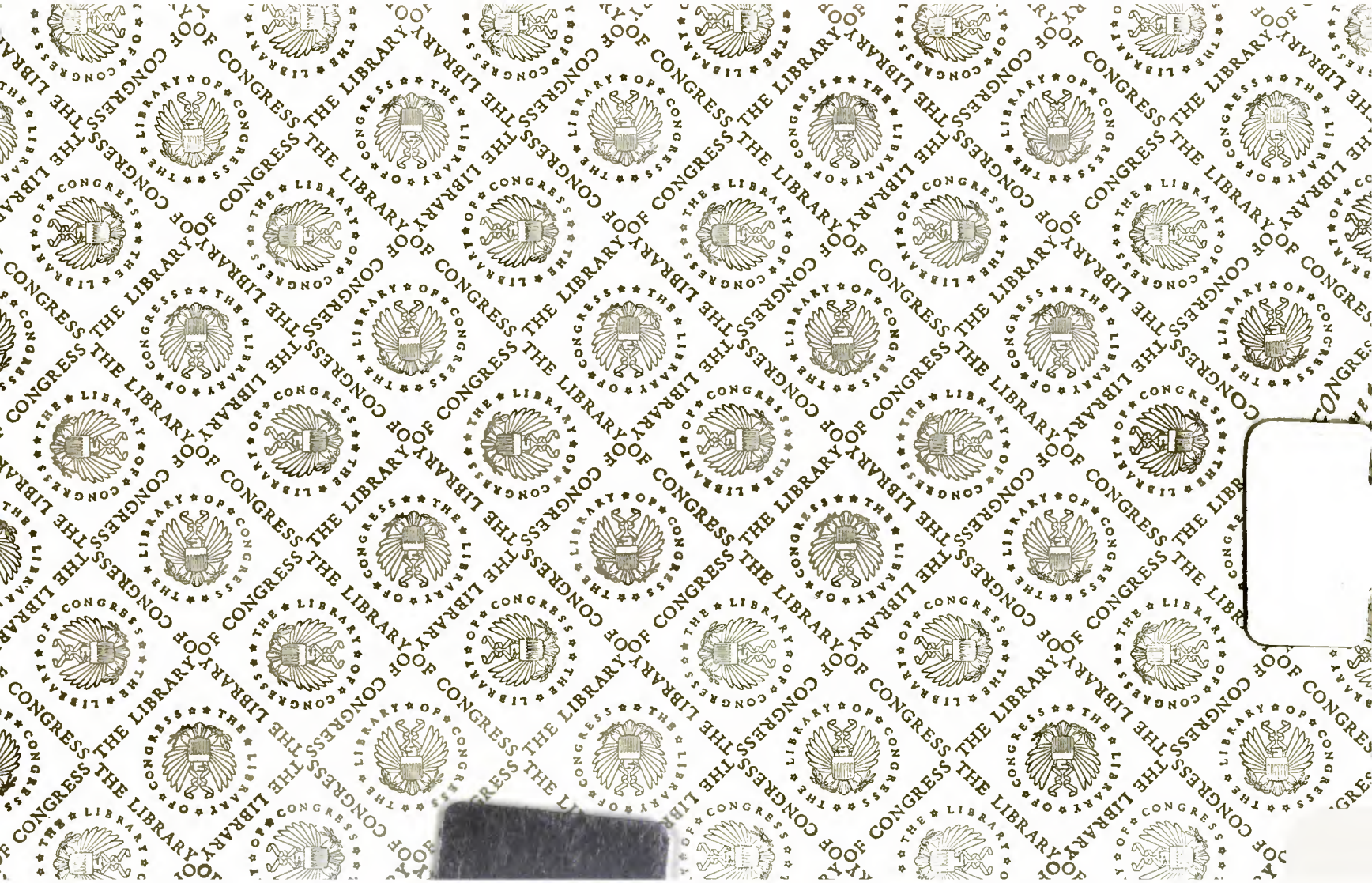
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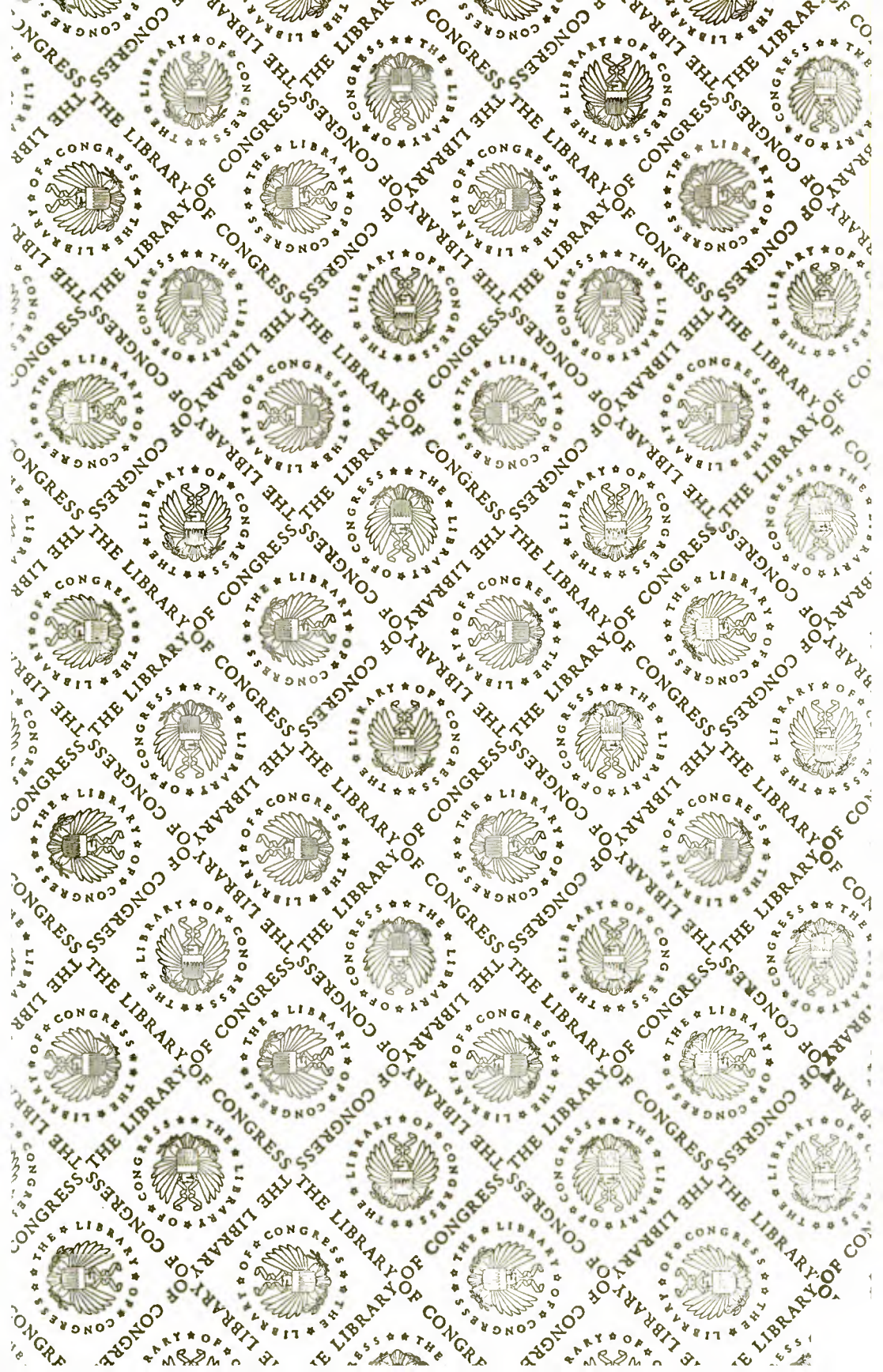
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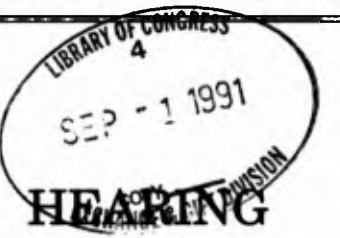
THE NATIONAL WEATHER SERVICE MODERNIZATION AND SYSTEMS ACQUISITION



HEARING

BEFORE THE

SUBCOMMITTEE ON ENVIRONMENT

OF THE

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY U.S. HOUSE OF REPRESENTATIVES

ONE HUNDRED SECOND CONGRESS

FIRST SESSION

MARCH 20, 1991

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March 20, 1991:

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THE NATIONAL WEATHER SERVICE MODERNIZATION AND SYSTEMS ACQUISITION

WEDNESDAY, MARCH 20, 1991

U.S. HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY,
SUBCOMMITTEE ON ENVIRONMENT,
Washington, D.C.

The subcommittee met, pursuant to notice, at 1:31 p.m., in room 2325, Rayburn House Office Building, Hon. James H. Scheuer [chairman of the subcommittee] presiding.

Mr. SCHEUER. This hearing of the Environment Subcommittee of the Science, Space, and Technology Committee will come to order.

We are here today to discuss the future of the modernization of the National Weather Service. This has been a long, winding, and rocky road for the National Weather Service.

There is no question of the fact that the Europeans are way ahead of us. I don't know how many of you are familiar with the European Center for Medium Range Weather Forecasts in Reading, England. It is a combined, collective service run by the European States at the state of the art cutting edge of high technology, and they are eons ahead of us.

We are still playing with 1950 technology. We are painfully and pitifully out of date, outmoded, archaic, and so forth, even though we have by far the toughest weather in the world. There are only two countries in the world that have the desperately tough weather that we have, the United States and China.

The European weather is comparative uncomplicated and simpler to forecast. Yet their facilities for two to seven day forecasts, more or less, are exponentially ahead of ours.

In a typical year, the United States can expect a staggering assault of weather happenings, assaults by the elements. We have 10,000 violent thunderstorms, 1,000 tornadoes, 5,000 floods, and several hurricanes. These events, along with heat waves, severe winter storms, and severe drought often result in considerable loss of life and property damage up into the billions of dollars.

The National Weather Service's ability to forecast timely and accurate weather warnings continues to be hobbled and crippled by outmoded, obsolete, and often inoperable equipment, some of it, as I mentioned, dating back to the 1950s. We now have the capability of forecasting a tornado in about three minutes. With the state of the art equipment, that could be 30 minutes. Think of the savings in life and even of property that that additional 27 minutes of warning could bring us.

Technology and more accurate forecasting have always gone hand in hand. From the earliest days of the telegraph and the Army Signal Corps, which was our first national weather forecasting system, new technology has always been a critical element in providing improved weather forecasts and weather warnings.

The Committee on Science, Space and Technology is strongly committed to improving the technology of the National Weather Service. Of course, legislation directing the modernization of the National Weather Service originated many years ago in this subcommittee. But it has had a very rocky road and it was compounded by disinterest, lethargy, and outright hostility from the Executive Branch.

Modernization of the weather service is always a difficult and tedious time-consuming job, but it is made very much more difficult, tedious, and time-consuming by the attitude of the Administration, which has played the modernization program with a disinterested, on again, off again attitude that has crippled the effectiveness and the efficiency with which we have tried to approach modernization of the weather service.

In 1986, OMB in its wisdom, decided that the Doppler weather system was not necessary. This resulted in a program delay of about a year while they tried off the shelf technology, picking and choosing what was available, and it took them about a year to find that this was an egregiously wasteful and foolish approach before they dropped that.

Two years later in 1988, OMB decided that the AWIPS program, the Advanced Weather Interactive Processing System, was not necessary either, and funding was terminated for that. That resulted in another year of delay.

In 1989, OMB cut the funding for AWIPS, further delaying the program to the point where it is now out of phase with the rest of the modernization program. It is the AWIPS program that is the brain and the central nervous system that pulls everything else together. So if you don't have AWIPS, you really don't have very much.

Perhaps the greatest enemy to an efficient, cost effective approach to weather service modernization has been us, the Federal Government in Washington, primarily the OMB, but in the interest of fairness, I will also say that Congress was sometimes not able to come up with the appropriations that were actually requested by the Administration, however reluctant those requests might have been. Anyway, in the last year or two, the Administration and Congress have been working together to provide the resources necessary to move forward toward the modernization of the weather service.

We expect today an explanation of the status of the modernization program and the problems that have plagued it with the problems that loom ahead. This will all be very enlightening and very interesting, especially considering the great divergence of views on this stuff. So I am looking forward to a very interesting hearing.

Mr. Packard?

Mr. PACKARD. No statement.

Mr. SCHEUER. Okay.

I would ask unanimous consent for these proceedings to be recorded by the electronic media. I don't see any electronic media present, but they are always welcome, as you know, in the halls of Congress.

I would like to swear in the witnesses.

[Witnesses sworn.]

Mr. SCHEUER. All right; we will start with Mr. Gray Castle of the Department of Commerce, Deputy Under Secretary for Oceans and Atmosphere in the U.S. Department of Commerce.

Why don't you take five, six, or seven minutes to give us your testimony? Your entire prepared testimony, as you know, will be printed in full in the record.

Mr. CASTLE. fine.

Mr. SCHEUER. Please proceed.

STATEMENT OF GRAY CASTLE, DEPUTY UNDER SECRETARY OF COMMERCE FOR OCEANS AND ATMOSPHERE, NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, U.S. DEPARTMENT OF COMMERCE; ACCOMPANIED BY: DR. ELBERT W. "JOE" FRIDAY, JR., DIRECTOR, NATIONAL WEATHER SERVICE, NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION; TOM PIKE, ASSISTANT ADMINISTRATOR FOR SATELLITES AND INFORMATION SERVICES; AND TOM GIAMMO, ASSISTANT COMMISSIONER FOR INFORMATION SYSTEMS, PATENT AND TRADEMARK OFFICE

Mr. CASTLE. Thank you, Mr. Chairman and members of the subcommittee. I am delighted to have this opportunity to meet with you today to talk about the status of the Modernization and Associated Restructuring of the National Weather Service and the other subjects as outlined in your letter of invitation.

Sitting with me at the table to my immediate left is Dr. Friday, the Assistant Administrator responsible for the weather service; to my immediate right is Tom Pike, Assistant Administrator for Satellites and Information Services; to Dr. Friday's left is Tom Giammo, who is the Assistant Commissioner for Information Systems at the Patent and Trademark Office. Mr. Giammo has been detailed to NOAA to assist us in putting together the structure for the proposed systems program office which we will talk more about later.

I would also like to take this opportunity, Mr. Chairman, to thank you for your continued support of the modernization. That support is legendary, and we appreciate it very much.

We believe that the Modernization and Associated Restructuring is a wonderful program. The National Research Council, in its report issued just today, characterizes it as bold and innovative. I agree.

As the report states, it involves three major components: new observational techniques, powerful new information and forecast systems, and a new organizational structure for the weather service. Today, I am going to focus most of my attention on the new information and forecast systems.

I would like to emphasize at this point that modernization of the weather service is NOAA's highest priority. I am pleased to say

that much progress has been made. Yet, we do have major problems with two of the four systems which are integral to the successful completion of the program. Before turning to those problems, let me briefly describe the four component hardware systems.

First is the automated surface observing systems, ASOS, or as I irreverently call it, instruments on a stick. ASOS replaces our old and obsolete surface observation equipment and manual observations with around the clock automated observations. The contract for these systems was awarded last month.

We eventually expect to have between 1,000 and 1,700 of these systems in place throughout the country. By the end of this calendar year, we will have the first 54.

The second system is NEXRAD, a Doppler radar system which is a state of the art advance over our present radars, which I suspect you know, date back to either 1957 or 1974. In pre- production tests, the NEXRAD performed better than expected. The accuracy of severe storm and tornado warnings was 91 percent, far better than the 60 percent level that we have with our present equipment.

The third of these systems is GOES-NEXT. As with NEXRAD, GOES-NEXT reflects a state of the art advance over GOES-7, the weather satellite which produces the pictures we see on our television sets today. GOES-NEXT will produce greatly advanced imaging and sounding and it will produce them simultaneously. On GOES-7 we can use the imager or the sounder, but not both at the same time.

Finally, we have the Advanced Weather Interactive Processing System. This is the nerve center. It integrates the information from the other components, ASOS, NEXRAD, and GOES-NEXT. It provides the meteorologist, in display form, with an enormous amount of information, greatly enhancing his or her forecasting ability.

