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Interview with Daniel F. Rex
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Interviewer: Earl Droessler

Droessler: Dr. Daniel F. Rex at his home in Palestine, Texas on Friday morning June 17th 1988.

Good morning Dan.

Rex: Good morning Earl.

Droessler: Let me begin by asking when was it that Walt Roberts first asked you to consider a position at NCAR.

Rex: I believe it was early 1960, sometime in 1960. At that time I was director of meteorology for Sack _____ at Norfolk, Virginia and Walt called first and said that he was in the east and would like to come and talk with me about the emerging national laboratory, which had been sketched out by Tom Malone and others in the so called "Blue Book," so he came. We lived at the time on the Lafayette River. I remember the visit very well. He seemed to really enjoy himself. We had a good long talk. The gist of the talk was to describe an opportunity with NCAR, which was just emerging, and it was a good time for me, a good time that is to consider a change. I had completed at that point about 23 years in the Navy and had in fact already explored and conditionally accepted a job with the University of Hawaii expecting to retire within the next actually half year. The University of Hawaii was very interesting to me. I had spent since 1954 to 1959, I guess, five years with the test force in the Central and South Pacific. So, I became very interested in tropical meteorology. Colin Ramage foresaw U of H as a place to develop Pacific meteorology and make it a real center, which is of course appealing. Anyhow, back to Norfolk. I was interested and told Walt that I was and he arranged a trip to visit Boulder. The High Altitude Observatory was the going thing there and Walt was the director. So, Mary Emery and I, my wife, went out and spent I think a week and liked what we saw and the tentative end of that was again conditional acceptance.

Meanwhile, something happened that was completely unforeseen. A last test series was organized called "Operation Dominick". Operative Dominick, in short for my viewpoint, meant that I stayed in the Navy another year and one-half and served as the staff weather officer for Dominick. When I returned then I, let's put it bluntly, had some difficulty retiring but the Navy was good enough to let me spend a week a month at NCAR in its very early formative stages. So, that's sort of how I got into the game.

Droessler: What position was it that he talked to you about and offered to you?

Rex: It was of course the organization of NCAR hadn't gelled but he offered the position to be the chief administrative officer, titles hadn't emerged yet, and to concern myself with the "facilities" aspects of NCAR. You remember the Blue Book of course stressed, or a large part of it, devoted to the needs of the university community in research from the facility point of view. So, it was to look at those two fields and play a part in developing them.

Droessler: This certainly was a very challenging job for you or for anyone.

Rex: It certainly was.

Droessler: To be the assistant secretary for facilities and administration.

Rex: That's right.

Droessler: What were some of the first things you remember that you took on as you got into your job there at NCAR?

Rex: When I first went NCAR consisted of about six or seven people all told. We operated in the old armory at the University of Colorado. Walt had been, as I said earlier, the director of the High Altitude Observatory for years and he ran that very effectively in sort of the family mode. The organization was more or less understood, more or less invisible. So, I think Walt saw, and I certainly agreed as a first need, some sort of organizational concept that could fill out and become NCAR. So, one main first task was to actually design the organization of NCAR. Walt had brought in as a consultant Dr. Thornton Fry, who had been the director of Bell Laboratories and was my pillar of strength as a consultant in helping design the organization. That was certainly a first task. We don't want to discuss the organization in brittle detail but it essentially consisted of four divisions of, I have really forgotten what the first name for the scientific division was, but became the Laboratory of Atmospheric Sciences, the High Altitude Observatory, a division concerned with solar

research and this emerging facilities laboratory, and an administrative division.

Droessler: How did you decide what facilities to begin to accumulate at NCAR?

Rex: Good point.

Droessler: How did you make the policy framework in which the facilities could develop a computer, an aviation facility and so forth?

Rex: That was a naughty question at the time, how to do this, because lets face it there was very early on competition between the universities and NCAR in the sense that they competed more or less directly for the same funding. So, there was a, in the very early stages what was done was Walt and I and Phil Thompson and various combinations traveled to the universities that were UCAR and others and simply chatted with the atmospheric science part of the house to find out what their needs were, what was their view of the national need, the old battle between a generalized piece of machinery vis-a-vis a specialized one. Do you lose all the golden eggs by making the power supply absolutely universal? Does it now weigh a ton? You can't move it, whereas all you needed was 500 milliamps 6 volts, very definitely a difficult problem to decide what should be the first facilities. We got all sorts of answers and came home and tried to digest them. Of course immediately emerged a computing facility. Sorry, let me go back. Immediately emerged a balloon facility, HAO, High Altitude Observatory, was of course a growing concern had real and immediate needs. Balloon flying in the country was largely done by the Air Force and the various private operators were having all sorts of difficulties. So, the first facility to clearly emerge was the Balloon Flight Facility. The story of how it became to be located here in Palestine is a long one; I don't think we want to get into it particularly.

In 1963, the decision was made and NSF approved the plan to locate and develop the flight station here. We may want to later on go into the Balloon Facility more. The second facility that immediately, of course, was defined and not a very sensitive one meaning all the universities could see how to participate, that was the Computing Facility. Again in 1964, NSF approved the first step, which was the purchase of a CDC-3600, which was then a state-of-the-art computer. (?PSR-1) _____ _____ which we located almost below water in a building by a very outrageous creek in Boulder and we had a spring flood just after the computer was in operation. Water came up to within about six inches. I'm sorry to say that it never occurred to me what we were doing. We had this computer in the basement of a building just several feet above water level. We were all filling sandbags and having lots of fun. It didn't do any damage thank God.

