environment of vibration acoustics and a separate facility for testing of

the communications systems in a noise free environment.

The facility that I had the most concern about over its utility, was the vibration facility, primarily because then it was in final design and construction, and all indications seemed to be that this kind of activity would also be carried out in contractor facilities. However, history has shown us that this really did not happen. There have been several instances where the vibration and acoustic facility has been needed for vital tests that could not be carried out at contractors' plants. The North American Acoustic Test Facility was a modification of an old existing facility that did not adequately provide the proper testing environment for this type of testing, so our vibration and acoustic facility has proved its utility in ensuring fidelity in the acoustic and vibration environment. In defining the requirements and the design of the vibration acoustic facility, I would say that the three men who contributed key leadership were George Griffith, Wade Dorland, and Bob Wren. Bob had been very very close to the details and requirements of the facility and worked closely with the Wiley Engineering Company personnel when we were proving out the concept of the acoustic facility. This facility was designed around a relatively new concept. No major facility had been built in the country that utilized this concept so we were plowing new ground in initiating this design. Before we did, in conjunction with Wiley, we carried out a R&D investigation that explored the concept of using a shroud enclosure with tailored passageways for simulating the external noise or pressure environment over the external parts of the vehicle for producing the sound or noise excitation.

Electromagnetic interference has been a problem that had to be properly investigated and checked out. No anechoic facilities existed at our contractors' plants or any place else that could adequately do this job. The wisdom of constructing our own anechoic chamber has been demonstrated conclusively since several of our major test programs have had to be carried out in such a facility. Alfred B. Eickmeier and Ralph D. Sawyer have been the two men who have been key importance in the development of this facility.

The Flight Acceleration Facility or Centrifuge, as a major facility was in its planning cycle and the requirement for it had been established in budgetary documents before SEDD was given the responsibility for defining its requirements and for carrying out its construction. Originally it was the concern of the Flight Crew Support Division. MSC management decided it would be more efficient if the facility design and construction, and all the problems associated with it be turned over to the Division that was also responsible for the other major test facilities. So, sometime in 1962, Dr. Faget asked SEDD to assume this responsibility. I selected initially Bill Lauten and later Art Henners to supervise the definition of requirements, to work out conceptual and final designs, and to oversee its construction in conjunction with Engineering Division personnel. Art had more experience in facilities and he was brought into this area in order to assist us in solving some of the design problems. Of course, in all of these activities E&D personnel did not have sole responsibility for this work. We worked with both the Corps of Engineers and the Engineering Division. In fact, the Engineering

Division served as the direct interface with the Corps in defining our detailed requirements and the Corps saw to it that contractors adhered to these instructions. We met with Corps and Engineering personnel in group meetings, discussed problems, and made suggestions as to how these problems should be attacked and solved. A large drive motor, larger than any that existed at that point in time and with the amount of horsepower and vertical driveshaft that we needed for driving the centrifuge were required. We even brought in some specialists from the Langley Laboratory to assist in the technical evaluations of proposals for this motor. We had major problems with this facility. One involved the requirements that the test gondola be capable of being evacuated to very very low pressures--on the order of several millimeters of pressure. During the development and testing of one of the first articles, we had a failure, an implosion of the gondola during a test. It was necessary to go back and review the designs and remedy that situation. This involved a lot of detailed attention from our structures organization in recommending a design that could take these kinds of loads. Another major problem area that we had with this facility was that the structure at the end of the arm during static loading failed during one of the static tests at very near the 100% of the design load. Again it was necessary to go back, redesign this structure and strengthen it in order that it could take the design load. This redesign caused the facility to overrun schedule completion dates.

When the decision was made by NASA Headquarters about December 1961, that the Corps would supervise the construction of our facilities, I viewed this policy with rather mixed emotions. I was a little bit concerned about getting a third party involved. However, because we were instructed to go this way, we decided that we would do all that we could to try to make it a workable arrangement. It was fairly evident after our first few meetings with the Corps personnel, however, that they preferred to be detached from direct contact with the user personnel and preferred to interface with just the Engineering Division. The Engineering Division was made the official contact with the Corps. We, on the user's side understood this. However, because of our intense desire to make sure that our requirements were not misconstrued, and because of the complexity of many of the facilities and the engineering requirements, we felt that it was necessary to be very closely associated in defining and describing these requirements to the contractors. I had a number of discussions with Mr. Wes Hjornevik on this problem, and he was instrumental in effecting arrangements whereby we, the users, on the Engineering and Development side, would interface as required in meetings with the Corps of Engineers and with the design contractors. The Corps of Engineers were used to carry out designs and deliver a finished article to a user. On a number of occasions we had some vital disagreements. They were all resolved in time; however, it did take a good bit of our attention in order to make sure that the user's viewpoints prevailed and the details of the requirements were properly reflected in the design. In spite of the major meetings held with the Corps, however, some fairly significant problems did develop that possibly could have been averted

had we had on our own staff the capability of doing some of these jobs ourselves.