When we put these systems together with a retrained and upgraded work force, we will truly have a state of the art forecasting ability which will greatly benefit the American people. As I said earlier, NEXRAD and GOES-NEXT are the two systems with which we are having the difficulty and which are costing more than program. Let's take a look at NEXRAD.

I emphasize that the NEXRAD technology is everything we hoped it would be. As I stated, the pre-production model, which we tested in the Spring and Summer of 1989, exceeded our expectations. However, UNISYS, the contractor, thus far has not been able to translate that pre-production success into fully specification-compliant hardware and software which would permit full-scale production on the agreed upon schedule.

Moreover, we are involved in a major contract dispute with UNISYS. They believe that we owe them a lot more money than we think we do. We believe that we have the ability to terminate them for default. Obviously, we would like to avoid this for all of the obvious reasons. Nevertheless, we are entering into a definitive negotiation within the next several weeks.

One way or the other, the problem will be resolved by the end of May. We will apprise you of the result.

Finally, on GOES-NEXT, I should point out that we fund, but NASA develops and procures these spacecraft on our behalf. There-

fore, those fall into a different category than the other three systems. In any event, NASA, the contractor, and especially ITT, the instrument subcontractor, are having difficulty developing specification-compliant sensors.

We do seem to be over the hump with the imager. That is the good news. The bad news is that we won't know about the sounder for several more months. Moreover, the cost of this cost-plus contract has ratcheted from $528 million to over $1 billion. Again, as with NEXRAD, we hope to be able to be in a posture by early this summer to know how we wish to proceed with this contract.

In light of these problems, we have reviewed the management structure for the weather modernization. Based on this review on our own part and that of an outside consultant, we decided that we should recommend the creation of a fully integrated systems program office. It has responsibility for all four systems and the procurement function.

In other words, it puts together in one place both program and procurement responsibilities. Contrast this with the present situation where we have three organizations, the weather service, NESDIS, and the Department of Commerce procurement involved.

The systems program office structure emphasizes our commitment to the modernization. We expect that you will have the reprogramming notification soon. We believe that this is the right management approach; we hope that you will agree.

Mr. Chairman, that concludes my prepared remarks. I am ready to respond to questions.

[The prepared statement of Mr. Castle follows:]

TESTIMONY
OF
MR. GRAY CASTLE
DEPUTY UNDER SECRETARY OF COMMERCE FOR OCEANS AND ATMOSPHERE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

BEFORE THE

SUBCOMMITTEE ON ENVIRONMENT
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
HOUSE OF REPRESENTATIVES

MARCH 20, 1991

Mr. Chairman and Members of the Subcommittee:

I appreciate this opportunity to talk with you today about the status of the Modernization and Associated Restructuring of the National Weather Service (NWS). Hopefully, it will enable me to provide you with a good overview of this program, which is NOAA's highest priority. Moreover, it gives me a chance to share with you our concerns with respect to problems we are having with NEXRAD and GOES, two of the systems which are integral to a successful completion of the modernization program.

As stated in your invitation to testify before this Committee, the ability of the NWS to provide early warnings of severe weather and flooding events is presently hampered by outdated equipment. In the Modernization Program, we are responding to the need to replace the outmoded systems and capitalize on the improvements in the sciences of meteorology and hydrology that have been made during the last two decades.

There are four major component systems in the Weather Service Modernization Program. Let me briefly describe these systems and the status of each.

ASOS -- The Automated Surface Observing System (ASOS) is designed to replace the present collection of old and obsolete pieces of surface observing equipment and relieve staff from the manual collection of surface observations. ASOS permits the taking of automated observations around the clock every day of the year. The combined ASOS programs of the NWS, FAA, and DOD contemplate having ASOS units at over 1000 sites, with the right, under contract options, to purchase another 700 units, thus providing complete coverage of the country. The production contract for ASOS was signed with AAI last month. The initial 54 systems are scheduled for installation by the end of this calendar year.

NEXRAD -- The Next Generation Weather Radar (NEXRAD) is a Doppler system designed to provide detailed data on storm systems. NEXRAD will enhance the detection and prediction of severe storms and tornadoes and provide detailed quantitative area precipatation measurements that will be extremely important to forecasting potential flooding. This system will: replace our existing, obsolete weather radar system; provide expanded

coverage across the continental United States; and, for the first time, provide radar coverage of the States of Alaska and Hawaii and the territories of Puerto Rico and the American Virgin Islands.

The prospects for the NEXRAD technology look excellent. We tested a pre-production version of the NEXRAD system in the spring and summer of 1989 at Norman, Oklahoma. The meteorological results of these tests were extremely promising. The accuracy of the severe storm and tornado warnings during the tests reached 91 percent -- a significant improvement over the current national average of slightly less than 60 percent.

However, the contractor has encountered difficulties in completing the development of the system - particularly the software - needed for reliable and maintainable production systems with the full range of required capabilities. While many of the hardware problems have been corrected, substantial deficiencies in the software remain unaddressed. This has caused serious delays in the NEXRAD program and has given rise to a set of claims and counterclaims between the Government and UNISYS.

We are currently conducting a detailed review of the NEXRAD contract, the contractor's performance, and the contractor's claims that it is entitled to substantially greater payments than we believe are contractually required. This review will enable us to determine the probability of UNISYS' successful conclusion of the contract. While we are seriously contemplating the

termination of this contract for default, we are still hopeful that we will be able to arrive at a definitive agreement with the contractor which will allow us to put this effort back on track. In any event, we should be able to provide you with a complete assessment of the status of NEXRAD and the contract by the end of May.

GOES-NEXT -- The next generation of geostationary meteorological satellites (GOES-NEXT) is designed to provide detailed meteorological information for the tracking of hurricane and severe storm systems on a continental basis with sufficient accuracy to overlay the satellite observed information with the information derived from the Doppler radar systems. The effective merging of satellite information with the radar information has been demonstrated in our Denver and Boulder experiments. It has yielded improved forecast and warning results. The GOES-NEXT will provide more detailed information than that currently provided by GOES-7, the present spacecraft, both in terms of spatial resolution and the number of different spectral windows in which observations can be made. The need for these GOES-NEXT capabilities has been well demonstrated.

The first of the GOES-NEXT satellites, GOES-I, was originally scheduled to be launched in late 1989. The series of five spacecraft, excluding launch, was to cost $528 million. However, technical difficulties, primarily with the development of the sensors - the imager and the sounder - have delayed the

scheduled launch until October of 1992 and ratcheted the total spacecraft program cost to over one billion dollars. While NOAA establishes the requirements and funds this program, NASA has the responsibility for development and acquisition of the system. Because of the extended delays in the development of the new satellite, NASA has recommended that the performance waiver process be invoked in order to meet an October 1992 launch date. If such waivers are approved, they will likely result in some performance degradation. We are currently working with NASA to ensure that GOES-I will improve the ability of the National Weather Service to perform its vital public safety mission. I should note that none of the reliability requirements, or any other factors that would affect the lifetime of the spacecraft, will be compromised.

The contractor is proceeding with the testing of the various components of the sensors. Within the next 45 days we should have a much better understanding of the likelihood of an October, 1992 launch. While we work toward a launch of GOES-I as soon as possible, we expect the current GOES-7 to last well into 1993. Indeed, we are taking every possible measure to ensure the longest life for GOES-7. We are not, however, ignoring the fact that a premature failure of the present GOES would have a severe impact upon the ability of the NWS to deliver accurate warnings and forecasts of severe storms, hurricanes and flash flooding events. We have developed a No-GOES plan for which contingency funds are requested in our FY 1992 budget. It consists of using

the polar orbiters to generate composite snapshot images of the United States, increasing the availability of all polar orbiter data throughout all weather service offices and relying more on European geostationary satellite coverage over the Atlantic Ocean. Recently, the Europeans launched another GOES-like satellite. Consequently, they have agreed to move another geostationary satellite halfway over the Atlantic, providing partial coverage of the area covered by GOES-7. This plan is the best "fix" available for a short term interruption in GOES coverage. However, you should understand that, even in the aggregate, these measures fall far short of constituting an adequate substitute for GOES-7. We are exploring options to provide coverage for a longer "No-GOES" period, including evaluation of whether to proceed with a "gap filler" satellite. At Secretary Mosbacher's request, NASA recently provided the Secretary, with Administrator Truly present, a comprehensive program review. We are confident that NASA is now devoting the necessary top-level attention and technical staff support to the GOES contract.

AWIPS -- The Advanced Weather Interactive Processing System (AWIPS) will be the "nerve center" of the future Weather Forecast Office. It is designed to integrate the weather data from all sources - including GOES, NEXRAD, and ASOS - providing the forecaster with the tools to process the data to produce his or her warnings and forecasts. The AWIPS system will provide fast-response, interactive analysis and display of the data which will

enable the meteorologist to make rapid decisions, prepare warnings and forecasts, and disseminate products to users. AWIPS includes the communications network that connects each Weather Forecast Office for exchange of locally generated data. Prototypes of this system have been developed in one of our labs at Boulder, Colorado. They are currently being used at our weather office at Denver and at our Norman, Oklahoma test facility. The development and deployment phase proposals for AWIPS were received from the two contractors on February 12, 1991. The evaluation of those proposals is currently underway. We expect to award the AWIPS contract to the successful bidder in fiscal year 1992.

THE NOAA SYSTEMS PROGRAM OFFICE -- The modernization of the NWS has put NOAA squarely in the major systems acquisition business. The NEXRAD and GOES-NEXT programs are the largest procurements ever undertaken in the Department of Commerce. NOAA is considering a new Systems Program Office (SPO) reporting the the Deputy Under Secretary for Oceans and Atmosphere. The SPO proposal arose, at least in part, because of criticism of the way in which these systems were being managed and in line with the recommendations of General Larry Skantze who, at our request, reviewed the management of these programs.

The new office being considered would bring improved systems development and acquisition talent to bear on all four of the systems in the NWS Modernization and Associated Restructuring

Program. The proposal would consolidate relevant system acquisition components such as those in the NWS, the National Environmental Satellite, Data, and Information Service (NESDIS), and the Department of Commerce Major Systems Procurement Division. The creation of this office would require a reprogramming. Under this proposal, NWS and NESDIS would retain program responsibilities for areas not directly related to systems development and acquisition such as program planning and requirements development, land acquisition, facilities construction, field testing and acceptance of the systems, staff training, spacecraft launch services, ground systems, and operations and maintenance.

This proposed office would strengthen program management by assigning full responsibility for the design, procurement, and acceptance of new systems in a single office rather than three as is presently the case.

The reorganization, we believe, would greatly improve NOAA's ability to meet critical time schedules and cost estimates. In addition, the change would allow NWS management to concentrate on the facility, training, and staff restructuring associated with the program - all vital to an improved NWS.

I must stress that the proposed SPO would in no way detract from the importance we attach to the Modernization of the NWS. On the contrary, our consideration of this proposal clearly

demonstrates our intent to focus as much talent, energy, and attention as possible on development and acquisition of these new systems. The SPO would be totally responsive to the functional and operational requirements for the execution of the Strategic Plan for the Modernization and Associated Restructuring of the NWS.

EDUCATION AND TRAINING -- The Modernization depends upon the new technology working well to deliver the kinds of information needed by our forecasters. But the Modernization will fail if we do not have well trained, dedicated professionals staffing the Weather Forecast Offices (WFO) of the future. We are presently concentrating on the training requirements for all categories of employees to provide them with the intellectual tools they need to make good use of the technological capabilities represented by these systems. Every one of our employees will undergo significant training.

We are working closely with the academic community through the Cooperative Program for Operational Meteorology, Education and Training (COMET), a program conducted by the University Corporation for Atmospheric Research (UCAR) through a cooperative agreement with the NWS. COMET has four objectives:

1. To improve operational forecasts and warnings through improved education and training;
2. To facilitate the transfer of research results into operational forecasting;

3. To serve the needs of the academic and operational communities and help bring them together; and

4. To promote education and research through better access to data, improved interactions between forecasters and researchers, and participation of faculty and graduate students in COMET activities;

COMET will develop several educational computer-based training programs that our employees can use in on-station interactive video training. It will also facilitate a close university-NWS cooperative relationship on operational forecasting problems, by supporting joint research and technology transfer programs between universities and nearby NWS forecasters.

The Modernization of the NWS is truly a national program. We are doing all we can to enlist the assistance of the national academic community. We are striving to collocate as many of our new offices as is economically and operationally feasible with academic facilities in an effort to promote a closer interaction between the researchers and practitioners of the meteorological and hydrological sciences. The collocation of our Norman, Oklahoma facility with the NOAA National Severe Storms Laboratory and the University of Oklahoma School of Meteorology has been invaluable in helping us make significant progress in improving our understanding of severe storms and our ability to forecast them.

RISK REDUCTION AND CERTIFICATION -- We have conducted many "risk reduction" activities in the past. These activities test everything about the Modernization from single component performance to fully integrated operational concepts. We have proven the utility of the ASOS program with our extensive tests-first, in Kansas with prototype equipment and, subsequently, with the AAI pre-production equipment at Tulsa, Oklahoma and Dulles Airport. We have proven the AWIPS utility with the evolutionary development at Boulder, Colorado and the implementation of prototype equipment at Denver. We have recently installed prototype equipment at Norman, Oklahoma with the goal of emulating a Weather Forecast Office as soon as we can accept the NEXRAD radar installed there. Let me reiterate for emphasis that the NWS will not accept the equipment until it is proven to work as advertised. We expect to have at that site a prototype of the modernized WFO we will be putting in place across the country.

Each of these risk reduction programs increases our confidence in our ability to execute the strategic plan for the Modernization and Associated Restructuring. We believe the results also will increase the public's confidence that the new NWS will meet their needs. I would be less than candid if I did not admit that we have a difficult job to do in this respect. Many incorrectly perceive the loss of an NWS office as a loss of service. Nothing could be further from the truth. Modern technology has made it possible for the public safety to be better protected with fewer offices so that communities will know

the NWS has been, and remains, the highest priority program within NOAA. There will be no compromise with the public safety.

Mr. Chairman, the NWS has a long history of providing the United States with the best weather coverage in the world. The NWS workforce is competent, highly motivated, and hardworking. The dedication and competence of the NWS employees remain a source of pride to all of us at NOAA and the Department of Commerce. The Modernization Program will enable us to provide them with the state-of-the-art equipment that will permit them to provide the American people with the protection they require.

Mr. Chairman, this concludes my testimony. I would be pleased to respond to questions.

Mr. SCHEUER. We have been joined by Congresswoman Morella. Do you have an opening statement?

Mrs. MORELLA. Thank you, Mr. Chairman, might I have the opportunity to make a couple of comments?

Mr. SCHEUER. Please.

Mrs. MORELLA. Thank you, Mr. Chairman. You are always very gracious.

It is a pleasure to be here, today, to discuss the efforts of the National Weather Service, in terms of the modernization of its technology and the reorganization of its systems acquisition program. The ability of the National Weather Service to provide timely, accurate information with regard to weather conditions, particularly hazardous conditions, affects all Americans. As a result, it is our responsibility in the Congress to provide whatever assistance we can to ensure that the Service's operations are among the most modern, efficient, and cost effective in the world.

It is no secret that we are presently experiencing some difficult economic times in our country. Resources are scarce and may get even scarcer. It is, thus, really imperative that we in government reexamine the way that we do business.

The Department of Commerce has taken a first step by restructuring the weather service and its procurement program. There are bound to be initial difficulties in these efforts and possibly even confusion at the outset. We are here, today, to examine not only whether this process is moving smoothly, but also to find constructive ways in which Congress can assist in the Weather Service's efforts to do that.

I heard some of Mr. Castle's testimony and have the rest of it here before me. I look forward to hearing the testimony of all of the witnesses today, some of whom are my constituents.

I thank you, Mr. Chairman, for bringing this important issue to the attention of the Subcommittee.

[The prepared statement of Mrs. Morella follows:]

Opening Statement, The Honorable Constance A. Morella
Subcommittee on Environment
March 20, 1991

Mr. Chairman, it is a pleasure for me to be here today to discuss the efforts of the National Weather Service in terms of the modernization of its technology and the reorganization of its systems acquisition program.

The ability of the National Weather Service to provide timely, accurate information with regard to weather conditions -- particularly hazardous conditions -- affects all Americans. As a result, it is our responsibility in the Congress to provide whatever assistance we can to insure that the Service's operations are among the most modern, efficient, and cost-effective in the world.

