

Entry Date 5-12-93
Data Base HDOCNDX
Index # INS. 0206025

ORAL HISTORY INTERVIEW

DATE OF DOCUMENT [Date of Interview] = 04 - 07 - 68
OFFICE OF PRIME RESPONSIBILITY = JSC
NUMBER ON DOCUMENT = 00
TYPE OF DOCUMENT [Code for Interview] = 1
PROGRAM [3-letter Program Archive code] = INS
AUTHOR [Interviewee's Last Name] = JOHNSTON
LOCATION OF DOCUMENT [Numeric Shelf Address] = 091-2

SUBJECT OF DOCUMENT: [use relevant bold-face introductory terms]

Oral history interview with Richard S. Johnston
[full name of interviewee]

about Crew Life Systems — equipment, atmosphere,
[main focus of interview]

Clothing, food, physical safety + comfort.

Title: 1962 Life Systems Division
[interviewee's current and/or former title and affiliation]

1968 Chief, Crew Systems Div, Dir. of C+D

Interview conducted by Robert B. Merrifield, Staff
[interviewer's name/position]

Historian at MSC
[location of interview]

Transcript and tape(s). [for inventory only: # pages 22; # tapes 1]

Master 1

CONTENTS:

Biographical - [date/place of birth; family background] _____

Education - Univ of Maryland, Chemistry

Career Path - Mid 1940s ^{Summers} Naval Research Lab, Wash DC;
Research Chemist, Naval Research Lab. @ 1955 Naval
Bureau of Aeronautics, Airborne Equipment Division.
1959 - STG Langley (Flight Systems Div)

Topics - Mercury environmental control system; animal
program; spacesuit program (Navy Mark 4 by
BF Goodrich); survival equipment; bio-instrumentation;
new Life Systems Branch; medical operations procedures;
blood pressure measurement; radiation effects; at MSC
environmental Chamber (B); Centrifuge; Surplus 8'
Air Force Altitude Chamber; analytical Chemistry lab;
food programs; 8 trailers plus temporary quarters;
MSC Building 7 - Life Support Lab; important role of Navy labs
(Phosville, Philadelphia, Wash) + Air Force labs (Wright Field,
Holloman); MSC Space Science Div under E+D (later Crew Systems Div);
role of animal flights; GFE explained; spacesuit dev; ^{staff} of young college grads;
astronaut relations; spacecraft atmosphere;
Apollo fire Aftermath equipment redesign; umbilical & space walk;
Russian + U.S. EVA Films; world wide interest in Space Prog.

p 4 - influence of NASA Acts on
status of life sciences in STB
(Dr. Dandl)

p. 11 - 1960 - medical research
transferred to ^{space} ~~space~~ ^{new} ~~new~~ systems
Directorate

Tel. No. (or Code) & Ext.

Name

Date

Code (or other designation)

To: Bob MORRIFIELD

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June 19, 1968

Dick,

The transcript of your interview, edited to remove extraneous material, is attached.

If you will, please read the statement and mark those sentences with brackets [] that you would not want alluded to in a Center history for reasons of embarrassment to an individual or the Center. As I mentioned during our recording session, this interview is to be part of the source material for the history, and it is doubtful that I will quote from it verbatim. Therefore, please don't worry about a sentence here or there which might not be as polished as would be desirable were it to receive public scrutiny.

If you want to add information feel free to do so. Just tack it on at the end of the statement, unless you prefer that it be inserted into the text.

After you return the transcript to me, I'll send you a copy for your personal file.

Thanks,

Bob Morrifield
BN

Please note deletions!