In many instances, because of contractual agreements and arrangements that the Corps had made with the design and construction contractors, they were constrained to work within contractual agreements. However, many of our requirements were not given proper consideration because of these contractual arrangements that had been agreed to. This stemed primarily from the Corps lack of understanding and experience in designing, developing and constructing facilities of the type that we have here at MSC. Problems also arose during the final acceptance phase. We insisted that we be intimately involved and made aware of the details of acceptance testing and checkout of the facilities. The Corps personnel would have been happy had we been kept out of this activity. There were quite a number of instances there where we had to insist that we be involved in order that we could make sure that the facility that we finally accepted did meet our detailed requirements.

We also ran into many situations where the Corps accepted a lot of second class work, that we did not find acceptable. As a result, after these facilities were finally accepted, we had to go in and retrofit and modify some of the systems in order to make them function and perform as we had originally intended. This was especially true in the case of the Space Environment Simulation Laboratory. Some systems were just almost completely unusable in their delivered form. We had a major problem in the Space Environment Simulation Lab during the first vacuum test on the large chamber as we experienced some structural deformation of the structure around the large door. We were obliged to

reexamine the total structural design, and an entirely new structural analysis much more thorough and in depth had to be performed at substantial cost. If I remember correctly, this special analysis cost MSC about $100,000. In addition, in order to demonstrate the adequacy of this second design, structural scale models of the design before and after the modification were built. We tested these models and actually proved that the models could be practical tools in assessing the structural adequacy of the design.

The use of structural test models had been suggested by Mr. Kotanchik and some of our other structural people during the design phase of the SESL. However, the Corps of Engineers personnel were of the opinion that they were not very useful and as a result, we were refused approval to build and test prior to construction of the Chamber. This we proved a major error after the fact, unfortunately. This is probably the most glaring example of the kind of misunderstanding that the Corps had in building facilities of this type. On the management level we had very good relations with Colonel West. He was very helpful and cooperative but on the working level, problems of the type that I have just mentioned were frequent. The same kind of thing happened in the case of the centrifuge. Then the Corps took a different position in the interpretation of requirements than we did. Since they were responsible for carrying out the terms of the contract, their interpretation held, As a result the facility did not, in fact, represent the desired design that was set forth at the outside of the program. Interfacing with the Corps and having to stay on top of their end of the business--did consume a great deal of time of our E&D personnel in order to be assured that we were

not getting into problem areas. We actually did not have enough personnel to cover the total effort for all the facilities, and as a result some problems just never did get taken care of properly.

With regard to our relations with the Engineering Division, again we did have some major differences of opinion. There were some personality problems, some of which were real, some imaginary. The Engineering Division, of course, was responsible for working directly with the Corps and they didn't hesitate to advise us of this fact. We acknowledged it, nevertheless, we tried to keep abreast of what was going on and make our needs known. On occasion we did antagonize some of the engineering people, but on the whole, we had a relatively good working relationship. I think that had we been given the numbers of people to carry out the contract administration and negotiation, within MSC for the construction for the facilities, we think that we probably could have averted some of the problems that we had. Needless to say, interfacing with a third party caused needless duplication and inefficiency in uses of personnel.