Droessler: But you learned a good lesson at that time.

Rex: Learned a good lesson; think in general.

Droessler: Certainly the National Balloon Flight Facility and the NCAR Computer Facility have been outstanding successful facilities and have served the country well and have grown in recognition nationally and internationally. I guess the third facility would be the Aviation Facility.

Rex: That's right.

Droessler: That probably had more difficulty in developing that one because some of the universities already had some parts of an aviation facility at home.

Rex: That's right. You're absolutely right, that was the third one that we developed. There was a great deal of difficulty in deciding…Let me start again. I guess the vision of something needed by everybody in aviation meteorological research was an understandable and reliable data handling system. So, the first steps were made, before we had an aircraft even, to develop data handling and instrument control system that could be adapted to any medium size aircraft. Then along it was a success. It was simple and it did the job for many years provided the state parameters that you would expect, also special channels.

First aircraft was a Queen Air, Beechcraft Queen Air, which was outfitted. I won't go through the whole history of all the aircrafts. But, did _____ like work in the early years, I'm thinking of '64 or '65, '66 was joined with a sister ship so we operated two identical instrumentation. Lots of things were done with the pair that you couldn't do with a single aircraft. Should I go any further you think as the planes came in so to say? Maybe I should. Altitude capability immediately disappointed a lot of potential "customers", mainly university research scientists. So, the third airplane that appeared was a Sabreliner executive type jet, which had the altitude capability to get up in the cirrus region and better thunderstorm tops and so forth. It was instrumented with a third; this was called an Adyne system, the data handling system, almost identical with the Queen Airs. So, we had three aircraft that we could calibrate and sit down with NASA's blessing at their ranges and go anywhere in the country. I think it was a success.

Then came the many experiments, global experiments, Tromax, Glomax, the Line Islands, field experiments of some size with all manner of private and governmental participants. So, of course a long range aircraft came into the picture and that turned out to be Lockheed Electra turboprop four

engine airplane, which I'm ashamed to say I don't know I think it is still operating isn't Earl? Or do you know? I think NCAR still has it.

Droessler: Do you see these NCAR facilities as being of vital need then to the growing needs of our country for participation in the national field observing?

Rex: Certainly did. I think, of course I am prejudiced, that the Line Islands experiment in a small way really was a look at the future. We didn't charter by or bag all the support necessary. We used available commercial engineering firms but we were able to transport into the field this going set of research aircraft without rediscovering gravity so to say. I think it was a great success. Of course it was designed to have measurements under the first satellite out there, _____ satellite.

Droessler: When did experimental radar come into focus at NCAR and your first approaches towards a Doppler radar?

Rex: I think that again was sparked a great deal by the developing interest in large scales experiments, global experiments, also by continuing interest in cloud physics, which after World War II enjoyed a period of real ascendancy with project cirrus and Langmuir and Schaefer and the Weather Bureau Project. All exploring this great potential of weather modification, let's face it. We got in the act with, as you would expect, surplus equipment, World War II radar equipment overhauled and revamped to be a mobile facility that any university could take in the field, do 3 cm or 10 cm observations of cloud development, track anything and I believe that was a success. But, let me add the end of the story. We stayed too long in the frame of mind of utilizing surplus equipment. By 1965 surplus equipment was…you could hardly get anywhere without stumbling over some. It was available at the drop of a hat. So, we really filled all our empty land with surplus equipment. Certainly became obvious that it had reached the point of no return. It was more difficult and more expensive to overhaul and modify surplus equipment then to start from scratch. So, our first development, in house development, of a Doppler radar from scratch started in about 1967 and the first one was tried out about 1972. The tryout was with the University of Oklahoma, their project at Norman. It has been used. My resignation from NCAR was in '76 and it was a worn out piece of equipment by then almost, a real success. A small four channel Doppler radar.

Droessler: It's interesting note that today the National Weather Service is ordering for the new weather observing network of the United States a whole set of Doppler radars in the vernacular of today it is called NexRad, the next generation of radars. The experimental work that led to this operation of development today both at NCAR and at the severe storm center under Ed

Kessler at Oklahoma, which you worked with. They were the two pioneering places for the new network of weather observation equipment were having today.

Rex: Right. I see none of that directly anymore but anyone who watches T.V. knows that Doppler radar is how you display weather.

Droessler: One of the most colorful people that you hired in the facilities program was Vin Lally.

Rex: Amen.

Droessler: I'm not sure where Vin came from but I know when he arrived that we all knew it and his program in innovative ballooning really took off and captured our fancy and led to good profit in the atmospheric sciences development.

Looking back how do you view Vin Lally's activity at NCAR?

Rex: Vin was and still is I'm sure a very animated as you say and talented man. I'm a little rusty on exactly where Vin came from but needless to say, as you have already noted, he arrived at NCAR with at least 117 different ideas of what ought to be done in ballooning. Most of ballooning at that point, of which I knew essentially nothing meaning 1963, was to buy from one of six manufacturers of balloon open _____ zero pressure balloon, which you hoped you could launch without ruining it and send up some equipment usually without telemetry so that again the hazard was could you find the package and retrieve it. The Air Force, of course, in their surveillance activities had developed the operational technique needed but none of the commercial companies really offered that to the university researcher. So, that was the void that the flight station here was designed to fill. It was operated with Vin at the helm and a collection of actually Air Force types that had retired and had experience in operating balloons, in ballooning. That group really developed the first flight station; built the pad, built the necessary structures, built the first special machines to handle huge balloons.