Dick Johnston

Interview with Richard S. Johnston

4/9/68

32 I had my professional training in the field of chemistry and started working at the Naval Research Laboratory in Washington, D. C. in the mid-1940's as a summer student. I worked there for several summers and when I graduated from the University of Maryland I became a research chemist at ~~Wallons~~ ^{In this position} Naval Research Lab. ~~There~~ I worked on a variety of programs, the prime ones being the development of chemical oxygen systems for firefighting and submarine air purification. Around 1955 I went with the Naval Bureau of Aeronautics and worked in the ~~A~~ ^E ~~airborne~~ ^D equipment division. ~~Initially~~ ^I in this job I was ^{initially} responsible for the conversion of aircraft oxygen breathing systems from gaseous systems to a liquid oxygen system. In this job I was responsible for establishing research and development contracts ^{with industry} ~~in~~ ^{and established} projects with various naval labs. The latter part of my work there was centered around escape systems from jet aircraft and in this job I got some background in pressure suits and oxygen breathing equipment in general. In late 1958, with the start of NASA, I became interested in the space program for it looked like it offered new horizons so I applied for a position with Headquarters. Around February 1959 I talked to George Low, who indicated that there was an organization called the STG at Langley and that this group was ultimately to be quartered at the Goddard Space Flight Center. He felt there were opportunities there and suggested I call Bob Gilruth. Shortly after that, about in the middle of a week, I was contacted by Max Faget, and he wanted me to come to work the following Monday. I drove down and talked with him. Within 2 weeks I rented my home and moved my family and was working

in the Flight Systems Division of STG. It was in April 1959, that I came to work.

69 Initially I was told I was responsible for the environmental control system for Mercury spacecraft. So I spent the first few weeks trying to obtain some background in what the environmental control system was. As time went on, the job expanded. For example, there was an animal flight phase of the Mercury Program and I was asked to obtain some background there. I attended a meeting with what was primarily a medical aerospace group to discuss the objectives of animal flight related to the Mercury Program. At the conclusion of the meeting, someone asked who had taken minutes. I indicated I had, so I wrote up the minutes of that meeting and since no one was assigned that responsibility, I was made responsible for management of the animal program until an Air Force Colonel, Dr. Jim Henry, came onboard.

72-1 Spacesuits was another area that wasn't really being managed by any one individual. Dr. Stanley White, Air Force physician, who was on Dr. Gilruth's staff had done some of the preliminary work but there were no engineering personnel assigned. When I came into the spacesuit program, there had been a paper study of three suit designs. These were tradeoff studies of suits built by David Clark (which was an Air Force X-15 type suit), a suit built by the International Latex Corp. (which was more of an R&D suit), and the Navy's Mark 4 operational pressure suit. Around May or early June, we decided that we should have an evaluation of these 3 suits. I made several trips to Wright Patterson Field

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and established an evaluation program which included criteria such as mobility, cycling, reliability, etc. At the conclusion of this evaluation we were to select one of the 3 suits and get the program started. The Air Force and Navy were highly competitive. The Air Force felt that their suits should be selected hands down. The Navy people likewise felt their suit was clearly the best. Around June or July, Wright Field completed the evaluation and forwarded the report to STG. We formed a suit selection committee composed of Max Faget, Dr. Douglas, Dr. White, Wally Schirra, Warren North (then in Hq), and me. We weighed all the factors carefully and decided the Navy suit offered the best potential for the Mercury Program. After we made our decision to buy the Navy Mark 4 suit built by BF Goodrich, we established a contract with the Navy to purchase these suits. I think we ^{initially} bought 20 suits.

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There were other equipment areas for which the STG was not staffed to handle that pretty soon I became involved in. Things like the survival equipment. Through my contacts with the Bureau of Aeronautics, we were able to secure this as GFE and this function was moved into my office. In June I got the first two people to work for me; they were young college graduates - Frank Samonski and Lee McMillion.