It is no secret that we are presently experiencing some difficult economic times in our country; resources are scarce and may get even scarcer. It is, thus, imperative that we in government re-examine the way we do business. The Department of Commerce has taken a first step by restructuring the Weather Service and its procurement program. There are bound to be initial difficulties in these efforts, and possibly even confusion at the outset. We are here today to examine not only whether this process is moving smoothly, but also to find constructive ways in which Congress can assist in the National Weather Service's efforts.

(CONTINUED)

I look forward to hearing the testimony of today's witnesses, some of whom are my constituents, and I thank the Chairman for bringing this important issue to the attention of the subcommittee.

Mr. SCHEUER. Thank you.

Mrs. MORELLA. Thank you, sir.

Mr. SCHEUER. Mr. Castle, tell us about the controversy pertaining to the system of procurement for the weather service modernization program. Tell us what evaluation you make of the Skantze report. What is your response to that?

Mr. CASTLE. General Skantze came in at our request and reviewed the management structure. I believe that you have his report in which he recommended the creation of the SPO. Independent of that report, we had thought of the SPO as one of several alternatives for a restructuring of the management of the weather service modernization program.

Mr. SCHEUER. The Skantze report was just an initial four or five page document. I presume that there was a fuller document that was anticipated to come down the pike after that.

Mr. CASTLE. I believe the contract with General Skantze provided for a phase 1 and a phase 2.

Mr. SCHEUER. Right.

Mr. CASTLE. In discussions with General Skantze and among ourselves, we concluded that we did not need phase 2.

Mr. SCHEUER. And what led you to that conclusion?

Mr. CASTLE. I think, as I indicated in my brief remarks, Mr. Chairman, that we felt it was very important to put the three components involved in weather service modernization in one place, the three weather service programs, the NESDIS program, and the procurement function. Having once made that decision, it was logical to look to the SPO as the appropriate organizational structure.

Mr. SCHEUER. Where does Dr. Friday fit in and how are his duties and obligations changed under your plan for proceeding ahead?

Mr. CASTLE. The weather service continues to have the responsibility for the modernization and restructuring. What has been moved out of the weather service and out of NESDIS are the systems development and acquisition responsibilities. That is all that has been moved out of the weather service or out of NESDIS. The staffing, the training, the location of offices, any modification in the overall modernization plan which Dr. Friday feels is appropriate—these are still within his area of responsibility.

Mr. SCHEUER. Let's assume that this committee has confidence in Dr. Friday's ability to exercise responsibility to make decisions on meteorological systems. Are you suggesting that we now should withdraw these responsibilities from him?

Mr. CASTLE. No, I don't think there is any intention to remove from Dr. Friday's purview any meteorological responsibilities. Dr. Friday and his organization establish the requirements for the weather modernization and the systems which are part of it, and the systems program office as contemplated meets Dr. Friday's requirements in developing and acquiring those systems.

Mr. SCHEUER. What are the relative roles of the OMB and the Department of Commerce as well as NOAA and the National Weather Service with respect to making recommendations to the Secretary of Commerce on certification and the schedule of weather service office closures and the process by which they are determined?

Mr. CASTLE. I am delighted to have Dr. Friday join me in response to that, but let me say initially that my view— and I will defer to Dr. Friday on this—is that certification will occur only after the appropriate people in Dr. Friday's organization have made the appropriate comparisons between an after modernization service and a pre- modernization service. At the appropriate time, after those analyses have been completed, they will be forwarded to the Secretary of Commerce with an appropriate recommendation.

Mr. Friday. Mr. Chairman, Mr. Castle has covered the essential ingredients of that. I would like to again assure the committee that this is not, as perhaps implied by your question, a budget decision. This is strictly a programmatic decision. It is a technical decision on whether or not we can comply with Public Law 100-685.

The Secretary of Commerce is required by that to certify that there will be no degradation of weather services as the result of our action. The recommendations for that Secretarial certification will follow the chain, not starting in Washington, D.C., but actually starting with the State offices involved, coming up through the regional offices involved, the people that actually provide the services to the community, coming through me to the administrator of NOAA and to the Secretary of Commerce.

It is a technical, professional judgment as far as service delivery, as contrasted to any other form of judgment at this point.

Mr. SCHEUER. I don't think that the question of organizing this whole modernization program with the decision as to what you are going to phase out of the existing weather service station—it seems to me that would be a technical decision. It seems to me to be a pretty broad-range decision.

I would like to know who, if not the director of the weather service, would be responsible for making the recommendation to Congress or certifying to Congress as mandated by Public Law 100-685 that weather services will not be degraded when you want to close down a weather station.

Mr. CASTLE. I think that Public Law 100-685 provides that the Secretary will make the decision. I must say, Mr. Chairman, that I believe it is a technical decision.

I would not expect, if I got a recommendation from the weather service that was based on the meteorologist in charge of the office in a particular location, that the service was at least as good if not better than that previously provided prior to modernization. I would not expect to do anything except pass that along.

I don't think that I have the ability to make any judgment with respect to that because it is a comparison of the forecasting ability before the modernization and after. I think that you are comparing meteorological events there, and I don't feel that I am qualified to add anything to that and I doubt that the under secretary would either. I just see that as really, in the final analysis, a decision which is based— even Dr. Friday—I see the meteorologist in charge at a particular location as being the single most important person in the whole certification process, because he or she is the one that is doing the comparing of the level of service that has been provided.

This is not a subjective kind of thing. I think that as I understand it, the weather service is in the process right now of estab-

lishing a baseline against which service after modernization will be compared to make this discreet meteorological decision as to whether or not service is better, the sanie, or worse than it was.

Mr. SCHEUER. Congresswoman Morella?

Mrs. MORELLA. Thank you, Mr. Chairman.

First of all to Dr. Friday, how is the consolidation of NOAA in Silver Spring, Maryland coming along? Let's start provincially.

Mr. Friday. That might more appropriately be addressed to Mr. Castle. We are there, but the rest of NOAA is still in the process of joining us.

Mr. CASTLE. I am pleased to report that buildings 3 and 4 are coming along. Construction always seem to move more slowly than you would like it to, but just as soon as they are completed, we will fully occupy buildings 3 and 4 of this project as we now already occupy buildings 1 and 2.

I can assure you that there is no one more enthusiastic than I about seeing those buildings completed and our people moved into them.

Mrs. MORELLA. Do you have some idea, or just as fast as possible?

Mr. CASTLE. I am afraid I do not have the dates. It certainly will not be for another year or so.

Mrs. MORELLA. If we can help with moving it along, you just give us the direction that we should follow.

Mr. CASTLE. Thank you; I appreciate that.

Mrs. MORELLA. Maybe this should go to Dr. Friday, and maybe Mr. Castle could comment.

Do you feel constrained by specific direction from OMB and the Department of Commerce about the weather office staffing and technology modernization office space size and all the things that go along with that? You can be candid.

[Laughter.]

Mr. Friday. Mrs. Morella, I appreciate that assurance.

[Laughter.]

Mrs. MORELLA. We learn such things around here, like "trust me."

Mr. Friday. The weather service modernization is not something that we did on the back of an envelope last month or last year. It is something that we have had in the planning stage for a very, very long period of time. It has gone through many reviews and many scrubbings and many updates as new factors have come into play.

We have changed concepts, for example, from the very early days to the present time and refined those concepts as we have gone along. Clearly, we have gone through a process of trying to balance technological necessity, service quality, overall staffing levels, and overall costs associated with that.

We came to a plan which has been submitted to Congress, the plan which we are currently implementing in the—if I remember correctly—January 1989 arrangement. We actually published the strategic plan for modernization at that time. That plan represents, to my best professional judgment, a sound, solid plan for providing services to this country.

We clearly have to worry about overall financial constraints. We clearly have to be always cognizant of ways to ensure that we are

shepherding properly the trust of the country, both in the service needed as well as the resources provided.

I do not feel constrained in the program which we are following. I certainly feel—indeed, I have the ability; I have done that many times as Mr. Castle may be willing to tell you—I feel that I am able to engage fully and openly in debates on a budgetary, staffing, and professional level at any time. My views are taken into consideration. I do not always get my way, but I still feel that the plan that we are working toward now is a very sound one and one which we can implement across the country to provide solid services to this country.

Mrs. MORELLA. That is pretty good. And, if you feel that you do have differences, you can voice them. I realize the context of my asking this question, and I appreciate your answer.

Mr. Castle, as you know, there is a great deal of controversy on the appropriate size of weather office staffs in the future. The Inspector General has expressed his views on this in various draft reports. Who do you think is best suited to make this determination?

Mr. CASTLE. The weather service.

Mrs. MORELLA. Why?

Mr. CASTLE. Because I think that it is basically a meteorological decision. I don't mean to imply that that should not be subject to review by people within the Department of Commerce and the Inspector General. However, I do think that at least great credence should be given to the views of the weather service on that issue.

Mrs. MORELLA. Is that the case currently? We hoped that there would be that working together.

Mr. CASTLE. We arrived, I think, in October of 1989 at an agreement with the Inspector General with respect to sizing of weather service offices. I think that it is incumbent upon us and upon the Inspector General to live with that decision.

Mrs. MORELLA. Thank you, Mr. Chairman. I will yield back the balance of any time I may have.

Mr. SCHEUER. Mr. Castle, in your testimony, you indicated that there is a software problem with the NEXRAD program.

Mr. CASTLE. Yes.

Mr. SCHEUER. Can you describe that problem?

Mr. CASTLE. I can tell you a little bit about it. I don't pretend to be technically qualified, Mr. Chairman, but I can tell you that it relates primarily to, not operational but diagnostic software. By diagnostics, I refer to that software which would be utilized if the equipment goes down.

Mr. SCHEUER. I take it that you are thinking of terminating the UNISYS software contract?

Mr. CASTLE. There is only one contract with UNISYS, Mr. Chairman. We are not thinking of terminating it. We believe that we have the right to do that, and we will be thinking about it if we are unable to arrive at an appropriate resolution with UNISYS in these definitive negotiations which will be conducted over the next few weeks.

Mr. SCHEUER. Somewhere, it came to my attention that you were contemplating the UNISYS software contract, but it may have been that that was a progressive thing or something you might be considering.

Mr. CASTLE. As I see it, we have a two-step process. The first thing we do is go through the negotiations, hopefully to a mutually successful conclusion. If we are not able to do that, then I think we have to consider the full range of options, one of which is clearly termination for default.

Mr. SCHEUER. For cause.

Mr. CASTLE. Yes, for default.

Mr. SCHEUER. If that happens, what implication would that act hold for the integrity of the weather service modernization program?

Mr. CASTLE. That would be unfortunate.

Mr. SCHEUER. Tell us what the result would be.

Mr. CASTLE. Okay. I think that we would do one of several things. First of all, we would consider re-competing and going to another supplier. We do know that there is at least one other supplier out there that is champing at the bit to be given the opportunity to provide this kind of a radar system to the weather service.

As you know, this is a joint program between the weather service, the FAA, and the Air Force. So that is one of the options, re-competing.

Mr. SCHEUER. How long a period of time would that re- bidding process take?

Mr. CASTLE. I think we are looking at two or three years. It would extend substantially the period between now and the time that we would have Doppler radar in place in our weather service operational context.

Mr. SCHEUER. I don't know if anybody has ever done a cost/benefit analysis, a financial analysis, of the results of this on again, off again policy or this on again, off again history that has resulted from the OMB practice of terminating it if they can get the same thing from the technology that is there on the shelf, and then they waste a year or a year and a half to find out that that is not possible, and then they start again.

I suspect that the drain of that kind of on again, off again policy is enormous, and that a policy of breaking this contract with UNISYS—they may deserve it; they may be clearly in default by every legal criterion—but the policy of breaking off that contract, putting them in default, and then opening up the bidding process, which would take as you suggested, two or three years—in terms of the impact that has on the whole weather modernization process, the loss of two to three years would be a fiasco.

The impact in terms of morale in your agency, impact in terms of attracting able young people—they can tell what is going on. It is the appearance of an agency that does not know how to administer programs.

The on again, off again process is terribly wasteful. No corporation could engage in that kind of conduct and survive; no university, no medical school could run any major program by fits and starts showing such total lack of commitment and irresolution.

You say very blithely that it will delay the program by two years.

Mr. CASTLE. I don't say it blithely. I understand all of the implications that the chairman has mentioned.

Mr. SCHEUER. Tell us then, how do you view the implications of such a two to three year delay?

Mr. CASTLE. One of the things that Mr. Giammo, who is with us today has been looking at, is the various options with respect to the radar. I might ask him to respond, if I may.

Mr. SCHEUER. Please do.

Mr. GIAMMO. Let me assure you to begin with that the impact on the weather service, on the Air Force, and on the FAA programs is foremost in our minds. I think that we have recognized the fact that the programs are already seriously late. The NEXRAD radar portions of the programs are already late and already are causing disruptions in the programs.

However, we are faced with a dilemma of serious proportions when we are dealing with the contractor in this case. We have a situation where the contractor asserts, to begin with, that to meet the requirements is beyond the scope of the contract because of some technicality that he finds in the wording. The magnitude of the claims is on the magnitude of a quarter of a billion dollars additional being asked for performing the work that we thought we had contracted for previously. This is not a trivial sum of money.

We also have some doubts about the ability of the contractor to successfully complete all of the work. Now it is fine to press on—and I think we are very, very sensitive to the fact that delay and any confusion in the program has impacts upon the weather service programs—but at some point, you have to decide whether you are throwing good money after bad. You have to look very, very harshly and coldly at: can this contractor indeed perform and deliver? Can he produce what he has been contracted with to produce within a price range that the Congress is willing to support?

Mr. SCHEUER. Let's break this down. Are we addressing a question of technical inability to perform the requirements of the contract by UNISYS, or are we addressing some legal shenanigans that their lawyers may be taking to open up the negotiations to get more money to do the same work that was contracted for?

Mr. GIAMMO. The answer is actually a combination of both. We had an Air Force team look at the quality of the work being performed by UNISYS in the software development area, and there is an accepted rating scale from 1 to 5 in terms of capability, with 5 being the best. The DOD considers 3 as being minimally acceptable.

The UNISYS software development shop rated a 1. The indication was that it was generous to give them the 1. They are seriously defective.

Mr. SCHEUER. In terms of just doing the physical work?

Mr. GIAMMO. In terms of being able to effectively and efficiently develop and test the required software to make the system operate as an entity. They have successfully, almost completely developed the hardware elements of the system. Where they are having trouble is tying it all together so that, not only does it operate as a unit, but so that it presents an interface to the meteorologist that the meteorologist can work with.

They are having much more difficulty than they had anticipated in being able to develop and test that. Partially, their inexperience and their inability to anticipate the difficulties caused them to un-

derbid the contract to begin with. Now this has fed back into sort of a death spiral type of arrangement.

In order to keep from losing money on a fixed price contract, they are engaged in finding, to my mind, very inventive ways such that they are finding to be out of scope whatever we asked them to do relative to the original specification. They are demanding that before we can proceed, we would have to give them additional money.

This has caused great consternation to the program because it has slowed down the development. The lawyer/engineer ratio at UNISYS is unbelievably high. In fact, I am not too sure which predominates in this situation. It is like getting gallons per mile on a car when you deal with them.

I am very seriously concerned that anything within reason in terms of a reasonable cost of completion is going to be difficult to reach with the UNISYS option. Now we are looking into other options.

Mr. SCHEUER. Do you mean just on the basis of professionalism and technical ability to produce the product?

Mr. GIAMMO. There is no doubt in my mind that they will ultimately be able to produce the product.

Mr. SCHEUER. Can you raise that 1 to maybe 2?

Mr. GIAMMO. I did not hear the question; sorry.

Mr. SCHEUER. Could you raise the 1, not to 5 or even 3, but maybe to 2?

Mr. GIAMMO. We have made recommendations to them from the Air Force study of improvements that we would like to see in the methodologies used in their software development activities. They have agreed that they will undertake these improvements. Whether that would give them a much higher score or not, I don't know.

Even with inefficient and ineffective processes, they will eventually finish. It is just at what cost in terms of time and money.

We have a very basic disagreement that has arisen for one reason or another relative to what we have contracted for with a fixed price contract. The last eyeball I had on the magnitude was a quarter of a billion dollars difference.

Mr. SCHEUER. How did that relate to the price tag for the whole contract?