Let me remark about that aspect. I must come back to some special kinds of ballooning, which then I think made a real contribution. Back to the normal zero pressure balloon flying. I remember very vividly the first time I came here was before I actually became full time to NCAR, I believe it was in '62 and it was with Vin; Vin was already here. I watched….Sorry that couldn't have been right, about '63 I watched a launch and it was sort of like a ballet dance. It was sort of mystical. If Vin blinked his left eye that meant it was time to check something or other and if Al Shiftley looked worried something needed to be done. Very

little was said and I'm not exaggerating this. They had done it enough by themselves as a team that it was second nature, automatic. That offended me, as you can imagine sort of Earl. I'm an engineer and I believe beyond, let's say, the fine arts that you ought be able to reduce this operation to something understandable to any dummy. So, my personal ambition from that one experience here was to at this flight station develop an open expertise recorded in books if you please, which would let anyone educate themselves and conduct reasonable ballooning operation. We made big steps in that direction. Don't misunderstand me, I'm not criticizing that first team, they were an exceptional team.

Droessler: No are you criticizing Vin? Vin Lowley was Vin Lowley.

Rex: Not at all. Absolutely.

Droessler: He was a highly interesting and vigorous personality and his style was to maintain instant direction of all activities to insure success.

Rex: Absolutely. No, you're absolutely right.

Let's say a word or two about other types of ballooning. He, I guess I shouldn't say because I don't know, I don't know that he solely developed super pressure ballooning but he certainly was a pioneer. Of course the idea is you inflate at the surface at the launch point a tough balloon, usually made in those days out of Mylar, which could stand internal pressure, it's the super pressure idea. This insured that if you do the aerodynamics of the thing by designing the size of the balloon and the amount of super pressure you can set the flow to altitude. So what you really had was a vehicle which you didn't need altitude control for. It would rise to equilibrium point in the atmosphere and then float, hence constant level balloon often called. The immediate application, of course, not physical research, I mean not carrying cosmic ray packs and so forth as high as you could, but to track the atmosphere. In other words to measure winds at various levels and all sorts of systems to let you do this winding up with satellite tracking of transponders in the…

Droessler: I remember those in my days back at NSF and we almost caused an international incident…

Rex: Amen.

Droessler: …with Vin Lowley's balloons. They were heading for the Soviet Union and there was a great debate about what we should do about informing the Soviet officials about this. Do you remember that incident?

Rex: I certainly do. I can appreciate your end. Our end was certainly exciting. The balloon was supposed to destruct itself, of course, after a certain time interval and obviously didn't. I remember two attempts to shoot the balloon down and this proved to me that ballooning might be a great way to get where you want to go. The fighters in both instances could never see the balloon, they could track it, hear it, but it's so tiny and they are so fast that they never got it. I believe the balloon went around four or five times.

Droessler: Yes, it went around the atmosphere and actually that balloon and several other balloons invaded the territory of the air space of the Soviet Union many times.

Rex: Indeed. Indeed.

Droessler: You did mention the U.S. Air Force and their interest in ballooning and some of their retired people working with Vin. Let me ask about your recollection of the other government agency interest. You were supported by NSF in this activity at NCAR in developing these facilities. What was the response or reaction from the U.S. Weather Bureau, NASA, the military agencies and other government agencies as this new facility nationally supported began to take shape?

Rex: Let's start with the Weather Bureau or it's been called ESSA, NOAH and various things but the National Weather Service and its relation to NCAR was certainly…well we needed to discover our most effective roles and not constantly conflict or duplicate whatever each other were doing and that took a bit of doing. As you know the National Weather Service established a research laboratory in Boulder and rather soon became interested in specialized sounding equipment, laser kinds of sounding equipment. There was competition is the right word I believe, which was healthy. We were trying to develop the Doppler radar at the same time; their people talk to one another. No disagreeable difficulty at all at that time. As global experiments emerged there was competition, sometimes nearly disagreeable about the role of NCAR. NSF supported national laboratory in large-scale field experiments visa vie ESSA or NOAH. How do the two cooperate? It worked out in all the large experiments. ESSA had aircraft. I'm thinking of everything since Line Islands. There was lots of preparation, planning so that there wasn't overlap. I think things worked very well.

Droessler: And from NASA there was nothing but good cooperation.

Rex: Nothing but good cooperation.

Droessler: Especially with respect to the National Balloon Flight Facility, wouldn't you say? And the group of experimental physicists that they had under contract had wanted to use this fine facility.

Rex: Absolutely, very excellent cooperation. Also think of the aviation facility again, NASA of course has the finest calibration equipment, you name it there is, and they made that entirely available. We spent about a month a year with their calibration equipment systems.

Droessler: I think if you or I were associated with the Weather Bureau at that time we probably would have looked a little askance at the development of this nationally supported laboratory because just a few years prior to that the National Weather Service, the U.S. Weather Bureau at that time, was the exclusive federal agency in this area and had responsibility for all national observing and analysis and forecasting. The development of a large facility you get into the observing business I think we might have looked at that as a threat too had we been on Harry Wexler's staff.

Rex: No doubt.

Droessler: Did you have any conversations with Harry about this?

Rex: Sure did.

Droessler: What was his particular attitude about this development?

Rex: I knew Harry quite well in various guises meaning my own role was different in each case. I knew him best back at the Institute for Advanced Study when Von Noyman and Rosby and _____, RCA, Phil Thompson, myself, Harry sat down in Princeton, were sat down I should say by Rosby and Von Noyman, to explore the use of the emerging digital computer in atmospheric modeling.