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There were other areas such as bio-instrumentation that due to their close association with the suit and other personal equipment this group that I headed started managing. This was really the beginning for

the Crew Systems Division. We continued to operate as a group until it was decided that a branch should be created, with Dr. Stanley White as its head and I as his deputy. This branch had functional responsibility for all the medical activities in STG, suit development and the support restraint system, then under Mr. Pessman. The new organization was called the Life Systems Branch. We had approximately 20 people. Organizationally we served as a branch for another year until through pressures from Headquarters, particularly from the Life Sciences Director, Dr. Randt, caused the elevation of the branch to a division status. Again Dr. White was chief of the division and I was his assistant chief. Dr. Henry had the medical branch, and Ted Hays was brought in to head up the engineering branch. The Life Systems Division was very active in the Mercury and Apollo Program while we were at Langley. The division was not only responsible for the equipment I've described, but it was also responsible for developing all the medical operation procedures for Gemini and Apollo. In other words as far as operations was concerned, we were responsible for establishing the medical recovery procedures, medical monitoring procedures, and the medical research program. Contrary to what many skeptics on the outside have said about the Mercury Program, the Mercury medical research program was really not as barren as one would believe considering the space and weight limitations. There were actually a series of medical experiments conducted, and although they were rather primitive, they were the first of their kind. For example we studied vestibular disturbances, the capability of man to assimilate food in weightless flight, and monitored the basic medical condition of the astronaut.

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// The measurement of the astronaut's blood pressure was an interesting aspect of the program. Just prior to our first suborbital flight, the PSAC committee came to the Center for a series of briefings on the Mercury Program. The medical members of that group voiced concern over the inadequacy of control data and medical data in general which would permit us to operate safely in manned space flight programs. The committee particularly felt that the animal test program should be greatly expanded through centrifuge runs. There was a lot of concern about high heart beat rates exhibited by X-15 pilots, and no one knew what would happen when man was boosted into space by a rocket. We ran a special centrifuge test for Al Shepherd and his backup pilot to insure that the crew was conditioned for the acceleration loads that would be encountered. There was a lot of concern over the fact that we weren't measuring blood pressure, and out of this concern we speeded up the development of a semi-automatic blood pressure measuring system. It wasn't started as a result of PSAC, but it was accelerated to have it ready for the first manned orbital flight and also to have a blood pressure measurement on the orbital animal flight. This was accomplished, and we did measure blood pressure on the animal and manned orbital flights. //

When the decision was made that the Center was coming to Houston the Life Systems Division was one of the 4 divisions at the Center: we were responsible for the life support equipment I have previously described, plus medical operations, medical research, and in the radiation field the effects of radiation on man, shielding requirements, and radiation monitoring. Shortly after the announcement was made that we were coming to Houston, we were asked to put together a list of facilities that we

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felt we would need to do our job in Houston considering the broad manned space flight responsibilities of the Center. You must remember the facilities of the STG itself were very limited. In our division for example, we had the space suit development lab, a survival shop, and we had set up a Mercury spacecraft boilerplate which contained a life support system. We also had a chemistry lab and a very small instrumentation lab. These had been in operation less than 6-8 months.

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Some of the major facilities we discussed and began planning were first the large environmental chamber (Chamber B) about 35' in diameter, with hot and cold walls, solar simulation, etc. Bill Kincaide put together the requirements which ultimately became the basic framework of the Chamber B facility in SESL. I think the decision was made by management that it would be wise to put both Chamber A and Chamber B together in a single organization. One of the facilities we omitted from our list was a centrifuge. Walt Williams or someone else brought up the question of the need for a centrifuge. We stated that the support we had received from Johnsville was satisfactory, and we could see no justification for a centrifuge for the Center. But it was pointed out that the astronaut group was expanding, which would increase training, there would be a need for equipment evaluation, etc. It made sense for us to build our own centrifuge. Jerry Pessman from our division was instructed to start assembling the requirements for the centrifuge. Some time after we moved to Houston, the function was turned over to Aleck Bond's Systems Evaluation and Development Division, and Bill Lawton became the project engineer. As it turned out in a subsequent reorganization

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of the F&D Directorate, Bill Lawton and all the people working on the centrifuge were later moved back into the Crew Systems Division and it's now part of our division.

We discussed the need for a drop tower, suit labs, chemical lab, most of the other labs we now have as a part of our division.