Mr. GIAMMO. The fixed price was $700 million for the completion of the contract.

Mr. SCHEUER. So that is about 50 percent over cost?

Mr. GIAMMO. Not quite; it is about 35 or 40 percent.

Mr. SCHEUER. We understand that you had a cost overrun for NEXRAD, up to now about 7 percent, estimated?

Mr. GIAMMO. In terms of expenditures to date against schedule, correct. That is because we have not resolved these outstanding claims.

Mr. SCHEUER. What was your cost overrun on the GOES program?

Mr. GIAMMO. I think, as Mr. Castle mentioned in his testimony, the cost of completion is now $1.1 billion or something on that magnitude.

Mr. CASTLE. It's $1.157 billion.

Mr. SCHEUER. On a contract that was originally contemplated to cost, how much?

Mr. CASTLE. Originally contemplated to cost $528 million.

Mr. SCHEUER. I understand that you had over a 300 percent overrun. This would be a 200 percent overrun, more or less.

Would you put those overrun figures into percentage for us?

Mr. CASTLE. The original contract was $528 million and it is now $1.157 billion, it is in excess of 100 percent.

Mr. SCHEUER. We were given a 300 percent figure.

Let's say that you settled your claim with UNISYS. Let's assume that the price went up 30 or 40 percent. As would happen if you gave them the full amount of their claim—and perhaps that can be negotiated down—but if you computed as a cost of doing business the delay of two to three years, the degree to which you would then would be out of sync with all of the other elements of the program—and I don't know how you put a financial tag on such a thing as morale, dis- spiritedness, and inability to attract top scientific talent because the feeling in the public out there is that you have a management basket case on your hands.

If you could put a round figure on all of that, how much would that increase as compared to the 40 percent that your faced with if you give UNISYS everything they are asking for?

Mr. GIAMMO. Since we are in discussions with UNISYS on that matter, I would rather not give you a number.

Mr. SCHEUER. All right; that's fair.

Congressman Tom McMillen, State of Maryland.

Mr. MCMILLEN. Thank you, Mr. Chairman.

Would you elaborate if there is a weather station at Baltimore-Washington Airport? I believe there is, and it is my understanding that it was one of the facilities that was slated for closure and consolidation; is that correct?

Mr. Friday. Yes, sir. There currently is a small office at BWI airport. It is slated for closure in the final configuration of the modernized weather service.

Mr. MCMILLEN. I wrote the Secretary about my concern about this. My overall point would be that, here we have facilities at our airport, and there is a direct link between weather and air travel safety, so I am wondering what is the rationale for closing weather facilities when so many of our airplane accidents of late have been related to weather. Does that make good sense in terms of having a safe flying public?

Mr. Friday. Sir, the program that we are undertaking as far as modernizing the overall weather service is aimed at providing improved services across the entire country. As you know, under the public law, under no condition will any of those services be degraded.

As Mr. Castle stated early on here, he feels, and I agree with him entirely, that the service that we will be able to provide under the modernized structure will be significantly better over the vast majority of this country. I certainly include the Baltimore-Washington area in that as far as that is concerned.

You are right in the fact that weather is a primary problem for aviation and indeed it contributes to 40 percent of the aircraft accidents in this country. It is a very important thing and something

that we are working very carefully on to ensure that we are able tc provide that.

The observations for BWI airport, for example, will be taker under the new structure with our automated surface observing equipment, 24 hours per day, 7 days per week. We will continue tc have that.

The new Doppler radar network that will be covering the Balti more-Washington area will be operating out of Sterling, Virginia just north of Dulles Airport, and that will give much, much bette coverage than we are able to get now out of the Pax River radai which supports the BWI area. The forecasts for BWI are currentl made in Washington, D.C. They will continue to be made in Wash ington, D.C.

The people at the Baltimore-Washington airport now are primar ily involved in taking weather observations, and that function wil be replaced with the automated surface observing systems. So the services will continue. The accuracy of those services, based on al of the projections we have seen and all of the activities that we have been able to demonstrate to date and will have to prove tc you before we actually terminate that office or close that office ir Baltimore, will contribute to improved services across the area a opposed to decreased services.

Mr. McMillen. The bottom line is that you automate more anc hopefully have no net reduction in the capability before actuall closing a facility?

Mr. Friday. That is correct.

Mr. McMillen. Thank you very much.

Mr. Scheuer. Let's get back to the weather service moderniza tion.

Mr. Castle, what action has NOAA taken against the GOES man ufacturer, LORAL, in that 300 percent cost overrun?

Mr. Castle. Of course, we don't have any privity of contract with a contractor, as I indicated earlier. We find ourselves in a positior where we fund, but the decisions are made with respect to the con tract by NASA, which has the responsibility for developing and ac quiring.

Mr. Scheuer. What actions has NASA taken in contemplation o a 300 percent overrun?

Mr. Castle. We have chatted with NASA about this since it is our money they are spending. As recently as a week or two ago the Secretary of Commerce met with Admiral Truly and there was a program review on GOES presented to the Secretary. I believe he made it quite clear to Admiral Truly what his expectations were from NASA in terms of NASA doing its very best to have the con tractor and the subcontractor do the job that is expected at the lowest possible cost.

Mr. Scheuer. You didn't really answer my question.

Mr. Castle. Let me give it another try.

Mr. Scheuer. Give me a specific answer. What action did NASA take—have they taken any tough actions designed to mediate the situation or improve the position of the Federal Government as the guy who is paying the bills, with a 300 percent overrun against LORAL—actions comparable to the kind that you are contemplat

ing taking or may take, namely, declaring the contractor to be in default?

Mr. CASTLE. I would like to give my associate, Mr. Pike, and opportunity to address that question.

Mr. SCHEUER. Sure.

Mr. PIKE. Mr. Chairman, in part, in response to numerous requests from NOAA over the last three years, NASA, following the time at which the contractors began to address difficult technical problems that were beyond their capacity at the time to resolve, set up a series of tiger teams, teams of experts from across the country, involving experts from within the government, NASA, even within the Department of Commerce, as well as from elsewhere in industry, to help in a constructive way to get these problems resolved and to do it in such a way as to reduce the schedule impact and to reduce the potential for cost growth on the contract.

In addition, on their own volition and at our request, NASA has given a substantial amount of attention to helping the contractor in getting the technical problems resolved through providing onsite and in some cases hands-on assistance to help the contractors get around the sticking point, so to speak, and in the process, to reduce the potential schedule delay and to reduce the cost growth to which the government is subjected in the cost-plus type of contract.

Mr. SCHEUER. Was there any contemplation of giving this kind of hand holding by the tigers to the NEXRAD contractor, UNISYS? If they were in trouble, could you extend that same kind of helping hand, which I think is a heck of a good idea? Could you get the tigers together to help UNISYS out of their confusion?

Mr. PIKE. If I may add, Mr. Chairman, one other comment before addressing your latest question: there was a time three years ago in which we, NOAA, asked NASA to seriously consider the possibility of terminating their contract for the development of the GOES contract. They went through a process in which they evaluated the alternatives as we requested before we all decided to continue on with that contract.

Mr. SCHEUER. What were the elements in their decision with this vast overrun looming up that impelled them not to terminate but to try to work cooperatively with LORAL? What induced them to make teams of experts available rather then terminate, as apparently Mr. Castle is contemplating termination of the contract with UNISYS?

Mr. PIKE. My understanding is that there was a considered judgment of the technical risk involved, the likelihood of additional technical problems being discovered that would need resolution, the potential for continued cost growth, and an evaluation of the alternatives to continuing on with that contract.

Mr. SCHEUER. Including the cost of many, many months or years of time, I presume, as a factor in that decision?

Mr. PIKE. Consideration was certainly given to the possibility of a gap in service or discontinuity in service for GOES data if a change were made at that time.

Mr. SCHEUER. Congressman Zimmer of New Jersey.

Mr. ZIMMER. Thank you, Mr. Chairman.

I note in the plans for NOAA that you are anticipating phasing out the stations in Newark and Atlantic City. I have no objection to doing that, if, in fact, the service will be equal or superior as the law provides and the costs will be less.

Could you explain to me how that is going to happen?

Dr. FRIDAY. Yes, sir. With respect to all of the transition into the new structure, it is based on integrating the new technologies involved, the Doppler radar capability, the improved satellite observing capability, the 24-hour surface observation capability at many more sites than we currently have available to us, and one thing which we sometimes forget, which is the improved numerical modeling ability from the National Meteorological Center here in Washington, D.C.

All of that information is provided, as Mr. Castle pointed out in his testimony, through a state of the art interactive computer system to the forecasters at the future weather forecast offices. We have seen in demonstrations to date in Denver, Colorado and in Norman, Oklahoma, two of the sites where we have carried out demonstration programs to date, that we can use that material, use that technology, with well trained individuals to provide better weather forecasts and better services than we are able to do today across the country. It is that technology that we are basing that on.

When the plan was assembled, we looked at the technological capabilities, the science capabilities, the actual ability to take the output of the research community and convert it into operational applications, the ability to train meteorologists to handle that technology, and we made a determination at that time as to what sort of structure it would take across the country to provide solid weather support for the Nation.

We started with the coast of the United States and putting in a series of radars along the coast to make sure that we had the maximum reach out into the ocean in order to detect the oncoming ocean storms, primarily the tropical storms and hurricanes that plague the East Coast of the United States and the Gulf. Then we moved inland to try to make sure that we had good solid coverage as we moved inland.

As a result of that, we need fewer offices than we currently have. Bear in mind that many of these offices that we have at the present time were put in place when the only way of observing the weather was with a human being and the only way of really passing weather information—don't forget that we are over 120 years now—was literally by direct communication with someone. We are well beyond that at the present time.

We will be continuing to test all of the new technologies, singly, together in groups, and then finally, the overall demonstration program that we have planned after all of the technologies are on line in the middle part of the country to ensure that we can indeed deliver what we think we can deliver and what our plan says we can deliver. That is the certification process that Mr. Castle alluded to in his testimony.

At that time then, we will be able to have solid evidence, no longer a paper promise, but solid evidence that we can indeed do that. The overall operation of the future service after a significant

capital investment, should be less expensive than the current operation of the National Weather Service.

Mr. ZIMMER. What will the manpower levels be nationwide before and after?

Dr. FRIDAY. The present staffing levels across the organization are at right around 4,900 people, 5,000 people. The future staffing levels will be around 3,900 people in the organization, so we have a significant savings in staff.

We anticipate—and I have no reason to doubt that, assuming that the technology performs as it needs to perform, assuming that we have the people that we plan to have in the offices, and assuming that they we are able to make sure that they are adequately trained—that the adequacy of the products and services that we provide will be much superior to what they are now for the majority of the country.

Mr. ZIMMER. When was the last time you eliminated a significant number of weather stations? Ever?

Dr. FRIDAY. I have only been with the weather service 10 years. We have reduced some weather stations during that 10 year period by consolidating with adjacent stations to produce actually better services with fewer people. Those have just been in one or two cases, not a significant number of cases.

Mr. ZIMMER. I am willing to grant that you can do more with fewer in this process, where you said that you will have absolutely reliable data before you actually consolidate. Is that going to be region-by-region, or is it going to be at one point when you prove it nationwide, and then eliminate the stations you are going to eliminate all at once?

Dr. FRIDAY. We will clearly be proving it on the major demonstration program that we have, the so-called MARD program, the Modernization and Restructuring Demonstration Program.

Mr. ZIMMER. Once you have proven the technology and the management, then, you will roll it out immediately?

Dr. FRIDAY. Then we will begin to implement across the country. The law requires that we certify each and every closure, and we intend to do that.

Mr. ZIMMER. As representatives of the regions that are going to go through those closures, will we get advanced access to the criteria that you are using and the conclusions you reach?

Dr. FRIDAY. Knowing the way we have operated in the past, sir, I would expect that you would have every bit of information and be watching over our shoulder all the way. It is a perfectly open process. We have absolutely no intention of doing this evaluation in the dark.

Mr. SCHEUER. If the gentleman would yield—the law requiring them to certify came out of this subcommittee. We wrote the law and the criteria are clearly spelled out.

They have to certify that there will be no diminution in service of any kind as a result of any closure.

Mr. ZIMMER. I commend the Chairman for his foresight. I am just hopeful that we get that data backing up the certification, before it is a done deal. I have no reason to disbelieve your projections, and I commend you for trying to do a better job with your resources.

Thank you.

Mr. SCHEUER. Congressman Dave McCurdy?

Mr. MCCURDY. Thank you, Mr. Chairman for allowing me to come back and join the subcommittee for part of this hearing. It is good to see the gentleman again.

When I was an active member of this subcommittee, we had authorized NEXRAD and had been dealing with this issue for the 11 years that I sat on this committee. I had hoped that we were finally going to see some significant progress in dealing with this 30 year old technology that the weather service continues to be saddled with.

Like everyone else, I have been disappointed by some of the delays, but to be perfectly candid, considering the two other committees that I deal with, the Research and Development Subcommittee and the House Armed Services Committee, delays in major acquisition programs are not unusual, however troubling and frustrating they may be.

There has to be a certain amount of patience involved and I think that we need to get to the roots of the problem and deal with those as opposed to creating more problems over the long-term. It is never an easy task and I certainly understand your concern.

I was going to ask, Dr. Friday, about how serious you think the procurement delays in the National Weather Service modernization are and how serious will they be if the NEXRAD system is replaced with another system as has been suggested? Did you want to comment on the accuracy of the recent "New York Times" article that appeared?

Dr. FRIDAY. That is a tall series of questions, Mr. McCurdy. Let me try to respond.

Mr. MCCURDY. That's all right, Joe. In my committee in intelligence, I swear all the witnesses in.

Mr. SCHEUER. We did here as well.

Mr. MCCURDY. I am glad to see that I am not alone in that practice.

Dr. FRIDAY. With respect to the acquisition delays and the technology, clearly, there is a very serious threat at the present time with the delays in the GOES schedule. The fact that the current projected launch schedule for GOES-I is now October of 1992 and the projected lifetime of the expendables in GOES-7 is somewhere in the Spring or Summer of 1993, which is already beyond its five year lifetime, is a serious threat as far as our being able to provide continuity of services. The delays in the GOES program are of immediate and serious concern.

With respect to the radar program, the currently existing radars, as you are well aware because you, in your district, have lived with one operating out of Oklahoma City for quite some time that was fairly archaic and was having maintenance problems in the past. The fact is that we have at this stage, I think this very day, two radars that have been down for extended periods of time because of the fact that they literally are very, very difficult to maintain at the present time.

The potential delays in replacing those radars with the Doppler system could mean significant delays in our ability to, one, take advantage of the modernization, as was pointed out earlier, and two,

even guarantee that we have continuity of radar coverage in many sections of the country as these radars continue to decay.

We are working very closely right now with Mr. Giammo to evaluate the various options. When we are talking about evaluating the cost and benefits of the various options, we are talking about not just simply what it would take to generate the contract or what it would take to terminate the contract or what it would take to appease UNISYS, which as was pointed out earlier, has perhaps more lawyers than engineers working on this process. I'm sorry about that.

Mr. MCCURDY. I support the engineers.

Dr. FRIDAY. The fact is that there is also a cost associated with not implementing an early radar. That includes the failure to be able to phase down the unnecessary staff as we modernize and also the cost of life and property that might result by failure of being able to provide services.

All of those are being factored in. As Mr. Castle pointed out in his opening statement, we expect to have a reasonably well thought out path to follow on this in the April time frame so that we can make some decisions along that line.

You asked one other question.

Mr. MCCURDY. The accuracy of the "New York Times" article.

Dr. FRIDAY. That's what I was afraid you would remember.

[Laughter.]

Dr. FRIDAY. The "New York Times" article, of course, points to the difficulties in the modernization and the difficulties in the GOES program and the NEXRAD program. It primarily alluded to that and the fact that the modernization might be considerably delayed.

Some of the "New York Times" articles were very clearly erroneous. The statement that the difficulties with the UNISYS contract might mean that we would not be able to start implementing radars across the country until 1997—I don't believe that schedule is valid under any of the assumptions we are looking at. If that is valid, then we are going to be in extremely serious problems across the country.

I am not as pessimistic, having had hands on the UNISYS radar, as some people tend to be. I think that we do have an opportunity, but if we cannot come to reasonable economic reality with the contractor, we may have no other option. I think that was the point that was made here.