Droessler: What was your role at that time Dan, because this was a project that was supported by the Office of Naval Research with money coming from both the mathematics program and from the geophysics program?

Rex: There was something called the Joint Committee for America Weather Prediction that you may remember. It had a Weather Bureau representative, Harry Wexler and Phil Thompson was there for us. I was Navy, and I'm ashamed to say I can't remember the Army member, and each of them had an assistant or two so I was the chairman of this committee. That's the reason that I participated in that summer's activities. That I brought in simply as one incidence of working with Harry. I knew him very well. May we jump back to Boulder now?

Droessler: Talk a little more about that development I think because it was the original colonel from which the use of computers by the atmospheric sciences developed the John Von Noyman brilliant idea of execution.

Rex: Right. It was exciting. I knew nothing in any detail about computers as devices but I understood the idea and I knew something about the weather problem, the physical problem. Von Noyman was the mathematical _____ that held all this together. He immediately saw how to set up solutions to the field equations in three dimensions. There was great glee and joy the machine actually worked, _____ was there himself. I never will forget the machine spoke; it had a voice it could talk. It sounded just like a modern day robot. It would say things like, "You dummy change tape three", which to me was space world stuff. Anyhow, it worked fine, the mathematics was refined, but as for years the problem was the machine was too good. If you had a small boundary condition error when you start the computation or a truncation error, the machine just liked that immensely and would immediately magnify that error. Pretty soon the error dominates what you are trying to look at. That was the basic problem initially, how to dampen out the junk and save the baby.

Droessler: But that experience must have been helpful to you when you were helping to devise NCAR's computer complex to serve the atmospheric sciences and the university community.

Rex: It was.

Droessler: The great deed was always for fresh and vigorous communications.

Rex: That's right. It still is.

Droessler: How did you accomplish this in the development of the facilities program? Did you bring in university folks to work with you or were they associated with you in groups of advisory committees, panels etc?

Rex: Good question. Originally, as you would imagine, I traveled and so did Walt again with me and sometimes we went along. I think I mentioned earlier we tried to determine what the community working in the universities thought was the need and then come home and in all our wisdom try and design a solution or where's the first step, what's the first thing that needs attention. That worked because the first few were so obvious. There was no argument really about the balloon facility. There was some argument from the private operators but none as to the need in the research community. The same thing is true of computing facility, no argument really about the idea. But, when you get to aviation and finally the field service facility there was a lot of disagreement, what is needed now. Everyone gives you a different answer. So, going and talking to the

researcher and saying what do you need next summer produced nothing, there was no focus, everybody is going in different directions lets say in the field observing field. So then with in fact I believe your own good suggestion that we needed…buffer isn't the right word…we needed communication in a formal sense with the university researchers and enhance the establishment of the advisor panels for each facility made up of university and government as was appropriate experts, workers, researchers.

Droessler: And they would help you then to focus the ideas into programs and into some sort of a priority arrangement so that your crew then would have an opportunity to say well this is what were going to get onto because that's going to happen next year or the next 18 months.

Rex: Exactly. To help decide priorities was almost number one good thing that they did. Don't start everything at once, start the most important one and finish it or nearly finish it and then move on. I remember…Something popped into my mind let me say it before I forget it, which is easy. In designing the research program of NCAR, which just sounds very bias but of course in the early days that was the need. What are we going to do would determine who should you try and get and bring in and so there was a lot of discussion of how do you design a national laboratories research program. I remember Pat Squires; my way would have been of course absolutely wrong. I'm very orderly and I would say we got one quart of water to apply so put one ounce here and one ounce here and one ounce here and so on. Of course yet no one washed that way. Everybody has an ounce of water. Pat said, "No way, don't pick more than two main research objectives and pack in the people just as close as you can. Don't have a, let's say, organic chemist and a photosynthesis man, (I'm sorry) don't try and even cover that little field. Get the best competitor there is to your leader and try and bring in that." Then those sprouts, his point was, will really prosper, they will really produce because there is competition instantaneously night and day if you have chosen the wrong field that's too bad, you prosper and it gets you nowhere but at least you move. My way spread it out thin, nothing happens.

Droessler: How did you decide on whether the facilities would be available for the use of the growing number of NCAR leading scientists or for the growing number of university professors and researchers in the academic community?

Rex: That was a tough one. There was, of course, an obvious competition between the in house scientists, the NCAR research scientists and the university scientists. Again, we asked the panels to help up here but that didn't really work because to be honest as you can imagine the director of the NCAR atmospheric science program grew up in the atmosphere and

felt that; I present my program, it's bought or changed or modified by NCAR direction and then finally taken to NSF defended as a program, how come I have to start all over again now and compete with the universities. I have already done this is the idea. That was a structural problem that's still I imagine to some extent exists now.

Droessler: Back to the old biblical.

Rex: Amen.

Droessler: You cannot serve two masters and yet you were asked to try to accomplish that to the best of your ability because only in that way could an NCAR facilities program foresee our _____ by having useful components for the in house scientists and then having a bridge of respect and encouragement and support and use of the facilities from the university community.

Rex: That's right.

Droessler: As the years went by and the facilities program grew and I was always watchful being at NSF about how the university community was responding to the development of NCAR. I can remember many congratulations to NCAR for the development of this facility, that facility or that kind of a network and I think the facilities program by enlarge, well had some difficulties, certainly was very acceptable to the university community. Did you find this also as the manager of that facility?