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In late 1961, we made our initial move to Houston and took up temporary quarters in the Lane Wells Building. Bill Kincaide and I had come down in November and inspected the building. It was a quaint old red brick building but became home for us for several years. Between December 1961 and June 1962, the Mercury support people from our division drifted into Houston. At the Lane Wells Building we acquired an 8' altitude chamber from the Air Force as surplus property. It was the first manned chamber the Center had in operation. We modified it so that we could put a Mercury spacecraft in it. This chamber and the other labs we had at Lane Wells were used for the development work which permitted us to fly the Mercury spacecraft for 34 hours before Cooper's flight. We ran tests on the adequacy of the life support system for this period of time. We found we had to provide more oxygen, more drinking water, and all the other consummables required for what was then a long term flight. Initially the Mercury spacecraft was conceived to perform a 24-hour mission but as the orbital flights came closer, requirements were cut back so it became essentially a 3 orbit spacecraft. We also developed many new pieces of instrumentation that were used for Schirra's and Cooper's flights and tested them in that chamber. We set up our space suit shop in the Lane Wells Building and an analytical chemistry lab to conduct such chemical research and testing as would be

required to create confidence in life support systems processes. We also established a physiology laboratory in which people worked on physiological experiments and developed requirements for future programs.

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All the food programs for Mercury and the early phases of Gemini were furnished by the US Army Food and Container group at Nattick, Mass. As we moved into Gemini we did start buying foods from industry but we continued to receive research support from the Army Food Container people.

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We set up an extensive bio-instrumentation lab and ECS shop in the Lane Wells Building and built a drop tower out of an old ejection seat - training tower. This drop tower was used to qualify a net couch to replace the form fitted couch in the Mercury spacecraft. If there had of been one more Mercury flight, that net couch would have flown.

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In this period we also had some medical research capability and were looking into the effects of blood oxygen saturation. In general the Lane Wells facility ended up being a fairly complete lab complex with adjoining office space for division personnel. I think those were very happy years while we were in that facility. It wasn't long, however, before we outgrew the building and ended up in trailers. Many of these were the animal trailers we had developed in the Mercury Program. There were five of them and one house trailer. We later bought two Magnolia house trailers. These were big trailers, and we could fold the floors out to provide additional space. We had a total of about eight trailers.

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We used the house trailer for crews to sleep when we made long term runs. One of the technicians we had then recently told me that a number of times he worked into the wee hours of the morning, slept in that trailer and came right back to work the next morning. This was the type of dedication the people had, and I guess still have. It's the thing that makes us different from many agencies of the government.

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While we were in Lane Wells Building, we developed detailed plans and layouts for our lab and office space at the permanent site. Building 7 was designated as the Life Support Laboratory, with a space-suit development lab, a 20' chamber (bought from Chicago Bridge and Iron), and our 8' chamber, extensive materials testing facilities, a 30' drop tower, a small clean room, an extravehicular life support system laboratory, and a survival equipment design and fabrication shop. Right after we moved to Houston Dr. Berry was brought in as a member of Dr. Gilruth's staff, and at the conclusion of the Mercury Program, the medical operational responsibility was transferred from the Crew Systems Division to a staff office under Dr. Berry. This was the first in a succession of transfers of function from the Division.

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In the Mercury Program, the Navy centrifuge at Johnsville played a vital role in astronaut training. There the initial testing was conducted on the support restraint system, which I might add, was considered to be one of the real problems in manned space flight. There was a great deal of concern about the ability of men to endure relatively high g's and high impact landing loads. The centrifuge and the staff at Johnsville played a vital role in the early period of the Mercury Program in getting

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the aeromedical question squared away, and to prove that man could take relatively high g's when properly supported in a semi-supine position. That was a pivotal point in getting manned flight under way. The Navy's Aircrew Equipment Lab also in Philadelphia, played an important role in Mercury. They provided support for the spacesuit, conducted the qualification review, and actually managed the initial contracts for the Mercury spacesuit. The Air Force Lab at Wright Field also played an important role in Project Mercury. They conducted the evaluation of the Mercury spacesuit, helped establish some of the food concepts, and provided zero g environment for training the crews and evaluation of the hardware. The Air Force Aeromedical Lab at Holloman was headed in those days by Dr. Rufus Hessberg, a Lt Colonel. Ruf was responsible for the acquisition, training and operational support of Enos and Ham, the monkeys used in the animal space flight phase of Mercury. We developed a very close working relationship with the Air Force people at Holloman.