The radar is performing very well meteorologically. It is not a radar that I could consider deploying operationally at the present time because of the status and reliability of its software.

Mr. MCCURDY. Software seems to be the gremlin that is in not only this area of the world, but also in both the intelligence community and the armed services community as well. The concern I have is—and I say this publicly—I don't care who has the contract. I could care less as long as it is going to be performed and is going to be performed well and they are working with the best technology and if, over the long-term, the National Weather Service and we as taxpayers are receiving the benefits from that.

However, I have seen too many of these types of contracts. With the Department of Defense, we either wait too long before we cor-

rect the problems in working them out with the contractor or we decide to terminate, but the requirement is still out there, so we go back into the field and try to reinvent the wheel. In the long-term it costs us probably a heck of a lot more than what it would have if we had just kind of stuck to the initial problem and let the engineers work out the details.

I also chair a special panel in the Armed Services Committee this year, looking at the health of the U.S. defense industrial base. Quite frankly, many of the problems that we see across the country are not just confined to defense industries. It is technology and major industry in this country, and there are financial difficulties being experienced across the board. This may actually have been a factor as well.

Perhaps Mr. Castle could respond to one last point. Isn't there some danger in separating the procurement from the human resources component of the modernization? I mean we talk about software and the problems there, but there is also this scheduling of education and training for the employees. One of the benefits that we felt concern about was having the test centers located where you could bring people along with the hardware or software in this case so that you do not have these big gaps. Isn't there some danger if we separate those?

Mr. CASTLE. I want to emphasize, Congressman, that we have no intention of separating the education and the training from the weather service. They will continue to have the responsibility for training and education.

What we are putting in the systems program office is quite simply the development and acquisition of the systems. Admittedly, there will be, I'm sure, some training done by contractors as when you buy a piece of IBM equipment and the contractor gives you some specific instructions on how to use that equipment, but then how that equipment is used within an organization is the response of that organization. That would be the same thing, and it would be true whether the systems were the responsibility of the weather service or the program office. The education would be done by different people anyway.

Mr. MCCURDY. When I chaired one of the subcommittees of this committee, we kept going back to the human factors issue and human resources. We need to have a scheduling and it needs to go hand in hand when you are trying to deploy new technology and new systems that you coordinate the education and development of the people as well.

Mr. CASTLE. Let me add, if I may, one other comment. We have provided under the total arrangements for the modernization of the weather service for there to continue to be a deputy assistant administrator of the weather service reporting to Dr. Friday for modernization, as well as one for operations. We also would expect, if the notification process is successfully completed and we are permitted to go forward with the reprogramming, we would expect the deputy program officer to be one of the senior officials of the weather service responsible for modernization.

I do not disagree with the Congressman at all about the integration problem, but I would suggest that we are doing the very best

we can to take cognizance of that and to respond in an appropriate manner.

Mr. McCURDY. You know it is our job to ask the questions. I am glad you are anticipating those answers.

I understand that you may not be prepared today, but still, I guess, the bottom line of all this—and I will end with this question, Mr. Chairman—is, given all the alternatives out there for the modernization—I think it is a given; we all admit that the requirement is still there. We all admit that we have a goal of trying to bring new technology into the field; that it is of national interest, national importance, and we want to do so in as timely and cost effective a manner as possible.

Given those goals and requirements, do you have any judgment as to which of the alternatives appears to make the most sense at this point?

Mr. CASTLE. I am not sure, Congressman, with respect to which issue you are asking about.

Mr. McCURDY. NEXRAD.

Mr. CASTLE. I will ask my associate, Mr. Giammo, to respond to that.

Mr. GIAMMO. What we are doing right now, Congressman, is preparing at the Secretary's direction, a decision paper for him that addresses all of the feasible technical alternatives. As we mentioned previously, all of the factors that have been mentioned here and then some will be considered in that.

We have a team that has been put together not only with the weather service personnel, but also the Air Force and the FAA have contributed expertise to this team. We have identified six various technically feasible options which we are proceeding to cost out, looking at contractual feasibility, technical feasibility, looking at impact on the various programs, not just the weather service programs, but also the FAA and Air Force programs.

The hope is that by the end of April—I have been instructed to bring to the Secretary's attention by the end of April the results of this decision paper and to make recommendations at that time. I assume he would then take some time to follow up.

Mr. SCHEUER. Recommendations on what?

Mr. GIAMMO. On how to proceed with the NEXRAD situation.

Mr. SCHEUER. All right.

Mr. GIAMMO. Right now, we are in the early stages of some of these. We are meeting right now at my office with a very large technical and lawyer team from UNISYS, discussing what get-well paths exist within the terms of the existing contract. We are meeting with Raytheon as an alternative source next week to pursue whether their original schedule that they bid previously could be accelerated to reduce this gap.

We are looking at hybrid situations, where we can take some early equipment from UNISYS and perhaps follow that up with long-term production units from Raytheon. We are looking at intermediate radars to replace the existing radars on a stopgap basis while we retool for a major reprocurement.

All of the options are being looked at. Some of them are looking better than others. Some of them look very good technically, but

not so good economically. We are going to digest that and we are going to bring it to the Secretary by the end of April.

Mr. McCURDY. Mr. Chairman, I apologize, but I have to pick up on one point, the current status of the contract today.

You say you are meeting with the lawyers. There has not been a default. You are talking about possible renegotiation and working out some problem; correct?

Mr. GIAMMO. We did address that previously. Let me briefly summarize that for your benefit.

The situation is that we are already seriously late. The contractor has not been able to deliver the products on time, and we are in serious arrears in terms of their obligations under the contract.

Mr. SCHEUER. This is UNISYS you are speaking of?

Mr. GIAMMO. This is UNISYS Corporation, correct.

A dispute has arisen that is related to that which has to do with what they were expected to do relative to the fixed price portions of the contract. Their allegation is that they had very limited obligations to develop a not fully compliant system, and our opinion is that this is not correct and that indeed they had the obligation at the time they bid, at the time of execution, to meet the full requirements of the NEXRAD system.

What has occurred is, because of the slippages in their ability to develop even the preliminary versions, we are getting into situations when we are requiring them to meet the full set of requirements, and they are arguing that that is out of scope work and will require renegotiation for out of scope work, which sets us off into an argument about whether it should have been done this way or it should have been done that way in the original contract.

This has further complicated and slowed down the process because it is hard to test a system if it is not completed. Not only has UNISYS been unable to meet the portions that they should have met by this time, but it is not clear that they are working on the full set of requirements even at this time. The amount of differences between their interpretation—once we required them to do something that they do not believe was in the original contract, they then said that it was going to take them longer and all the subsequent delays then become the problem of the government. This causes retooling problems. This causes lapse in staff problems.

When you add up the pile of claims—and no one has been able to give us a good estimate from UNISYS yet—we are in the magnitude of a quarter of a billion dollars additional cost of completion under what we thought we bought for the original fixed price contract.

Mr. SCHEUER. Of what?

Mr. GIAMMO. This is in the neighborhood of the $600 million, $700 million range.

Mr. SCHEUER. The fixed price contract of what?

Mr. GIAMMO. This is for the NEXRAD. I don't know the fixed price portion of it. There was a small cost-plus portion of it. The sum of those is in the $700 million range.

I don't remember exactly how much was the fixed price and how much was the cost-plus, but mostly it was the fixed price contract.

Mr. SCHEUER. So you are talking about $250 million overrun on a $700 million contract?

Mr. GIAMMO. That's my eyeball. The IG has a different eyeball and he sees $400 million in that pile. I see $250 million.

Also, you have to realize, sir, that they are already significantly late and they are projecting additional delays beyond what they have already incurred. It is not the choice of getting the radars on line now and waiting two or three years to get an alternate source. The difference is whatever the additional delays are in UNISYS of getting on board.

Those are hard tradeoffs to make. It is going to be a hard decision for the Secretary, I think, for all the reasons that you folks pointed out.

Mr. MCCURDY. Do you think the nature of the contract itself was valid?

Mr. Chairman, Yogi Berra said, "This is deja vu all over again." Every time we turn around in defense—we just cancelled the A-12, for instance, because the contract was screwed up actually. We did it the wrong way.

In this case, we did a prototype and then they were going to split apart and compete after you developed a prototype, whereas, with the ATF, we did competition and then went to one and then you had a product. We found that in these very technical, difficult development programs that firm fixed price contracts are very rarely met.

Are you satisfied with the nature of the contract? Have you had enough experience with that?

Mr. GIAMMO. This is a personal opinion now. I have only been on this about eight weeks looking at it. I have very much focused on that point. I had the same experience in some of the other assignments that I've had.

My opinion is that that is not a structural part of the fault of the contract. They had very good early phases where they had taken the alternate designs and gone through a validation.

If an error was made, the error was made as a judgmental error. We did not bring the validation phase to absolute final completion in the sense that the last 5 percent of the validation would take 20 percent of the time. The judgment was made on the part of both parties that we saw the end of the tunnel. We could actually stop the validation phase.

The difference between what had been validated and what needed to be done were obvious, straightforward, simple, and well within the scope of what could be done within a fixed price contract. Both of us, UNISYS and ourselves, agreed to that.

In retrospect, UNISYS now claims that that was not true; that the gap between what was validated and what was needed under the requirements was in fact far more complicated and difficult to do and, therefore, this is one of the originating causes of the dispute between us. This is a judgmental question.

The contract, when you look back at it, was well structured and, I think, fairly well executed up to that point. It has only been recently, in the last two years or so, that we have run into this death spiral on the contract.

Mr. MCCURDY. Thank you, Mr. Chairman.

Mr. SCHEUER. Thank you, Congressman McCurdy.

Let me just read to you a quote from that "New York Times" piece that you are scrutinizing by Dr. Charles Hosler, whom we are going to hear from as soon as we finish with this panel. Dr. Hosler says, "It would be a real crime and a shame if these things were to be considerably delayed." He is talking about the NEXRAD contract, and he is the chairman of the National Research Council committee that monitors the modernization program.

He goes on to say, "The country will pay a price in lives and productivity." That is in addition to the price in dollars occasioned by the increased price of the program and the increased time of the program. He is saying that there is going to be a price in human life and in productivity of industry, farming, trucking, and all of the elements in our society that rely on the National Weather Service. I think that is a significant quote.

When you make your final recommendation to the Secretary in another month or six weeks, are you going to try and quantify somehow or another the dollar value, the importance of not letting this two or three year slippage be occasioned? Are you going to try to quantify the effect that not having sophisticated weather forecasting services will have on every component of industry and agriculture that now relies on it? Are you going to crank in the additional lost lives? In other words, is the Secretary going to have a rounded and thoughtful and sophisticated estimate of the true cost of delay when he makes his decision based on your recommendation?

Mr. GIAMMO. The answer would be yes. I have no delusions that I can put a dollar value on a human life or even on some of the more subtle aspects of property damage and so forth. I don't expect to do that.

I think that what I intend to do and what I hope that I can execute would be to put together some sort of narrative package that is relying on the information primarily from Dr. Friday, from the Air Force, and from the FAA, to put together a description of the impacts in those non-quantifiable areas so that he is certainly aware of them and has them on the table when we are discussing the decisions. My interaction with him has been that he is very much aware of those to begin with, but I certainly would want to make sure that the recommendations did explicitly cover them.

Mr. SCHEUER. It is difficult to quantify the dollar value of a human life, although our government does it in various departments, insurance and death benefits and all of that. I would think that it would not be all that difficult to quantify the impact on industry and agriculture of not having this far more helpful and productive weather service information for another two or three years.

I would suggest that you probably can get some help from the Department of Agriculture and maybe from some other branch of the Commerce Department in helping to factor that into your analysis.

Mr. GIAMMO. As part of my ability to delegate authority and responsibility here, I am looking to Mr. Friday to help quantify the impact on the program.

Mr. SCHEUER. Good. I hope that before you make your recommendation to the Secretary, you will write us a letter or a memo indicating what your conclusions are and the way in which you fac-

tored a loss of time, which you state is likely to be two or three years, but based on experience, could be three to four years or four to five years. I see that as a colossally cost ineffective way of moving, especially since all of these component parts, ASOS AWIPS, NEXRAD, and GOES all have to woven together into a system where the whole is greater than the sum of the parts, particularly since AWIPS is the central nervous system for the whole thing.

NEXRAD is what feeds the basic information into AWIPS. If you delay NEXRAD, you have really put the whole bloody system into a holding pattern for years and years.

Mr. GIAMMO. I am very sensitive to that and I am very sensitive to the tradeoff question. What I am not comfortable with is the blank check implications. If you are giving us a blank check for whatever it takes to get it done within the period, that would change my understanding.

Mr. SCHEUER. No, I am not giving you a blank check. It is a very tough judgment call you had, but I presume that you didn't take your job, anymore than I took my job, at gunpoint. You wanted it.

Mr. GIAMMO. It came close to being at gunpoint.

Mr. SCHEUER. Sure.

[Laughter.]

Mr. SCHEUER. Well, I am embarrassed to say that I never came close to being at gunpoint.

[Laughter.]

Mr. GIAMMO. The Secretary is very persuasive when he wants to be.

Mr. SCHEUER. Okay. The point that I am making is that it is an agonizingly difficult decision, but somehow or another to do yourself justice and to do the country justice, you have got to factor in, in a sensitive and hardnosed way, a hands-on way, the cost of delay. It's enormous.

Our next witness was quoted as saying that the country will pay a price in lives and productivity. It would be a real crime and a shame if these things were to be considerably delayed.

Mr. GIAMMO. Agreed.

Mr. SCHEUER. It is not as if NEXRAD is standing by itself. So what if NEXRAD is delayed? It is one component in a larger system where the whole is greater than the sum of the parts and they depend upon each one of the parts to be in place or you don't have a system.

I would like you write to us and advise us before you make your final recommendations to the Secretary. We may want to invite you down here to chat with us or we may want to meet with you privately.

Mr. CASTLE. I think, Mr. Chairman, that there will be a number of us who are involved in developing the recommendation, which admittedly, will come in the first instance from Mr. Giammo. I expect to play a role and I am sure that the under secretary does, with some of the people in the Department of Commerce and OMB as well. We will all play a role in developing the recommendation for the Secretary.

Mr. SCHEUER. What is the timetable for this decision?

Mr. CASTLE. I would hope that we would be in a position by the end of May. Hopefully, we will never get to the decision, because hopefully, these negotiations with UNISYS will result in a resolution that will be in everyone's best interest.

Mr. SCHEUER. Okay. I would hope that you would keep us informed informally of your progress.

Mr. CASTLE. We certainly will, Mr. Chairman.

Mr. SCHEUER. If you find that you are at absolute loggerheads with them and that you are seriously considering the option of default and then finding another bidder and opening up the competitive process, maybe taking two, three, or four years or more, I wish you would let us know. Maybe we will have a hearing at that point and canvass the whole matter.

This full committee as well as the subcommittee is vitally interested in this topic; okay?

Thank you very, very much for your forthcoming testimony. We appreciate it.

Dr. Friday, I wonder if we might ask you to stay in the room in case we have other questions from the two witnesses we are going to hear now? You can either sit in the audience or stay at the table if that suits your convenience.

Now we would like to ask Mr. Francis DeGeorge, Inspector General of the Commerce Department, to come to the witness table. We are happy to have you with us, Mr. DeGeorge. Why don't you take five, six, or seven minutes to give us your testimony, and then I am sure we will have some questions for you.

Mr. DeGeorge, I would like to swear each of you in before you testify.

[Witnesses sworn.]

STATEMENT OF FRANCIS DE GEORGE, INSPECTOR GENERAL, U.S. DEPARTMENT OF COMMERCE; ACCOMPANIED BY: JOHN NEWELL, ASSISTANT INSPECTOR GENERAL FOR AUDIT; AND MR. MARK MC COY, SENIOR TECHNICAL SPECIALIST

Mr. DEGEORGE. Thank you, Mr. Chairman. I want to introduce Mr. John Newell, to my immediate left, who is the Assistant IG for Audit, and Mr. Mark McCoy, to my right, who is the chief of our technical staff.

My statement is rather brief, Mr. Chairman. I will read it.

Mr. Chairman, I am pleased to be here to discuss the vital issues regarding the progress of the National Weather Service's modernization efforts. I strongly endorse this oversight hearing and share the subcommittee's concern about the status of the modernization.