The first indication that I had of a need for a lunar receiving facility occurred while we were still located out at Ellington, about the summer of 1963. Jack Eggleston mentioned that a special committee, I don't recall exactly its title, had addressed itself to the problem of what special handling would be required for specimens and materials back from the lunar surface. Jack asked me whether we had any vacuum facilities that could be used as a deposit for this lunar material. He also asked how I would plan to handle such materials if they were turned over to us to examine and to repackage for shipment to investigators that might

be interested in them. The prevailing attitude toward this problem was quite naive. We would probably make available a facility like Chamber B as the point where the storage boxes could be delivered, and we considered the possibility of sending in an attendant who would then open the boxes in a vacuum. The attendant would be dressed in a space suit. He would then separate the material and maybe examine it until such time that we felt that all the necessary analysis in this kind of environment had been conducted. However, we were very quick to see the fallacy of this type of operation in that it was evident that certainly the kind of environment that was produced in this Chamber B was not adequate to prevent contamination of lunar material, particularly from outgassing products that are in the chamber and outgassing of the space suit. So, we began to consider how this kind of activity might be carried on, and began to develop our ideas. Meanwhile, a special ad hoc committee made up of some Headquarters personnel, MSC personnel, people from universities, and representatives of other agencies was formed, and during the course of the next year or so, began an intensive effort to define in detail all of the requirements of such a handling facility. The Headquarters group took the lead role in this effort and we supplied various personnel to work with them. As a group they began to evolve the detailed requirements of a lunar receiving facility that could remotely open the vacuum boxes, separate the specimens and conduct biological examinations for any pathogenic content. During the course detailed requirements definition, the E&D organization assigned Mr. Jim McLane to be the individual at the staff level who would coordinate E&D activity. At that time, we anticipated that E&D would be the operator and user of this facility.

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Because of the possible back contamination of the earth with any microbial or pathogenic material that might be present in the lunar material, Mr. Webb established contact with various regulatory agencies such as the Public Health, The Department of Agriculture, and the Department of Interior, for the formation of an interagency committee that would establish the handling procedures for the recovered spacecraft, the crew, and material returned to the earth's surface. I don't recall the date this committee was established but I was a member along with with Dr. Berry. After the Lunar Receiving Laboratory was turned over to the Science and Applications Directorate, Bob Piland took my place on the Committee.

We went through a lot of briefings and discussions with people on the interagency committee to try to convince them that there is practically no liklihood of any harmful bacterial life in the lunar material because of the bombardment from the solar radiation, the intense ultraviolet content of sunlight, the proton bombardment, the meteoretic bombardment (which continually stirs up the lunar surface and exposes the new material and impacting it which causes heat, the hard vacuum, and extremes of hot and cold. We felt that there is very little liklihood that there is any bacterial life on the lunar surface. However, these agencies had to take the position that if there is any probability of it at all, we have to take precautions to protect the earth's biosphere and we cannot afford to take any chances of bringing back any foreign material that might contaminate the earth's surface.

Joe Kotanchik was extremely instrumental in developing detailed requirements for MSC test facilities. Joe understood the operation and facilities at Langley very well, and was of key importance in developing

the facilities we would need here. Another guy that contributed greatly was Kurt Strass. When we were organized as SEDD, Kurt was one of my branch heads, and I gave him responsibility for supervising detailed activities on SESL, Thermochemical Test Area, and the Centrifuge. As work on them began to progress, we split up this responsibility. We turned the centrifuge over to Art Henners, the Thermochemical Test Area to Jesse Jones, and Kurt directed all of his energeis toward the development of SESL. This being such a large and diversified facility required a lot of high level attention practically all of the time. Responsibility for the development of the solar simulators for the Space Environment Simulation Lab was separately contracted by MSC rather than the Corps. Kurt Strass was again primarily responsible for this activity. Rich Piotrowski, one of the first people that I hired that had any kind of knowledge and background in designing and building vacuum facilities, and Rudy Williams, one of our systems engineers who was responsible for tracking and the design details on many of the facility systems like the vacuum systems, repressurization systems, and things of this nature in SESL, and Don Cole, responsible basically for electronic systems, instrumentation and data gathering within the chamber all should be recognized for their contribution to the design and construction of the SESL.

Of specific interest on Chambers A and B, is the fact that both of these chambers from the outset were designed as man-rated facilities. They were designed with the provisions for sustaining life within the chambers and also for taking emergency action in the event that we had some kind of difficulty while the men were inside the chambers. These

provisions included a system that will permit repressurization of the chambers to 6 psia in 30 seconds and to ambient conditions in a minute and a half. We have many other systems that are involved in manrating of Chamber A such as closed-circuit TV for constant viewing of the test personnel, portholes in the various locations in the chamber where we can view activities inside the chamber, hardline verbal communications, instrumentation leads that measure the body functions, heart rate, respiration rate, and the oxygen flow rates in the suit, etc. Jim Chappee should be singled out as the one person to whom major credit is due for developing procedures for man-rating the chamber.