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Another DOD lab which was a lot of help was the Naval Research Laboratory, which analyzed all the lithium hydroxide activated charcoal canisters for all flights. NRL provided traced contaminants that were found in spacecraft and also provided us with a baseline against which we could make some estimates of metabolic rates while flying.

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When Mercury started there was a lot of infighting between the DOD aeromedical community and NASA as to whether NASA should build any capability in this area. I think despite this initial squabbling, the Air Force, Navy, and Army provided excellent support for Mercury and I don't think there is any question that the program could not have been

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completed as quickly or as efficiently without their support. Shortly after we moved to Houston we set up a formal coordination process with Brooks School of Aviation Medicine. We coordinated all of our research and development work with the Air Force and allowed each to recommend cancellation of the others programs if there was duplication or if it was felt they were not worthwhile. I think this coordination activity is a shining example of how real cooperation can be accomplished in the government. Something like \$2 million worth of programs have actually been cancelled. Congress was impressed with this effort, and it served to prove a much better working relationship between the Air Force and NASA.

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When we moved to Houston, E&D had a Space Sciences Division under Dr. Faget, [for which there wasn't a division chief.] This group had rather broad responsibilities; one of them was in radiation. Around 1964, we transferred the radiation responsibility that we had maintained in the Life Support Division to the Space Sciences Division. Bill Gill who had headed our radiation effort was transferred with all his people over to work for this new division. This was the second major responsibility to transfer out of the division. About $1\frac{1}{2}$ - 2 years ago, when Dr. Berry was elevated to directorate level of the Center, all the medical research responsibilities were transferred to the new directorate. Dr. Dietlein and around 25 people were transferred over to the medical directorate. In 1963, when Dr. White left, the division's name was changed to Crew Systems Division.

As we started in the Mercury Program, the medical community had established more or less from their classical training, that medical

experimentation is done with animals before done with men. I think many of the leaders in the aerospace medical community felt that manned space flight was almost a medical experiment. There were a million reasons why we couldn't do the job, and with the problems we were going to encounter I guess it just fell in line that the logical thing to do was to fly animals. The animal flights in Mercury were very complex in that the complete mission had to be automated since you did not have a man onboard to assume control. We had problems in the suborbital animal flights which a man could have taken care of. We did have some problems in the orbital flight ~~psycho~~ ^{psycho} motor task. As we moved forward to manned orbital flight it became evident that we did not encounter any medical problems which were of the magnitude that the people had anticipated. Initially when Apollo was started I think the major design philosophy was to put maximum emphasis on simplicity of design and to use the crewmen as the prime controllers of the spacecraft. // Also based on the limited experience of both American astronauts and Russian cosmonauts, it was decided, and a position paper was written (it originated in the Crew Systems Division), which said that animal flights should not be a prerequisite to manned flights. Rather that the manned flight program should move ahead on a progressive basis with man, rather than animals, as long as this could be done with a reasonable expectation of safety and reliability. I don't mean to give the impression that CSD established this policy with the agency. This did not preclude any additional animal flights as in the bio-satellite program. These animal flights are conducted more or less for

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in-depth research. They are not a prerequisite to manned flight. Most people don't understand that by having animals instead of a man in the spacecraft, there is a risk, because the animal is incapable of acting on a judgmental basis or upon instructions from the ground. I don't think any of the management of the Center is openly opposed to animal flights, [although I think deep down inside they are.] They just don't like the idea that the whole program might hinge on the services of the animal flights. //