There are many issues that should be discussed and understood by the subcommittee and the Congress as a whole. Decisions will soon be made that could influence the success or failure of the modernization effort.

Let me first and foremost say that as the Inspector General, I speak only for myself and not for the Department of Commerce. My views in many instances may differ substantially from NOAA's as well as the department's. Let me add that while I am paid to be a critic, I am not paid to be negative. I see my job in a more positive light.

If I can issue reports and have serious, constructive operating and administrative discussions with NOAA and Commerce before poor management decisions have been irretrievably made, then I have helped. There is no excuse for an Inspector General simply adding up the cost after a program is completed and criticizing management's conduct retroactively, especially when he could have helped to correct the problem either before or during the implementation of the program.

Let me also say that I am very supportive of efforts to modernize the weather service and believe it is a necessary and vital step that must be taken. In that vein I have watched these efforts develop over the years.

During the past four years, I have been involved in considerable detail personally. Starting with our September 1989 semiannual report, we identified formally and directly the modernization and restructuring effort as a program that could be a major area of concern to the department if not addressed.

Let me quote: "Critical design decisions to be made over the next several years will determine the success of weather service throughout the end of the century. These decisions will also have a major effect on the department's budget over the next decade. NWS plans to acquire and integrate the new technologies in phases, adjusting its field structure gradually. Timing will be critical. If not properly managed, the transition could be significantly disrupted, causing loss of continuity and significantly increased cost."

In March of 1990, we said, "The modernization effort will probably cost $300 million to $500 million more than presently budgeted... Technical problems, program redirection, delays, and changes to original project scopes will, in our opinion, cause additional cost growth beyond 1995. Decisions on the number, location, size, equipment, and staffing of the new field offices continue to be serious concerns to this office."

In September of 1990, we said, "...by traditional measures of successful systems development, the agency has serious problems. Costs are increasing, technical performance standards are not being met, and the schedule is seriously slipping."

We went on to repeat that we believed costs would continue to escalate. We summarized by stating that, "Strong technical and program management is critical if these programs are to be corrected. NWS needs to establish a senior level systems integration office to oversee all components of modernization efforts, including the budgetary and procurement aspects."

I might interject that I am pleased to see that the department, NOAA, and the weather service now agree.

Mr. SCHEUER. Excuse me. Isn't this more or less what General Skantze recommended?

Mr. DEGEORGE. A year later; yes, sir.

Mr. SCHEUER. And apparently that sort of holistic approach that you and he share is being rejected, as I understand it.

Mr. DEGEORGE. The approach is being rejected?

Mr. SCHEUER. The approach that General Skantze recommended.

Mr. DEGEORGE. I would put it this way, Mr. Chairman. A year ago we said that a systems integration office was necessary. General Skantze said so most recently.

My constant discussions with the Deputy Secretary, Mr. Murrin, and his discussions with NOAA and Mr. Castle resulted in the General Skantze report, basically confirming the same needs. I hear today—and I've had previous discussions with Gray and Joe, and they basically have agreed that the creation of the new office, which is temporarily headed by Mr. Giammo, addresses the concerns of both General Skantze and myself.

Mr. SCHEUER. Is there agreement at NOAA and the Commerce Department that General Skantze's approach, setting up a whole new office to coordinate and integrate the programs and take care of the contracting functions, is a correct one?

Mr. DEGEORGE. Yes, sir; to my knowledge, yes. I have had personal discussions with the Secretary and the previous Deputy Secretary and this Deputy Secretary.

Mr. SCHEUER. Excuse me; please proceed.

Mr. DEGEORGE. It is now March 1991 and time for another semiannual Inspector General's report. I would like to discuss what I believe the report should say. That report will probably be issued within the next 30 days.

The weather service modernization effort continues to have very serious cost, performance, and schedule problems. Every indicator confirms our previous judgment that the modernization will cost $500 million or more then presently budgeted.

The NEXRAD contractor and NOAA have potentially unsolvable contract and technical problems. The AWIPS-90 contract development has been further extended, at least another 12 months. I presume there will be attendant costs to go with that.

Relationships with NOAA's acquisition partners, the FAA and the Air Force, are strained, and the Inspector General seriously questions NOAA's accountability for the funding provided the Joint Systems Program Office. We are basically discussing with the weather service and NOAA now whether there has been a correct accountability or whether, in effect, we have been moving some dollars around incorrectly.

We will be concluding our audit work on this issue in the very near future. We continue to question the weather service's new office decision process as well as the concomitant telecommunication decisions. Full systems testing has been delayed another year to 1996, and finally, the weather service—and I should have said NOAA here—does not yet have in place the senior level systems integration office, including the certification.

What I am trying to say here is that while the proposals have gone ahead, the reprogramming request has not yet cleared OMB or the Congress. Without the reprogramming request, the whole office and its function is little more than Tom Giammo and the desire to do it at this point.

Let me add the following general concerns. The department needs to immediately move forward with its reprogramming request for the systems integration office. I cannot stress enough the need for OMB and Congress to immediately approve this reprogramming because it supports this office.

Without such an office, I believe the program management of the weather service will continue to deteriorate. Neither the department or NOAA can at this point provide reasonable estimates of contract costs individually as well as estimates to complete the weather service modernization program by program.

Congress should not accept the amendments to the National Aeronautics and Space Act, fiscal year 1989, proposed in S. 98 by Senator Pressler. This proposal would require, in my judgment, an unnecessary operational redundancy which, by any conservative estimate, would add at least $50 million, possibly much more, of unnecessary expenditures.

Let me conclude by supporting several positive moves by the department and NOAA that have taken place over the past several weeks.

The creation of the systems integration office is vital. I commend NOAA for moving in that direction. However, as I previously mentioned, authority to proceed is critical. Authority to proceed on the reprogramming is necessary.

The Secretary, the Deputy Secretary, and the Under Secretary of NOAA are all personally involved in their oversight capacities with the review of the program. I applaud their present sense of urgency to deal with the issues.

I would be glad to answer any questions, Mr. Chairman.

[The prepared statement of Mr. DeGeorge follows:]

STATEMENT BY

FRANK DEGEORGE
INSPECTOR GENERAL
U.S. DEPARTMENT OF COMMERCE

BEFORE THE
SUBCOMMITTEE ON ENVIRONMENT
HOUSE COMMITTEE ON SCIENCE, SPACE AND TECHNOLOGY

March 20, 1991

Mr. Chairman, members of the Subcommittee,

I am pleased to be here to discuss vital issues regarding the progress of the National Weather Service's modernization efforts. I strongly endorse this oversight hearing and share the Subcommittee's concern about the status of the modernization. There are many issues that should be discussed and understood by this Subcommittee and the Congress as a whole. Decisions will soon be made that could influence the success or failure of the modernization effort.

Let me first and foremost say that as the Inspector General I speak only for myself and not for the Department of Commerce. My views, in many instances, may differ substantially from NOAA's as well as the Department's. And let me add that, while I am paid to be a critic, I am not paid to be negative. I see my job in a much more positive light. If I can issue reports and have serious, constructive operating and administrative discussions with NOAA and Commerce officials before poor management decisions have become irretrievable, then I have helped. There is no excuse for an Inspector General simply adding up the costs after a

program is completed and criticizing management's conduct retroactively when he could have helped to correct the problem, either before or during the implementation of the program.

Let me also say that I am very supportive of efforts to modernize the weather service and believe it is a necessary and vital step that must be taken. In that vein I have watched these efforts develop over the years. During the past four years I have been involved in considerable detail. Starting with our September 1989 semiannual report we identified formally and directly the modernization and restructuring effort as a program that could be a major area of concern to the Department of Commerce if not addressed. Let me quote: "Critical design decisions to be made over the next several years will determine the success of weather programs through the end of the century. These decisions will also have a major effect on the Department's budget over the next decade."

"NWS plans to acquire and integrate the new technologies in phases, adjusting its field structure gradually. Timing will be critical. If not properly managed, the transition could be significantly disrupted, causing loss of continuity and significantly increased costs."

In our March 1990 report, we said, "The modernization effort will probably cost $300 million to $500 million dollars more than presently budgeted.... Technical problems, program redirection, delays, and changes to original project scopes will, in our opinion, cause additional cost growth beyond 1995. Decisions on the number, location, size, equipment, and staffing of the new field offices continue to be serious concerns to this office."

In September 1990, we said, "...by traditional measures of successful systems development, the agency has serious problems. Costs are increasing, technical performance standards are not being met, and the schedule is seriously slipping." We went on to repeat that we believed costs would continue to escalate. We summarized by stating that, "Strong technical and program management is critical if these problems are to be corrected. NWS needs to establish a senior-level systems integration office to oversee all components of the modernization effort, including the budgetary and procurement aspects." What has been lacking to date, is a synergistic approach to managing the weather service modernization as an integrated whole instead of as separate, unrelated projects.

It is now March 1991, and time for another semiannual Inspector General's report. I would like to discuss what I believe the report should say.

The Weather Service Modernization effort continues to have very serious cost, performance, and schedule problems. Every indicator confirms our previous judgment that the modernization will cost $500 million, or more, than presently budgeted. The NEXRAD contractor and NOAA have potentially unsolvable contract and technical problems. The AWIPS-90 contract development has been further extended at least 12 months. Relationships with NOAA's acquisition partners - the FAA and the Air Force - are strained and the Inspector General seriously questions NOAA's accountability for the funding provided the Joint System Program Office. We will be concluding our audit work on this issue in the very near future. We continue to question the weather service's new office design decision process as well as the concomitant telecommunication decisions. Full systems testing has

been delayed another year (to 1996). And finally, the weather service does not yet have in place the senior-level systems integration office.

Let me add the following general concerns:

- The Department needs to immediately move forward with its reprogramming request for the systems integration office. I cannot stress enough the need for OMB and Congress to immediately approve the reprogramming. Without such an office I believe the program management of the weather service will continue to deteriorate.

- Neither the Department nor NOAA can, at this point, provide reasonable estimates of contract costs as well as estimates to complete the weather service modernization - program by program.

- Congress should not accept the amendments to the National Aeronautics and Space Authorization Act, fiscal year 1989 proposed in S.98. This proposal would require an unneeded operational redundancy which by any conservative estimate would add at least $50 million of unnecessary expenditure, probably much more.

Let me conclude by supporting several positive moves by the Department and NOAA that have taken place over the past several weeks:

- The creation of the Systems Integration Office is vital. I commend NOAA for moving in that direction. However, as previously mentioned, authority to proceed is critical.

- The Secretary, the Deputy Secretary, and the Undersecretary of NOAA are all personally involved in their oversight capacities with review of the program.

I would be glad to answer any questions, Mr. Chairman.

Mr. SCHEUER. Thank you very much, Mr. DeGeorge.

In your September 1990 report, you indicate that by traditional measures of successful systems development, the agency has serious problems. Can you elaborate on that a bit?

Mr. DEGEORGE. Yes, sir. In the contract management office at that point in time, all of the individual program pieces, including GOES, NEXRAD, and AWIPS-90, were all managed individually two levels down. The effects of one program on another, a delay in one program, how you might make up time, the question of whether it gives you more time to continue a development in another phase, as the chairman indicated, just were not effectively directed.

Costs were high. I don't want to get into any more specific numbers than I have to, but costs were growing exceedingly all the time.

The technical performance was up in the air. We had a contractor, at least one major contractor, UNISYS, who basically was claiming hundreds of millions of dollars and was inoperative in many senses of its technical performance, not only programming but prior to that, in certain of its design capabilities.

The testing had produced a number of issues, a number of problems. All of this, by my traditional measurement, comes together in an office that decides effectively: do we have enough money? How do we make a decision? Can we move Congress to move money around? Reprogramming? How do we technically operate a program?

In industry, in effect, you normally have a large systems integration program office that has the contracting officers working for it. Until now, the contracting officers have been in a third office, in the Office of the Secretary. You had the contracts people in the Office of the Secretary, the technical people diversely managing their individual programs, and Joe Friday was trying to run the weather service and work with the development of those contracts, and there were just substantial shortfalls.

Mr. SCHEUER. Mr. DeGeorge, we read in the "New York Times" in January about the reprogramming you have just discussed. When are we going to hear from you directly? When is Congress going to be officially notified of this reprogramming that will create the office of procurement?

Mr. DEGEORGE. As Mr. Castle indicated, I think, sir, they expect to have the reprogramming up here very shortly. I know that it is now at OMB, and I would suggest that I called OMB personally yesterday and tried to convince them to get it over here as soon as possible. I would imagine it will be a very short period of time.

Mr. SCHEUER. Do you have any feeling that OMB is aware of the grave responsibility that they are entitled to, that they have earned, by this continuous delay, on again, off again, flip-flop, and total lack of confidence in the program that they have exhibited over a period of many years? Do you think they have any consciousness of the hurt and harm that they have caused this program at your agency?

Mr. DEGEORGE. I don't know that they would admit it, but I guess I would say that they are very deeply concerned that the program can actually be implemented over time. They know the deterioration of the present system.

There are two basic problems on this program, and OMB is sensitive to both of them. The political noise from the failing weather service as it continues to deteriorate and all the attendant noise that that can bring—the sooner they operate and the sooner they make management decisions, probably the cheaper it is going to be. They are sensitive.

Mr. SCHEUER. But they have been responsible for years and years and years of the delay.

Mr. DEGEORGE. Without confirming that, since I report both to the Congress and to the Administration, I would simply say that you have at least four levels of sensitivity, starting with Dick Darman, Bill Diefenderfer, Janet Hale, and all the other folks that I have personally talked to. They understand that they cannot procrastinate on making meaningful funding decisions to bring the program along.

Now there is considerable difference as to the style of management and the amount of dollars we can afford to spend on management, and I don't always agree with them and they don't always agree with the department. We have many diverse views.

I think a lot of the problem will be solved cost-wise and leadership-wise, if I can use that term, when in effect everyone realizes that we cannot delay the management of the process. The management of the process, the integrated decision-making process, the contract decisions, all those elements that were beyond NOAA's control—putting them into NOAA brings a point of accountability.

I talked to the Secretary personally on this issue. The Secretary has talked to OMB. OMB will have to talk to you personally and give you their opinion. I think that they realize the pressure and I think that they want to make it happen. Whether their numbers will be enough, whether they will support the reprogramming request per se, I do not know.

I think that they are moving a lot faster than they normally move on a reprogramming request. That is the best way I can define it to you, sir.

Mr. SCHEUER. As I understand it, Mr. Castle indicated that General Skantze was originally scheduled to produce a comprehensive two-part report, not the four page report that we have seen alone. Do you know why NOAA never got the second part, the second stage of a two-stage rocket?

Mr. DEGEORGE. I can only speculate. I have never discussed this subject. In fact, I have never seen the Skantze contract. I do know that there many of us bringing the same pressures on NOAA to make an integrated management decision as to how we are going to bring these programs along and manage these programs with all the shortfalls we had in organizational structure.

My guess is that, with the noise level I was making and with the concerns of all the committee members—and every Congressman has the individual influence on his own particular office—if you combine that with Mr. Castle's sensitivity to the effect that he really wanted to make this thing work, but they decided that after the first four or five page process that said essentially what a number of other people were saying, that they felt that they ought to move out.

I don't even think that I know, sir, what the second phase of the contract was to do, other than perhaps lay out some more details. I am not even certain.

Mr. SCHEUER. Do you think you could find out and let us know?

Mr. DEGEORGE. I surely can.

[The material to be supplied follows:]

UNITED STATES DEPARTMENT OF COMMERCE
The Inspector General
Washington, D.C. 20230

MAR 29 1991

Honorable James H. Scheuer, Chairman
Subcommittee on Environment
Committee on Science, Space, and Technology
House of Representatives
Washington, D.C. 20515

Dear Mr. Chairman:

This responds to your request of March 20, 1991, made during the NWS Modernization hearing, for an explanation for the record of the termination of the contract with General Skantze (retired).

The contract called for General Skantze to measure the accomplishment of initially defined objectives for modernization and predict the likelihood of the accomplishment of the remaining work and objectives. He was to evaluate the current efforts and plans for systems integration and provisions of facilities, and then make appropriate recommendations. He was to identify significant variances in planning versus accomplishment and inadequacies of remaining objectives, as a basis for any recommendations for change. The contract was split in two phases. Phase I called for the General to evaluate the extent of the proposed scope of work. The second phase, to be continued at the sole discretion of the government, was to be composed of the actual program reviews.