Rex: Sure did. We had some, of course, well you can't satisfy everyone so we had some dissatisfied customers always but we had those we tried to serve with just a few exceptions. I thought we did a useful job. My goodness Earl, may I shut down here for a minute? (end tape)

Droessler: We have covered the field observing network and facilities very much and your communications with the universities except through the advisory panel. Would you like to make some comment about the developments of the facilities in that area?

Rex: Yes I would. We did speak a bit about the radar development, which is one undertaken in the field observing group but beyond that a number of things were done. Just take as an example if you're interested in, let's say, some kind of cloud physics field experiment, everybody wants of course a surface record. They want the parameters, wind, temperature, pressure, humidity and so forth on a net under the experimental area. So a need, a mundane if you please need, but nonetheless an important need was a standardized rugged as precise as they needed it surface measuring network. As I say, not a very exciting thing but needed by everybody who moved into the field, almost everybody, and the need was met in a variety

of breadboard ways, real amazing hookups of this and that. It was low priority, let's put it that way, in the overall program. So, we saw as a contribution system that we could make rugged vary the precisions according to the sensors, transportable, loanable to anybody and I think that was, as I say, not exciting but it was the first thing that we did that I think we won some praise for. People when we started had a tendency to say well anybody can do that; we do that. But then you look at how they did it and heaven only knows whether point A measurement was twice as precise as point B or what. It was jury-rigged and they saw the end product and were delighted. I must hasten to add complete, which I insisted on with not just a wire diagram, a hook up, as the instruction but with a typical GE instruction manual that told them what the components were, how to use it and what to do if it went wrong.

Droessler: Are you speaking of the PAM system?

Rex: Yes.

Droessler: What does that acronym mean?

Rex: I'm sorry you asked. I've forgotten. It was essentially though, as I say, a surface end we could couple radar and other things into it.

Droessler: You'll be delighted to know that early in 1987 the PAM's network system was employed in North Carolina in the project GALE activity.

Rex: Right. What was that? I remember the acronym but GALE.

Droessler: This is the Genesis of the Atlantic Lowell's Experiment. A study of the wintertime development of the severe low pressure areas just off the Carolinas over the Gulf Stream that bring abundant winter weather and blizzard snowfall conditions to North Carolina, Virginia and all the way up to the New England and Canadian…

Rex: Destruction on the shore.

Droessler: That's right. I was involved in that project, project _____, and the PAM's network just worked beautifully. We could trace individual thunderstorms. We could trace frontal systems as they passed through and over the network. As a matter of fact it was so solid and so well working that people just took it for granted.

Rex: Without questioning.

Droessler: Yes.

Rex: Because it worked.

Droessler: And one technician, one young woman technician from NCAR serviced the network on a daily basis and kept all of the individual stations operating.

Rex: Right. Among other things that were developed, remember we talked about being drowned in surplus equipment that was one of the first things done from scratch. I mean no attempt to modify something.

Droessler: How about the computer center and its outreach to the universities. Presumably you used dedicated telephone lines for that purpose.

Rex: Right. I think that was the development of an online capability for university scientists at home was one of the real successes of the facilities groups. Anyone can do it with a personal computer but when you try and make a 6600, and bigger and better, when you try and make that available it's another ballgame requiring a lot of brand new engineering or without building your own line or microwave link. It was just really…well the flaws were just being worked out of it when I left.

Droessler: Who provided the ingenuity for that at the NCAR site?

Rex: At the NCAR site that was Glen Louis and myself and Phil Thompson. We had various private telephone people in the act of course. AT & T sent representatives. The trick was to, as we just said was to be able to utilize something like half the capability of the 6600 through a phone line. That's hard to do and of course we used six phone lines. When I left people were taking it for granted. They were making their plans not in an iffy basis but that was a given that they could sit at home and use the 6600.

Droessler: Two of the outstanding successes then of the facilities program as we can document it today for the field observing network and the computer complex that was developed at NCAR and the ability of this computer network to serve the scientists on the campus. Are there other successes as you look back on the facilities activity that we can observe very clearly today?

Rex: I think we mentioned it earlier, maybe in last night's chat I don't remember. Anyhow, the data recording and sensing system for the aircraft, again I forgotten the acronym, was certainly a success. It filled a real need at the time; this was early on '64 or '65. It was applauded I think by most university types. It was always…I think we said I guess this was last night…adapted to the jet, the Saber Liner, and eventually in an expanded way to the Electra. But it turned out to be very reliable and

never really lost a set of data, calibration problems sometimes but it filled a real need, it really did.

Droessler: How about the remote sensing area including the radar development.

Rex: That of course wound up in a mixed up between what we talked about last night and earlier today. Anyhow, in a Doppler radar system, an embryonic four channel one, which I really lost track of …I'm speaking up to I should have said initially really 1976. I've had very little contact, which is too bad with what's going on up there since then so I'm sort of ancient history. I read things and I know things have come together in a nice way.

Droessler: You may say ancient history but I will say a very important part of the history of the development of the atmospheric sciences. While you were engaged in all of this over the oversight and management and the part of the spirit of the facilities development of NCAR, you also had another job at NCAR, which was to be the chief manager and a minister of the center. How did that job go?

Rex: That job was fascinating because I guess I said earlier this morning that the first thing Walt saw as a need was agreement as to how we would be organized. No sense going into details, I guess I did this morning. Anyhow, we did get organized with the help of Thornton Frye and everybody else and only a moderate amount of bickering from the players in house who had been accustomed as I said earlier to a family organization. You go to dad if something goes wrong and he decides what to do, nothing written down, no pictures and no charts. We developed one, it's maybe not the best, it seemed sensible I think it worked. Didn't I say this morning the four divisions?