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The Life Support Division and later CSD historically has provided support in the various mission control centers. When the operational concepts for Mercury were established, people at the subsystem level were initially assigned to positions in the operational net for the Mercury Program. For example, Dr. White was assigned to the control center as a medical monitor, and I was assigned as the ECS monitor. We also had people assigned in Bermuda and various other stations around the world. Division personnel participated as team members in the monitoring of the Mercury Control Center. This close relationship with Chris Kraft and his operational people carried over into the Gemini Program. Throughout all the manned flights we had the staff support rooms manned with Crew Systems people monitoring the ECS and the extravehicular life support systems. Larry Bell, Elton Tucker, Bill Huffstedler, ^{Joc}~~Bill~~ McMann and others played an important role in providing good operational support for the Gemini Program. We have been informed that this support will not be required for Apollo and future programs, as the Flight Operations Directorate supposedly has this type of expertise available within its own organization. I believe this decision is most

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regretable, as it brings to an end the close working relationship between this E&D Division and elements of Flight Operations. It also seems to be me to be one more step toward the run-of-the mill government agency--a far cry from the small, elite, and highly motivated staff that we had back in STG and early MSC days.

One of the unique things about our division is the amount of government furnished equipment we provide. When I say government furnished equipment, I am not referring to equipment purchased through the prime spacecraft contractor like North American or a subcontractor such as AiResearch. There are a lot of pieces of personal equipment: spacesuits, survival equipment, bio-instrumentation, waste management and many other similar pieces of equipment that we develop ourselves and provide to the program. That's the reason we call them government furnished. The spacesuit is, of course, the glamour piece of equipment that we work on in our division. // The spacesuits were initially developed for use primarily for inter-vehicular flights--that is, just to provide protection in the event of loss of cabin pressurization. The suit provides the astronaut with an environment which will keep him alive and allow him to complete his mission. As we moved into Gemini the suits became more a prime system as they then had to provide protection for extravehicular activity. EVA encompassed not only protection from the vacuum of space but as well thermal protection from both hot and cold temperatures encountered in orbital flight. It also provides protection from micrometeoroids, and protection of the eyes from UV, infrared, and other energies from the sun. Next in evolution is the Apollo suit which

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has to do everything the Gemini suits could do--be compatible with the planned operation of the command module and be capable of being worn pressurized for 115 hours on the return from the moon. The most important requirement of all is the necessity for it to be compatible for lunar surface operations. It has to be able to keep a man comfortable in temperature ranges from -250°F to somewhere around +300°F. In spacesuit development activities, a couple of the key individuals are worth mentioning: one is Ted Hays. Before coming to STG in the summer of 1961, Ted, was a chief engineer at the Navy's Aircrew Equipment Laboratory. Jim Correale who also came from the Navy's Aircrew Equipment Lab deserved major credit for the design and development of the Navy's Mark 4 suit. He brought into our program ~~probably~~ 10-15 years of pressure suit experience. Charlie Lutz joined STG from the Air Force Aeromedical Lab at Wright Field, and he also brought 10 years of experience with him in Air Force suit development. These key men together with a group of aggressive and competent engineers constituted a work team in a very difficult development area.

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From the beginning, our division has been staffed with a very young staff and in many cases people fresh out of school. Through necessity we have allowed them to assume a major role in management of subsystem development, major test programs, operational support, etc. I have been extremely pleased, and in some cases even surprised at how well they have risen to the occasion, have been willing to give of themselves and their time (and in many instances at a personal sacrifice to their families), to do excellent work under very trying and frustrating

circumstances. It is a marvelous commentary on the capabilities of the United States and the faith that we have to have in the younger generation. I also believe it has proved that it isn't necessary to have 20 years experience in a particular area to be able to do a job. Without the groups of young college graduates the Center acquired from time to time, its programs would really have suffered.

A good example is the group of 1959 college graduates; these men have assumed important roles in the space business and in the years to come will be the ultimate leaders in this whole business. Yet they started on the ground floor less than 10 years ago.