General Skantze had briefings and discussions on the program status and management with the Deputy Secretary of Commerce, the Deputy Under Secretary for Oceans and Atmosphere, senior NOAA staff, and me and my staff. He also reviewed documentation provided by DOC staffs, IG reports and briefing materials, the NWS Master Plan, and NOAA organization charts, duties, and responsibilities. At the completion of these discussions and reviews, General Skantze held a meeting with the Deputy Secretary and the Deputy Under Secretary to discuss his observations. Based on his work, General Skantze determined that he had enough information to make conclusions and recommendations about the ongoing modernization efforts.

Upon receipt of the General's report, the Deputy Secretary and Deputy Under Secretary were in agreement that the additional work contemplated under phase II was not necessary, because the problems and actions needed were clear. The Deputy Under Secretary made the determination with the full concurrence of the Deputy Secretary to terminate the contract. In addition to the General's report, the Deputy Under Secretary also had information

from briefings and discussions with the Office of Inspector General and the Nexrad Program Council, especially General Kelly of the Air Force and Robert Valone of the Federal Aviation Administration. Further delay in taking action to address problems with the NWS program management was not acceptable. All parties, including the Secretary of Commerce, had made clear their desire for immediate action to address program management issues.

We reviewed the contract, General Skantze's report, and discussed the decisions made with the Deputy Under Secretary for Oceans and Atmosphere. We are in agreement with NOAA's actions in terminating the contract. General Skantze pinpointed and summarized the overall problems and we agree with his recommended corrective actions.

If you have additional questions regarding the contract with General Skantze, please let me know.

Sincerely,

Francis D. DeGeorge

cc: Honorable Don Ritter

Mr. SCHEUER. Do drop us a line. I will ask unanimous consent for the record to be help open for another 10 days to 2 weeks.

Mr. DEGEORGE. Surely. I don't think there were any ulterior motives in there, sir.

Mr. SCHEUER. I am not suggesting that. I just want to know why we don't have anything more than that preliminary four page report, which I thought was well put together and had some good ideas in it.

Mr. DEGEORGE. So did I.

Mr. SCHEUER. If there was more of the same, I think it would be very useful to NOAA, useful perhaps even to NASA, and certainly useful to this committee.

Mr. DeGeorge, in your most recent report to Congress, you identified alternative approaches to the National Weather Service Modernization and Associated Restructuring that you were pursuing. You described something called a two-tier weather system.

Can you tell us what that is, and can you tell us whether NOAA has retained or has availed itself of the meteorological expertise to advise you and to advise the agency regarding the design of the future weather system for this country?

Mr. DEGEORGE. The two-tier proposal was really an OMB proposal. It goes back many years. As one of their thrusts of trying to figure out how they might save some money in this program, they asked NOAA to consider these two-tier approaches. We originally started off to review the two-tier approach from the office size viewpoint.

Mr. SCHEUER. Could you just describe what it is?

Mr. DEGEORGE. Basically, big offices and little offices is what it meant, with less staffing and an overall weather forecasting office in each State, the real downsizing of 450 offices down to 115 offices. How many of the 115 offices should be very large offices, one generally per State, and how many should be a lot smaller?

That is not a viable option to my mind anymore. We had a long discussion with Joe Friday resulting in general agreement on a process of doing a cost/benefit analysis maybe a year ago or longer, which came from the thrust that we ought to stay in the offices where we could, which was a change in direction. The weather service basically conceptually wanted to have new offices everywhere.

Joe Friday will have to give any rebuttal he wants to that. But our agreement was that we would go through a cost/benefit analysis to make individual judgments and essentially stay where we could stay, and not have any larger offices that were not absolutely needed given the tremendous cost that could be invested in that area.

With the new technology of the radars, sir, and the lease line capability rather than microwave linkages, you can pretty much get that signal wherever you want it. Where the radar is, compared to where the office is, is really not the prime driver anymore.

We were concerned that we not just build new offices as desirable as that would be, but that in effect we would make individual decisions based on the tradeoffs. There were some cases you had to get out. There were other cases where it was optional. There were

other cases where it was desirable that we just simply not routinely build 15 new offices.

At that point in time, we were convinced that there was a significant amount of money that could be saved. I still am convinced of that, most recently because of the microwave decisions, the lease line decisions, which basically enable offices subject to size to pretty much get the signal as exactly as if they were next door to the radar.

That situation, I really do not think, is an operative issue. It isn't on my agenda as to the two-tier office. I think that OMB has pretty much gotten off that point of stress as well.

Mr. SCHEUER. Mr. DeGeorge, have you found any improprieties between the Department of Commerce and NOAA on the one hand and the modernization contractors on the other, any of them?

Mr. DEGEORGE. We had an open investigation some time ago on one of the significant contractors that resulted in our going to the Justice Department. They have taken it into consideration for settlement. I would just like to leave it there. That did not implicate any present employees of the Department of Commerce.

Mr. SCHEUER. Have your investigations revealed any fundamental problems in a conflict of interest or integrity, again, in either the Department of Commerce and NOAA offices relative to the principal contractor associated with the National Weather Service?

Mr. DEGEORGE. No present employees, no.

Mr. SCHEUER. Okay; thank you very much. We appreciate your very forthright testimony.

We will now hear our last witness of the day, Dr. Charles Hosler, Jr., Chairman of the Weather Service Modernization Committee of the National Research Council.

Dr. Hosler, would stand to be sworn in, please?

[Witness sworn.]

Mr. SCHEUER. Okay, why don't you take six or seven minutes and give us your testimony, and I am sure we will have some questions for you.

STATEMENT OF CHARLES L. HOSLER, JR., CHAIRMAN, WEATHER SERVICE MODERNIZATION COMMITTEE, NATIONAL RESEARCH COUNCIL

Dr. HOSLER. I assume that the written statement will be entered into the record.

Mr. SCHEUER. The written statement will be entered into the record in its entirety.

Dr. HOSLER. I would like to make some comments based on the prior discussion and some highlights in a little summary.

Mr. SCHEUER. Maybe you could summarize your written testimony.

Dr. HOSLER. Sure.

We are talking today about a quantum jump in the ability to forecast weather on the scale of people, the small scale, short-term weather on which most people base their day to day decisions. Your comments previously about the cost of delaying this operation are particularly relevant, not only with respect to loss of life in flash floods, severe storms, hurricanes, ice storms, and so forth, but

the tens of millions of individual decisions that are made every day by people in this country, whether it is to go on a trip, cut the hay, paint a building, put on a roof, or go on a picnic—the economic consequences of that may not be as great—but individually, these are all small decisions that may involve thousands of dollars, but collectively, integrated over the whole country, billions of dollars are lost and productivity is lost because of these individual small decisions.

To the degree you can increase—and this modernization most certainly will tremendously increase—our capability to be accurate and precise in short-range forecasting, our productivity will be considerably enhanced. The cost of this entire program, in my opinion, will be recouped in a year or two based on these reduced losses. That may sound like an exaggerated statement, but after 46 years of trying to forecast the weather and having been frustrated by not being able to see the weather on this scale with the precision this system will permit, I can assure you that this is going to be a noticeable thing on everybody's part. I refer to the increased accuracy.

Mr. SCHEUER. I take it that is what you were referring to in that "New York Times" quote that I read?

Dr. HOSLER. That's right.

Mr. SCHEUER. And I take it that you would say that if you add the cost savings to all of these individual citizens and the cost savings to agriculture and the trucking business and the many other businesses that depend on accurate weather forecasts, that the benefits of having that information two or three or four years earlier would far outweigh the couple of hundred million dollars, the $300 million, $400 million, or $500 million that we are talking about as a possible cost overrun?

Dr. HOSLER. I sincerely believe that, and there is more beyond the systems we were talking about today; for instance, the wind profilers which will be an add-on to this system eventually to give continuous upper air wind readings. One study was made that indicated that within one year of installation of that system, that system would be paid for simply by the fuel cost savings by American aviation, through more accurate knowledge of winds and the ability to pick routes accordingly.

Mr. SCHEUER. To avail themselves of tailwinds rather than running into headwinds?

Dr. HOSLER. Right; to minimize headwinds and so forth.

Not only will this system give us better data and better forecasts based on present techniques, but I think that there is an open-ended nature of this system. The insight we will gain into the mechanisms by which these small scale weather systems operate and the modeling that can now be done, will give us new techniques.

There will be not only the increment due to increased information on present techniques, but also the development of new techniques. We point out in our report that we would like to see many of these weather forecast offices associated with universities, so that they could take advantage of the intellectual capabilities of not only the faculty but also of the students there to add value to the system through development of new techniques.

I think I also need to underline the obsolescence, as you did in your introductory remarks, of the system we have. I think that one of the ironies—and it is somewhat amusing— is that the electron tubes that are used in these old systems, are not even made anymore in this country. It is conceivable that we may have to go to the Russians to buy electron tubes to maintain some of these old systems. That is an irony in itself, it seems to me.

The other thing I would like to point out is that while all these individual decisions can be improved, there will be a further improvement in reacting to forecasts because we so often cry wolf today. The point was made that we issue watches and warnings for severe weather. You issue so many of them in some areas that people don't pay much attention to them anymore.

Once they realize that the accuracy and precision is there, which will be the result of this system, they will be more apt to respond in the appropriate manner to those watches and warnings. There is an incremental value added through that increased reliability of these systems.

To run through the over-arching recommendations that are in our report, which I believe you have available to you, this is a complicated system to install, not only because it is complex in itself in ways which you have outlined, but we have to maintain a very complex operation at the same time. You are integrating a new system with an old system. For that reason, there was some discussion in our committee and some apprehension about superimposing a separate bureaucracy on top of this if there was not great care taken in coordinating the introduction of this system with the operating people to make sure that they were not looking at it in isolation.

I might say here that we, as a committee, were very impressed with this almost 15 year plan for this modernization, at the dedication, the intellectual capabilities, and the energies and devotion on the part of the people in the National Weather Service to the implementation of this modernization. We would like to not see any degradation in the morale of these people through the superimposition of another group, and make sure that they were well integrated into that group to the extent that, where compromises have to be made and decisions have to be made, that they are made with the operational people in mind as well as the financial and legal people doing what they also have to do.

We did recommend a strengthening of the systems capability and of the manpower devoted to this introduction of this new system. We also wanted to make sure that things like the wind profilers that I mentioned and the lightning network, which actually is in existence commercially, be integrated into this new system as we go along and not put out of mind until the new system as presently contracted for is put into place.

We have seen the systems in Norman, Oklahoma and in Denver in operation. The committee visited these sites. We are extremely impressed with the capability of the hardware. Within five minutes, members of the committee could sit down at the consoles and look at a prototype AWIPS system or something like what it would look like and manipulate it and use it.

To an old codger like me who used to forecast weather for the whole Pacific Ocean from one place in the middle of the ocean, to now be able to sit down an manipulate data from thousands of points and superimpose one set of data onto another is a whole new era. It is the difference between the diagnosis on the part of physician 100 years ago and today with the availability of CAT-scans and magnetic resonance imaging and things of that sort.

We are moving in the National Weather Service with this modernization into the CAT-scan, MRI type era of weather prediction. It is not just another new gadget. It is a major change, and I will keep emphasizing that.

Mr. SCHEUER. A whole quantum jump?

Dr. HOSLER. It really is a major jump. And this will require a major jump in training and in education of the people using this system in order to get the most out of it.

Mr. SCHEUER. And in management.

Dr. HOSLER. And in management of the system. Of course, this has all been thought of in the plan and we are very complimentary of the thought that has gone into that.

The one concern that we exhibited was of the integrity of the climatic record. While the objective of all this planning is short-range weather forecasting improvement, the fact is that the climate record is important to many areas of commerce and to studies of long-range climate change, warming, and these new concerns.

We are going to a different observing system which, of necessity, will introduce a certain discontinuity in the nature of the record. It is essential that this be taken into account and that there be sufficient overlap between the old records and the new ones so that that disconnect can be minimized in terms of the integrity of the record.

We have made a recommendation that the National Weather Service and NOAA more specifically be charged with maintaining, as a part of their weather observing system, the climate record. After all, the climate record is derived from the weather observing system for the most part. It is essential that they give close attention to the maintaining of that climate record even though that was not really a charge to our committee; it was not really a big part of the modernization plan. Again, as you have emphasized, the AWIPS system is the brain of this, and this has to come along as rapidly as the individual sensors like the NEXRAD that we are talking about.

You brought up the question of a two-tier system and a two-tier evaluation. The committee was very negative about that. This is sort of analogous to putting all of the restrooms in one building in Washington or something. There is a limit to how far you can go with that and not destroy the purpose of their existence in the first place.

Mr. SCHEUER. Don't mention that concept to OMB or they'll mandate it for every agency in Washington.

[Laughter.]

Dr. HOSLER. We feel—and I was a part of studies previously—that the 115 stations mentioned are a good compromise with all the factors taken into consideration. That number was chosen for scientific reasons, for coverage reasons, and not arbitrarily. Some

have suggested trying to go to 50, and we think that would be an absurd concept.

It would be very expensive because in order to get multiple radars reporting to one station, you would have to have a broader band width of communications capabilities. Expenses would be incurred there. You would have to have increased staffing, and again, it would rely on people thinking farther and farther away from their own geographic location.

We have data which show that when you get too far away, you start getting a deterioration in the quality of the warnings and the frequency of the warnings. That was something we were rather negative on.

We were concerned that we need to give a lot of attention to the hydrological aspect. One of the things that this system will enable you to do is to make better forecasts of very short-term flash flooding types of events. Many communities every year encounter these flash flood events with practically no warning. To get a 30 minute warning and to put in place the chain of communications which gets that warning down to every household is an important consideration in this whole thing.

For that reason, again relevant to some prior discussion today, we feel that it might be well worth looking at to retain many of these stations, which are now scheduled for closure with the focus on the 115, as communications centers with maybe one person there. This whole system with all the wonderful things it can do will not be very useful unless the information is understood by the emergency management people, the fire companies, and the sheriff and police in every community. It is going to require constant attention of NOAA and the National Weather Service to maintaining those communication links, having drills, and making sure that if a warning comes out, you can get it within minutes to the people who need to have that warning.

So we feel that it may be worth looking at, and not terribly expensive in the large scale of things, to maintain a communicator in some of these places that might have been scheduled to be shut down, which will give that human element by knowing on a first name basis the people in charge, whether it is the mayor, the police chief, or whoever that is and having confidence in that person looking out for that community and being able to translate what the warnings and watches mean to that community. This is an important aspect. It is not a big element in the modernization with all this talk about contracts, delays, and software, but it is a vital link in making this valuable to the American public.

Mr. SCHEUER. And you would suggest that that be instituted; that we keep those small stations, perhaps with a single professional, at least for a year or two until we know that the new system works all the way down the line?

Dr. HOSLER. And then maybe even beyond that on a selective basis where they could demonstrate value added to the system by that communications link.

Mr. SCHEUER. Right.

Dr. HOSLER. We made a recommendation here that there be some panels of experts set up to parallel the nature of the modernization to make sure that all of the expertise in the country—not that we

don't trust the expertise of the National Weather Service or their contractors, but there are additional experts in the country, in industry and in universities, who might be able to make constructive suggestions as this program moves along to improve the service and improve and fine-tune the design.

We also feel that what we would call the constituent affairs department of the National Weather Service and NOAA should be beefed up to make sure that they are maintaining good liaison with the constituency they serve, with the private sector. After all, in the long run, most of the communication to the man in the street or the woman in the street—nowadays, it's the person in the street, I guess— is maintained through public radio and through television and newspapers, and through the media in general.

A lot of attention has to be paid that we don't get a mismatch there between what is offered by the weather service and what is needed in a timely manner by these communications services. The dollars spent on air time just on radio and television for relaying this information to the public exceeds the National Weather Service's budget, I believe, by something on the order of a factor of five or so. Billions of dollars are spent providing these services.

So this is an important part of the system. It is a private part of the system.

In addition, you have the hundreds of private concerns that now provide specialized weather services, whether it is the forecast for snow-making for a ski resort or airlines for shipping, for agriculture, or whatever that may be. The fact is that these people need to be assured that they have access not only to the products put out by the weather service, but the raw data that they may manipulate in a different way for their special needs and for their special use, which also is a value added in productivity to society.