Droessler: Yes.

Rex: Ok, I won't do it again.

Droessler: I suppose you were urged by the board of trustees too. Command the National Science Foundation to come up with a formal structure for the, in which in framework, which NCAR could develop.

Rex: Amen. I should have said that too many we's and I's in what I've said. All of these things develop with the detailed interest of NSF and the UCAR board and rightly so, very happy times. If anyone was shy and afraid it was the internal staff wondering what are all of these books that tell us how we are organized. I'm overdoing it but they were a little concerned about our organization and again rightly so. Anyhow, what happened I think as I say I believe the organization is essentially the same

today. I think it worked organizationally. What happened was that we built the new laboratory again with some shouting and screaming about what it should be like. The new laboratory, the present headquarters, was I better not say figures, you maybe remember Earl, like four million dollars worth something like that.

Droessler: 4-6 yes.

Rex: And of course entailed not only the development of the plan with I.M. Pey but then of course the selects of the general contractor ____ and a multitude of questions of course. We had the architect. We had a contractor, a good one, both of them good, but thousands of questions. So, to make a long story short…Well let's face it after the initial push I had devoted most of my attention to facilities and helpers, I don't mean depreciating that, really ran the administrative division budget times and so forth. Of course I got in the act. The administrative problem in building the labs is too big to ignore, too much time needed. So, I proposed to Walt that there should be a dividing of the way and we needed a full time administrator and a full time facilities manager.

Droessler: At that time you had a choice.

Rex: I did I believe. I'm sure I did. I just felt that facilities were still, this sounds egotistical, not over the hump they really hadn't found the path so to say and I wanted to stay with that. Maybe that was a mistake as I said last night but that's the way we went. We got a man again with Dr. Frye's help and the board, I have forgotten and administrative trustee from Pennsylvania. Anyhow, found this gentleman who had come from business accustomed to doing big projects and that man got us through building the building, which was a success in spite of the rook leak, which I'm sure you remember the roof leak. But he was not accustomed as I had joked the other night; he had trouble because you couldn't count the number of paper clips that came out each week and just was not at ease managing a research organization and so wanted to leave and did leave. Then with Fred Recker, who was an assistant, took over as the administrative chief at that point.

Droessler: Looking back on the development of UCAR/NCAR how do you approach it from the point of view of the impact of this development in Boulder, Colorado on our atmospheric sciences generally, let's say nationally in the United States, our atmospheric sciences development at the universities and our atmospheric sciences development within the federal government.

Rex: Ok. I certainly think, let's just pick one out, that the application…let's go back a step. Everyone has been trying one way or another of course to model the atmosphere, at least model the troposphere numerically and run

into all kinds of trouble of course and build in better physics slowly and gotten a better result. The basic problem, how do you forecast general circulation, and in my days there that was *the* project in LAS. Of course trying to involve/invoke/include more physics, how do clouds really form? What do they do to the heat structure? And so forth. What I'm getting to, I mean that was obvious to everybody it was being done everywhere one way or another but I think the development, the application of a numerical facility to the climatic problem at least in a modern sense had a real strong arm in NCAR. I believe that has effected or shaped or influenced the national picture in atmospheric science.

I think that, well witnessed what has happened, I think that an impact was made in as we've said in the ballooning field. I'm thinking of NASA as a participant or user of the facility. I think that it was a demonstration that you don't have to own everything in order to utilize it effectively. In a sense not the first and not the last but a happy story about cooperation, hands off cooperation. Of course the end of the line is they manage it now…Sorry, I beg your pardon, they don't. They fund it now but not manage it. I think, although I disagree mildly with him, Earl I have forgotten his name. The chemist at NCAR, been there forever…Ed Martell. I think that his, although I disagree about some of the things he did, I think his attempt, and I can't think of his cohorts name, to involve air chemistry as an essential part of the meteorological problem was unique and disappointing maybe as far as results are concerned but it started a lot of people doing things. They were measuring the exhalation of pine trees and all these good things. It's bound to have some effect on what's going on.

Droessler: And today that is a very vigorous field, atmospheric chemistry. One of the most vigorous leadership points comes from NCAR, Ralph Cicerone.

Rex: Right. I didn't know him but I know the name. It would be nice to say that we made huge steps back to that basic problem. The turbulent structure of the atmosphere just defies dissection I guess. I'm thinking now of Phil Thompson who to me, I've known him as a younger man I haven't seen him for years, but I think disappointed himself. Always the payoff was just around the corner and of course you went around the corner and there were 16 vortices instead of three and so with infinite patience Phil would start over again. Of course Von Carmen did it earlier and finally said the hell with it and we'll treat it statistically. Of course that's Earl what we do in atmospheric science. But Phil was really trying to get in there and look at the little things go round and seemed to have…I couldn't understand his mathematics half the time but it always eluded him, I think still has.

Droessler: When you joined NCAR there were 14 universities associated under the UCAR corporation umbrella. Today it's approaching 60.

Rex: I believe it was 29 when I left or something like that. Let me comment. I thought, and this is very sincere, I thought when I first got on the scene and was understanding how we were organized notably when I really realized what the board of trustees was like and how many people were on it, or let's put it the other way, it's lack of organization as a group, I was appalled. I didn't think…there is no way we could operate with that as a really going board. We needed a going board to get going. Do you understand what I am saying? Not a figurehead. It would have been easy, maybe not with those players, but it would be easy to distract a board of 120 people and have them all going in different directions so they had no effect, which many people do. But, we needed an effective board and I just thought this is not the way. My hats off to them. I'm amazed at the relations with the board, not that we always agreed; we disagreed diametrically sometimes. But it was always constructive disagreement in my view. So, I think it worked in an amazing way. The UCAR management structure fuzzy as it was initially was effective and supportive and it wouldn't have to have been so because we were a competitor in a very real sense.