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Since the beginning of work on spacesuits here in the division, we have been closely associated with the astronauts. In general, the association has been good. But being in the suit business, it seems like we are always in an argument with one astronaut or another about a suit fit or other problems. Now all of us have a considerable amount of dedication to trying to do a good job for these guys and we often have known the astronauts from "way back when". For example, I personally worked with John Glenn before he came into the program while he was head of the F-4U Flight Desk in the Bureau of Aeronautics. [But we do have a couple of the astronauts who have caused us problems.] It seems that the problem of building spacecraft systems is tough, but when you attempt to satisfy the needs of human beings it gets tougher. For instance we carefully fitted one astronaut with a suit, and a few months before he went on a mission, he began a diet and by the time he was ready to fly, all of a sudden his suit doesn't fit him anymore. We have this type of situation to contend with continually. We do have many humorous moments

with them. But I guess, really, we have more damn arguments with the astronauts over spacesuits than you could shake a stick at. Frank Borman told me the other day that he wouldn't take \$100,000 a year for ~~our~~^{my} job.

358 The Crew Systems Division played a prominent role in the selection of the spacecraft atmosphere. In Mercury we started off with a mixed atmosphere on the pad. We launched with normal air environment and then enriched with oxygen as we got off the pad. Early in the test program we discovered that in a situation where men operate in spacesuits on a small spacesuit loop, it was possible to incur in-leakage from the cabin atmosphere to the point where nitrogen began to accumulate in the suit. As the oxygen was breathed out of the air, nitrogen concentration increased. In several tests, we actually had men pass out from this cause. We made the decision then that it made sense since the suit was operated in 100% oxygen, to go ahead and operate the spacecraft in 100% oxygen. This is really the crux of the rationale to employ an enriched oxygen atmosphere for Gemini and Apollo. The ~~division~~^{decision} was carefully considered. Early in the Apollo program, we talked about a two gas system but this discussion was based on physiological hazards, not fire, although it was a consideration. I think the medical community felt that long term exposure to pure oxygen would perhaps cause toxicity or other problems. We actually conducted an exhaustive manned atmospheric validation program, and based on its results, we determined that there were no physiological problems. We made the recommendation that from medical

or physiological standpoint, there was no reason why we could not use 100% oxygen in the spacecraft. Also, there was the simplicity of the 100% oxygen system that was an important design consideration. It was recognized from the beginning that the oxygen environment was a fire hazard, but it was felt that by proper materials selection, safety of the spacecraft and crew could be insured. [It was actually the breakdown in the discipline of materials selection that really got us in deep trouble with the 204 incident.] //

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The effect of the fire on the Division, people, and equipment has been staggering. Almost every piece of equipment we are responsible for has undergone major redesign as a result of that tragedy. For the most part, this has been in the nature of materials substitution, but as well there has been a significant change in attitude and safety goals. This, in turn, has resulted in equipment being redesigned. The fire was a terrible period in everyone's lives. All of us have become more dedicated in trying to do the Apollo job, to do it right and on time. The only thing I personally can compare the 204 tragedy with, is the loss of a brother or father. It was ~~about~~ the worst tragedy I've ever been through.

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Gemini 3 went extremely well. Either just before or just after Gemini 3, the Russians had made their space walk. A few days after the flight, George Low called Warren North, Chuck Mathews, and me over to his office and asked if we could go EVA on the next flight. We had equipment under development, but not for the next flight. This was like a Thursday, and we asked to be allowed to do some investigation and

promised to report back to him on Monday. This was to be handled in a discreet manner and to be discussed only with a limited number of people. I got a group of guys in my office and we laid out a hardware program, and over the weekend actually built a mockup of the chest pack that Ed White wore. The umbilical was under development with AiResearch and we looked into the possibility of accelerating that effort. Harold Johnson's Flight Crew Support Division had done some preliminary work on the maneuvering gun and ultimately the responsibility for this hardware item was given to this division. On Monday we met with George Low and Dr. Gilruth, laid out what we thought would be required, our schedule charts and everything we thought needed to be done. We were given a tacit approval to go ahead with the hardware. Within a few weeks some elements of Headquarters were down and they were given a briefing on what we were doing in this area.