Droessler: Perhaps one of the seekers of success of the UCAR board and this relationship to the corporation and to the general guidance of the NCAR programs was that the board and the representatives from the university were not just the university scientists but were some of the top administrators from the best universities in our land.

Rex: Good comment.

Droessler: Did they keep you out of trouble from a managerial point of view and a personnel point of view and so forth from time to time?

Rex: Oh yes. Thank you for saying that because I had been thinking science before. Amen. Very specifically and directly we had a manner of…well growing up problems in every field; personnel, personnel management, budget process, you name it, legal activity.

Droessler: Salary scales.

Rex: Salary scales exactly, fringe benefits, all of that. They were ready, willing and able to propose, consult and comment about anything. That was a tremendously strong reservoir in a much more specific way than the scientific help so to say. These were specifics, experts dealing with them. Good point. I'm glad you mentioned it.

The other thing I wanted to mention I certainly have to give Wall credit for being a seemingly effective moderator, director, politician; I mean that in the best sense. I could have, I say "I" all the time, many people could have driven the board in all directions by instant disagreement or ill-considered reaction; you know what I mean. Walt was patient, politically _____. We could have had an excellent scientist who…everything would have blown up; not that Walt isn't an excellent scientist, excuse me, he is obviously recognized. You know what I mean I think. It was a good choice. Many people didn't think so as you know.

Droessler: It was important to the role that you played as the chief administrator during these very early and tender years of NCAR's growth to have a person like Walt and yourself who were patient and were willing to listen to this wonderful advice that was available to these top administrators. The university administrators did not feel very much of any of the competition that you stressed earlier between the growth of NCAR and the scientific conflicts that are bound to occur between and among scientists as they move along.

Rex: Absolutely true. No difficulty in communicating or in getting enthusiastic support from the administrative trustees; more differences of opinion among the scientific trustees, which you would expect of course.

Droessler: Do any of these administrative trustees stand out? You mentioned the person from Penn State. I believe that was Mike Farrow.

Rex: That's right. Earl it's been so long.

Droessler: There's Carl Flow from MIT and Gil Lee from Chicago just to name a few who were…

Rex: And of course John Calvin was a great help. They were a joy. One name that escapes me who did a tremendous service in giving us the underpinning to defend what was, let's face it, a generous fringe benefit program. I can't think of his name. It was defensible; I mean certainly at the time. You all joined in a supported it. We could have made bad mistakes. The essential question; do you raise salaries and cut our fridge benefits or do you make a tremendous fridge benefits package and lower salaries? Dilemma. Good arguments both ways and different results both ways. He just provided a tailored package for us for nothing. It was amazing. It was a joy. Let's be facetious that's really one reason I hung onto the administrative job as long as I did; I enjoyed it. I enjoyed meeting these people. I still have a copy of the great **Blue Book** if you need a copy.

Droessler: Let's leave UCAR and NCAR for the time being and let's explore who is Daniel Farrell Rex. Where were you born and when, something about your parents, what do they do, brothers and sisters and a little about your academic education?

Rex: Ok. This is easy. I was born in Wichita, Kansas on the 4th of December 1916. My father was a physician and practiced in Wichita of course. He married my mother who was the daughter of Lloyd Farrell who was a pioneer in Wichita. He came to Wichita in 1869 and let me tell you something about him. He is figure in my life larger than my father. My father died when I was six months old. So my mother and I lived in her parent's house, my maternal grandparents. This gentleman, my grandfather, was a telegrapher, which was open sesame in those days. You could go anywhere and get a job, railroads were expanding and everyone needed a telegrapher. He put in the first telephone system in Wichita, ran the company for some time and sold it to somebody. He had a dollar store, so called, and ran that and began buying property, city and country.

My recollections as a little boy are of sitting at the table with my grandfather and grandmother and mother and me and that was my family. He was a great guy, an Irishman. He could get real man and even throw an inkwell at people but he really had a twinkle in his eye. He obviously as you can tell is my father figure. He believed in giving young people responsibility. When I was 14 years old he sent me to Yucatan by myself to buy 1100 head of cattle. This was some adventure. I'm sure that he obviously had arranged the right reception in Yucatan but in other words I met the right people handling. But, to get to New Orleans and get on this miserable bucket of bolts, the ship, go to Yucatan and get the cattle loaded and come back. To ride the train to Beaumont, Kansas was something. I will never forget it.

I grew up in Wichita with various trips here and there. Mother being a widow believed that getting around was the way to educate a person. I went through high school in Wichita with one year in Washington due to the fact that I became Senator Capper's pageboy, which was a real experience in my life. I went to school in the _____ school and also at the high school. I always thought I would be a doctor, physician. Everybody of course always said, naturally you're going to be a physician; your father was so I thought that. It started out that way with two years of pre-medics. Believe it or not in all my wisdom I thought mother had told me many times that practice really killed my father; night and day and just wore himself out. So, I have a black mark on practice. In all my wisdom I thought there was no future in medical research. No support for that.

Droessler: You can't foresee everything.

Rex: You can't foresee everything. I overtly changed courses and was interested in engineering and went to MIT. I had gone to the University of Kansas for the two years pre-medics. I spent four years happily at MIT in the good old days, Earl. This was '35 to '39 or something like that. MIT had a total enrollment undergraduate of 1100 people at the time. Graduate school was another 370 some souls. Isn't that amazing? In not so long a time, 50 years. Now it's unbelievable. Anyhow it was a good undergraduate education. In fact I fuss at them all the time as an old grad. I don't think there is feeling among under graduates, not just due to the large size now but due to the integration of course structures, you don't feel you're getting an education even when you go there as a freshman. You go there to become a chemical engineer in organic chemistry polymer type. That's not good if you understand what I mean.

Droessler: You had more of a general education including some of the liberal arts.

Rex: Yes, absolutely. So, I graduated from MIT obviously going to be a happy electrical engineer, that was my field. I got three job offers the top one, this was in I guess '38 actually, the top one was $110.00 a month and it was with Phelps Dodge Company. It involved going out into the wilds of Utah and Nevada and I turned it down and instead accepted a fellowship at the University of Tennessee and went there and got a master's degree in physics. It was a stopgap thing but an exciting year. I met a lady I'm sure you've never heard of, Catherine Way, she joined Fairme in the group that eventually produced the first _____ Chicago, very much interested in atomic engineering; she was and her class in electricity and magnetism, that's what it was called, was essentially looking ahead to nuclear power.

Then the war came along and settled everything because I had taken Naval ROTC when I was in Boston so I was called to active duty in late '40. I weaved my way through the war but the war did one thing; it converted me from a very happy electrical engineer to a frustrated meteorologist. My first tour of duty was on the submarine. I had trouble physiologically with the snorkeling, terrible scientist problem, so they sent me to the naval academy to teach submarine engineering. They saw the war coming and were allowing first classmen to decide are you going to go on submarines, aviation or general line and they were going to tailor the last year of course shorten the course. By the time I had gotten there they had changed their minds so I taught physics for a year at the naval academy. I met my wife and had a great time but got impatient with the wars going on. This always sounds unlikely but it was true. I just wasn't happy not being in more active involvement in the war. So, I remember it yet, there always came through opportunities to apply for postgraduate school and this thing came along, aerological engineering. I was an engineer so that's sounded great, let's get in that. I did as you know and was somewhat

appalled when I found out it was really meteorology. For a long time, Earl, I wasn't at all really interested in meteorology. The first assignment was down in Trinidad, which didn't help because the only meteorology was an occasional hurricane.

I then went to the Hornet and began to really see what effect meteorology directly had on operations so I got really much more sincerely interested. I came out of the war still expecting to retire as soon as I could. I had an opportunity to teach at Cornel. This is because of a professor at the University of Tennessee who had gone to Cornel, expected to get out, was counting my points and all that good stuff. My last year of duty I thought was in _____ with my good friend Mrs. Oliver and my good friend Earl Droessler and Jean Ballet got me into something called the office of research and inventions and the opportunities and the amazing potential there convinced me to transfer to the regular Navy. Earl knows all about a large segment of my Navy career after the war was…project cirrus was the first one and Langmeir Schaefer, artificial nucleation research project jointly supported Army/Navy Weather Bureau. Then three years, bless the Navy and the good lord graduate study in Sweden with Rosby, a tremendous experience for the whole family. Back to _____ to worry about research in the Navy…

Droessler: You should mention though that you received a PhD.

Rex: PhD, did. Philosophy _____ as well.

Droessler: At the University of Stockholm.

Rex: At the University of Stockholm, right.

Droessler: It was a well-earned degree.

Rex: Right. Rosby my professor and constant helper, except he traveled too much.

Then into the task force affair for five years. Then to fleet meteorologist _____ fleet and finally _____. Then we pick up with Walt…

Droessler: Tell me when were you married and how many children do you have?

Rex: I think I said I met Mary Emery at Annapolis when I was teaching there at the academy. I lived at Carl Hall, being by then very prosperous and very elite. I noticed this blonde girl who taught a dancing class. That turned out to by my wife, Mary Emery Hill. I just watched her from a distance for at least nine or ten months and remarkable went to a party given by a PG school classmate, Bob Drummel was his name, and sure enough there

was this blonde. So, I met her and had a big argument with Bill Landerman as a matter of fact about who was going to take her home and I won. It didn't take long to know that was the girl. We were married on October the 13th, which was another story. It was Friday believe it or not. Because of the fact that we anticipated getting two days leave from PG school to add to the weekend so we could go down to the homestead and have a little honeymoon. The superintendent decided before it came to pass that this was wartime young man and so you can't have Monday and Tuesday. So, we were married on Friday and had Saturday and Sunday and back to school on Monday. We spent our honeymoon watching Bambi in Washington, stayed at the shore and it rained constantly, Earl. It rained forever.

We have been very happy. The good lord has blessed us and we had three children. Let me tell you a little anecdote about the first children. We had twins it turned out and at the time I was in Trinidad. This was during the war, and I was with…they had a jungle training operation in Trinidad all manner of Army troops here and there going through the cane fields and I was supposed to be providing weather information. The commander had no idea what to do with the weather information, which is another story. Anyhow, I was out at the end of this field telephone line in the swamp expecting to hear from Mary Emery, I knew when the baby was due, and I got this garbled message that you have a message and I said fine read it, this is Lieutenant Rex and I would like to read it. He read something and it sounded something like he said, "Twins boy or girl born today." I beg your pardon, no twins, I thought he was saying boy or a girl born today all is well. I asked him to repeat it about three times and he finally said, "You have twins son!" I can still hear that voice. "Twins you've got twins boy!" That really stopped me. I thought everything else, bad news, whatever.

(TAPE END)