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We organized a team of people to take care of the hardware development and testing. We got excellent cooperation and support from Jack Kinzler's people in Tech Services. Ed Samfield's people in Engineering, and Jack Jones's staff in QC. We had regular morning meetings in my office to go over the status of each item and the entire program. We had blanket procurement authorization, so we could buy equipment without the usual paperwork and delay, and were given priorities around the Center without people really knowing what we were working on. We built the equipment and we gave Dr. Seamans a briefing when he was at the Center. It started taking shape, and Center Management was given a go-ahead, and if we could indeed get all the hardware qualified, perhaps

it would be considered as a flight item for the following mission. We worked around the clock, got the hardware built, got our manned test program under way, completed the zero g familiarization flights with the Gemini 4 crew, and put a Gemini boilerplate in our 20' chamber, ran chamber tests and trained the crew on the use of the ECS and the chest pack. Gradually everything started falling in place and by a few weeks before the flight the crew was trained, the equipment was built and qualified, and we were ready to go. We had a FRR at Headquarters with Dr. Mueller and presented the status of all the equipment. About a week before the flight, the fact that we were going to do this was released to the press.

Subsequently, the inflight movie film showed it was a tremendous success.

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Shortly after the GR-4 flight I gave a paper to the International Aeronautical Federation in Paris. I summarized the work done on the Gemini suit development and extravehicular equipment development activity and showed the film. The Russians also showed their film at this meeting. It was a very interesting and exciting occasion--I really felt that I was not over there representing the division, MSC, or even the agency. I felt I represented the United States, and I really felt a considerable amount of pride to be able to do so. I was impressed in the conversations I had with the various international scientists, reporters, and even the man on the street by the fact that our space program is an extremely vital thing to us as a nation in terms of our international image, as it showed the vitality of our country.

I don't mean this in a parochial way, but my own personal observation as a result of that and other international trips I have been on is that the space program represents truly a new horizon--at least it did several years ago and perhaps it still does. It grabs the imagination of everyone and probably does our image in the world a lot more good than we really give it credit for.

174-2 I was also fortunate in being selected to take John Glenn's spacecraft on tour to Africa, but when Carpenter's flight was delayed, I ended up getting assigned to the European tour. I "picked up" the spacecraft in Mexico City, flew to London, then on to Paris, to Belgrade, and Madrid. I had many exciting experiences on that trip starting with an earthquake in Mexico City, and met literally thousands of people. I answered their questions, discussed the program with them, and gave little talks in various places. The people I met ranged all the way from the man on the street to the head of state of Yugoslavia--Marshal Tito. The thing that most impressed me was the tremendous interest in our space program. People stood in lines for miles, for hours to look at that spacecraft. I was amazed at the amount of knowledge people had about the Mercury Program which, if you consider the fact that this was in May 1962, and after we had had only one orbital flight.

174-2 I had a dramatic experience in Belgrade while I was exhibiting Glenn's spacecraft. Carpenter's flight was in progress and the PA system at this big fairground carried a running commentary. When Carpenter came down he was lost for several hours and it was a dramatic moment for me to be in a Communist country thousands of miles away from home and listening to the progress of something you had worked on, and knowing a friend was

perhaps in deep trouble.

389 I had another interesting episode in Belgrade. I got a telegram from Bill Bland asking me to take some pieces out of Glenn's spacecraft and ship them back to the States immediately. With only a screwdriver and a pair of pliers, I went out one night about midnight to the fairgrounds and removed the verastats from the Mercury spacecraft. To this day, I am one of the few people who knows that part of that spacecraft in the Smithsonian Institute has a part ^{missing} ~~mission~~, and some bailing wire holding a couple of other pieces together. When I called Bill Bland at the Cape the next morning to tell him the part was on its way, he was at breakfast. The motel's switchboard operator in paging him stated that he had a telephone call from Belgrade, Yugoslavia. Everybody in the breakfast room looked at him like he was some kind of a spy or something. Those were good days. I feel very fortunate to have been a part of the Center. I think the Center has a lot of potential and I hope we can somehow maintain the esprit d'corps that we have had in the past and continue to move ahead, and not just become another government agency.