It is something the Americans have done very well. Unlike the Center for Medium Range Forecasting in Reading, which has been a good center—I think we are almost as good as they are; I might differ with you a little on that—but they have not done as good a job in Europe or anywhere in the world in relaying information to the people who need to use it as we have done in this country. It is a competitive advantage that we have and that I think we should maintain and even improve upon through our skills in communication.

I think that covers most of the points I would make except that I would feel like I was violating the religious precepts of Washington if I did not say that all of this means that it requires resources. It requires the continued support of this committee and it requires the provision of the resources to make all of this come about.

There was a feeling, as many of the people that come before you will repeat in many contexts, that it would be shortsighted to skimp on a few dollars now to wind up with a system that is not state of the art. As you indicated in your introductory remarks, I think it is a disgrace to this society that we have fifties technology in this service right now, whereas we have the wherewithal right now to get eighties technology in place and really improve the material wellbeing, the safety, and welfare of the people in this country.

Thank you.

[The prepared statement of Dr. Hosler follows:]

NATIONAL RESEARCH COUNCIL
COMMISSION ON ENGINEERING AND TECHNICAL SYSTEMS
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NATIONAL WEATHER SERVICE
MODERNIZATION COMMITTEE

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Statement by
Dr. Charles L. Hosler, Jr.
Chairman, Committee on the Modernization
of the National Weather Service

before the

Subcommittee on Environment
Committee on Science, Space, and Technology
U.S. House of Representatives

March 20, 1991

Mr. Chairman and Members of the Committee:

On behalf of the National Research Council and its Committee on the Modernization of the National Weather Service, that I chair, I am pleased to summarize the findings and recommendations contained in the Committee's report released today regarding the program to modernize the National Weather Service (NWS). The Committee was formed at the request of the National Oceanic and Atmospheric Administration (NOAA); its charge is to review the appropriate technological and scientific capabilities for the modernization and investigate the necessary planning and implementation.

Since World War II, significant improvements have been made in the prediction of large-scale weather features (high pressure areas, large storms) owing to increased knowledge of atmospheric processes, new observational techniques such as radar and satellites, and the advent of large computers and numerical prediction models. However, improvements in the forecasting and warning of smaller-scale phenomena (hurricanes, severe thunderstorms, tornadoes, flash floods) have been less dramatic. Yet recent scientific advances in the understanding of these phenomena and new capabilities to observe and rapidly process information on these smaller scales (from a few to several hundred miles) now permit a major advance in weather service to the nation.

As a result, the United States has launched a bold and innovative program to modernize the National Weather Service (NWS). The modernization involves new observational technology, powerful new information and forecast systems, and a new organizational structure. It promises to provide a dramatic improvement in weather services to the nation, including more accurate and timely predictions of those weather events that have regular and dramatic impact on both private and public activities.

Modernization of the NWS thus offers great opportunities to the nation, but it is also a complex undertaking. The National Weather Service Modernization Committee endorses the organizational approach and implementation philosophy of the NWS, but recognizes the challenges ahead; success will depend on the continuity of strong leadership, of good management, and of adequate resources. Although the Committee is impressed with the progress made by the NWS, it is also cognizant of the commitment required by the federal government to complete successfully the modernization and revitalization of the nation's weather services. The recommendations of the Committee are intended to be supportive of the national effort and to increase the possibilities of success.

Over-arching recommendations

- The National Weather Service modernization requires the development and implementation of complex observation and information systems. Rigorous and creative management of the overall structure and of the individual components of each of these systems is essential for success. The system management capabilities of the National Weather Service must be strengthened through the commitment of additional resources and personnel.

- Modernization of the National Weather Service involves a variety of scientific and technical issues and challenges. The National Weather Service and the National Oceanic and Atmospheric Administration should create technical advisory panels for each of the major systems that contribute to the technological modernization. However, these panels cannot substitute for the additional resources and personnel recommended.

- Modernization must continue beyond the implementation of systems now being procured. Provision should be made to incorporate data from additional new technology, such as wind profilers and a lightning detection network, and to take advantage of scientific developments as well as improved computational and information systems as they become available.

New Observation Systems

The Next Generation Weather Radar (NEXRAD) system utilizes Doppler radar technology to provide improved estimates of precipitation amounts; to detect the transition between rain and snow; to track storm movement and intensity; and to allow for earlier detection of the precursors of tornadic activity, thunderstorm development, and other important weather phenomena. The NEXRAD program is currently in a limited production phase. A number of software problems have been encountered and are in the process of being resolved. The Committee cannot judge how well NEXRAD will meet its technical and functional requirements until the test and evaluation phase has been completed.

- Steps should be taken to ensure the continued development and improvement of Next Generation Weather Radar processing algorithms as new developments and operational experience accumulate. The National Weather Service should develop a continuing comprehensive training and education program so that the skills of the Next Generation Weather Radar maintenance and operational staffs, as well as the meteorologists and hydrologists, reflect the ever-changing state of the art.

The Automated Surface Observing System (ASOS) network will provide the basic data required for severe weather, flash flood, and river forecasting, as well as for support of aviation operations. However, although the ASOS has some clear advantages over the present surface observation method in operational weather forecasting and warning, serious concerns exist about its use in monitoring climate as discussed in the following section. The ASOS network will substantially increase the spatial resolution of surface

observations, but even greater resolution will be needed for additional improvement in small-scale weather forecasting and warnings in the future.

The Next Generation Geostationary Operational Environmental Satellites (GOES-Next), now under development, will allow higher-quality and more frequent atmospheric soundings and cloud images to be obtained simultaneously (only one or the other can be obtained from the current GOES). These advances are very important for improved prediction of severe storms and flash floods. Improvements now being developed in the free atmosphere temperature and humidity soundings acquired by NOAA polar orbiting satellites will also contribute to improved longer-range numerical forecasts. Development and funding problems in the GOES-Next program may result in a delay until mid-1994 or later in reestablishment of the full two-GOES constellation, should there be a launch or spacecraft failure. The NOAA polar satellite system is in better condition, but continued funding constraints have decreased the availability of replacement satellites, thereby raising the threat of an interruption in observations in the event of launch or premature satellite failure.

Viability and Integrity of the Climate Data Record

The nation's climate record is a valuable resource whose viability must be maintained. Climate information is used in the design of structures, drought assessments, agricultural planning and assessment, and water management. The possibility of climate change as a result of human activity emphasizes the need for a data record from which climate trends over the coming decades can be determined unambiguously. The NWS is the primary organization engaged in observing and recording in situ weather information in the United States. It must ensure the accuracy and integrity of the weather information it gathers to fulfill its operational requirements; however, the Committee is concerned about the adequacy of NWS data to meet NOAA's climate requirements. Modernization and restructuring of the NWS will affect the viability and integrity of the U.S. climate data record, but it will also provide the opportunity to enhance this record significantly through the availability of new kinds of data; such opportunities should be

examined by NOAA. Because the NWS has traditionally viewed its role as collecting observed data to prepare forecasts and warnings, data quality has been determined largely by these needs. However, the accuracy, continuity, and consistency required of observed data for climate studies are more stringent. The Committee argues that the NWS must be concerned that its data satisfy the needs for consistent climate records as well as for forecasting. Because NWS modernization plans give little attention to the issues of data management and the quality of the climate record, the Committee recommends the following:

- **The National Oceanic and Atmospheric Administration should set the requirements for the climate data to be derived from the modernized National Weather Service observations, establish the role of the National Weather Service in generating these data, and ensure the availability of the resources necessary for this purpose. The National Weather Service at all levels should recognize its responsibility to acquire a major portion of the national climate record; the preservation of data quality for climatic purposes should have equal priority with its mission of providing forecasts.**

New Information Systems

Improved information systems are critical to the NWS modernization and associated restructuring. The key component of each modernized Weather Forecast Office (WFO) will be the Advanced Weather Interactive Processing System (AWIPS) supported by its associated communications system. The AWIPS at each WFO will be the information system used by the meteorologist on duty to prepare warnings and forecasts and to disseminate these products rapidly to the public and other users. The Committee is favorably impressed with the prototypes of AWIPS and the capabilities that are afforded to meteorologists and hydrologists in producing warnings and forecasts. However, it is concerned with the steady slippage of the schedule for full implementation. Without this system, WFOs will be unable to use the new observational technology in an effective manner or to reduce staff through restructuring while increasing service effectiveness. Attention also must be given to

providing adequate access by private meteorologists and weather services, and by universities to raw data and information from AWIPS.

- The Administration and Congress should take the necessary steps to maintain the implementation schedule for the Advanced Weather Interactive Processing System and its associated communications. The National Weather Service, in consort with the university community and private sector users of National Weather Service data and information, should develop viable plans for broad access to the raw data and information that will become available via the Advanced Weather Interactive Processing System, keeping in mind the benefits such collaboration can provide to the government, the public, and the private sector.

Improved numerical forecast and guidance products, with higher space and time resolution, are required by the WFOs to improve their forecasts and warnings of small-scale weather features. In turn, these improvements necessitate continuing enhancement of computer capability and refinement of atmospheric models at the National Meteorological Center.

New Structure of the National Weather Service

A major purpose of the NWS modernization is to improve dramatically the short-term forecasts of significant weather events and warnings of severe weather. To achieve this aim, meteorologists and hydrologists must be able to observe their service domains continuously and must have a workload commensurate with the area covered, the short response time necessary for effective warning, and the effective range of available observations (e.g., Next Generation Weather Radar). These human factors must be paramount in evaluating field service structures proposed for the modernized NWS.

Weather Forecast Offices

The Committee has examined the various configurations of the Weather Forecast Office (WFO) network that have been considered and endorses the proposed network of 115 WFOs, which coincides with the expected effective

coverage of the new Next Generation Weather Radars (NEXRADs), a radius of around 200 km from each unit. The efficacy of this network will be validated by the Modernization and Associated Restructuring Demonstration (MARD) to be conducted for one year in the midwestern United States around 1993, a schedule that is in jeopardy because of continued delays in implementation of the Advanced Weather Interactive Processing System. However, the Committee is very concerned about a report that the Department of Commerce has decided to modify the MARD to test the efficacy of using about one-half as many WFOs as now planned while maintaining the current proposed network of 115 NEXRADs.

Attempting to double the area covered by each WFO without a proportional increase in staff on shift could seriously jeopardize the ability of each WFO to deal effectively with small-scale weather events over such a large area. Moreover, coordination of warnings with state and local government would also be degraded by doubling the area of responsibility for each WFO. Furthermore, a two-tier test would surely increase significantly the difficulties involved in using the MARD results in the certification process required by Congress. Finally, the need to transmit the full-resolution data from two or three remote NEXRADs to a WFO and to merge these data in "real time" for use by meteorologists, although technically feasible, would add significantly to the complexity, cost, and the time required to implement both the MARD and, subsequently, the entire modernization.

- The Department of Commerce should carefully reconsider its decision to have the National Oceanic and Atmospheric Administration/National Weather Service conduct a two-tiered Modernization and Associated Restructuring Demonstration because a configuration of significantly fewer than 115 Weather Forecast Offices will lead to serious degradation of weather services. Moreover, such an experiment would be much more complex and expensive, and would probably lead to a serious delay in the National Weather Service modernization.

Hydrology in the National Weather Service Modernization

The nation's need for improved management of water resources and more accurate flood forecasting will increase during the 1990s. Modernization of the NWS presents opportunities for improving hydrological services on all time scales by taking advantage of the new observational technology and forecasting capabilities, and by enhancing the collaboration between meteorologists and hydrologists.

- In light of the National Weather Service modernization and restructuring, the workloads, responsibilities, interactions, and cross-training of meteorological, hydrometeorological, and hydrological personnel planned for Weather Forecast Offices and River Forecast Centers should be examined carefully and redefined.

New and Stronger Collaboration

Strong and effective collaboration between the NWS and the academic community, the private sector, and public institutions is necessary for the NWS to accomplish its mission to provide weather and flood warnings and public forecasts for the protection of life and property, as well as to improve its services. Thus, planning and fostering these collaborations must be an important part of the NWS modernization.

The success of the NWS in accomplishing its mission depends on the effective integration of the skills and knowledge of its meteorologists, on employing advancing technology for observing the atmosphere, on continued improvement in its systems for transmitting information and creating numerical simulations and forecasts of atmospheric behavior, and on effective utilization of new and basic scientific understanding of the atmosphere. Clearly then, the effectiveness of the NWS is dependent on education, on technological development, and on scientific advances. Thus the Committee believes that the federal government must take a new view of the relationship among NOAA, the NWS, and the atmospheric sciences community, especially in the universities. An important new component of modernization of the NWS

should be a strong commitment by NWS and NOAA to strengthen their research partnership with the academic community.

The Committee agrees with the NWS intent to collocate, to the extent possible, Weather Forecast Offices with universities offering undergraduate and graduate education in meteorology. Unfortunately, NWS efforts to implement this ideal situation are being impeded by lack of a high-level federal policy on collocation and by ponderous procurement procedures that delay and mitigate against the necessary commitments.

- The Administration and Congress should adopt a policy that fosters the collocation of as many Weather Forecast Offices as possible on university campuses with atmospheric science departments.

The Committee believes that more intimate and effective collaboration between the NWS and the universities in education and research would greatly benefit both parties and the nation.

- The National Oceanic and Atmospheric Administration and the National Weather Service should implement enhanced collaboration with universities in the atmospheric and hydrologic sciences, in both education and research.

The private sector provides much of the new technology now being implemented in the NWS modernization and also contributes to the technological advances on which operational improvements are based. The primary sources of weather forecasts and warnings for the general public are the mass media: television, radio, and newspapers. Clearly, maintaining effective collaboration with the mass media is crucial, and any inadvertent actions that might impair linkages between the NWS and the media would have serious impacts on the safety and well-being of the populace and on the commercial sector as well. Private weather services, which provide a variety of services regionally, nationally, and even worldwide, constitute another major interface between the NWS and the general public or other elements of the private sector. Thus although these components of the private sector are providing many important services today, they will become

even more important in the era of the modernized NWS. Increased attention to collaboration with the private sector will be required as modernization of the NWS continues.

- To ensure that the association between the National Weather Service and the private sector functions smoothly and efficiently to the best advantage of all parties, including the general public, the constituent affairs activities of the National Weather Service should be strengthened; the Constituent Affairs Officer should act as an ombudsman for the private sector to the Assistant Administrator of the National Oceanic and Atmospheric Administration for Weather Services, coordinate program changes with the private sector, obtain its inputs to National Weather Service planning and evaluation, and arbitrate or resolve conflicts as they arise.

Community preparedness is essential to save lives and minimize property damage during severe weather situations. The critical role of the NWS is to participate actively in preparedness planning and then communicate both to state and local governments, and to the public, the seriousness of specific weather situations. A leadership role is necessary, and the Committee believes that a limited, part-time approach to this key function is entirely inadequate.

- To ensure adequate community preparedness, professional staff time equivalent to a full-time person should be provided at each Weather Forecast Office to work with state and local governments and other involved agencies in preparing plans for the community's response to severe weather. To maintain liaison with public institutions and to assist in community preparedness, the federal government should consider retaining, with limited staff, most weather service offices now planned for closure.

Implementation Process

The NWS has done a commendable job in planning its modernization. A new matrix organization is in place and top management staffing is complete. Since the completion of the Committee's report, NOAA has announced its

intention to establish a centralized systems program office that would assume responsibility for the development and procurement of the new systems for the NWS modernization. However, the Committee believes that its conclusions and recommendations are still germane although some of them may now be applicable to the new NOAA systems office rather than the NWS. Both NOAA and the Department of Commerce appear to have a shortage of staff to provide administrative support, such as procurement and personnel, and to handle the external contacts with Congress, user groups, and the public that are essential for implementation of the modernization and associated restructuring. Moreover, the Committee is concerned that the project management, engineering, and support staff may not be as strong as required for an effort of this magnitude.

It appears to the Committee that the NWS lacks an overall policy for configuration control of large systems and for the development and maintenance of complex software. System engineering in the NWS environment is vital because of the phased development and because NWS systems must remain operational during upgrading and modernization.

- The National Weather Service should establish overall policies and procedures for the development of major systems, including consideration of the interaction between systems, and establish software development and maintenance standards.

Overall, the Committee is impressed with the progress that has been made in developing hardware and preparing for field installation. Delays in procurement and funding constraints for the Advanced Weather Interactive Processing System (AWIPS) are of serious concern, as are the troublesome delays in software and hardware for the Next Generation Weather Radar.

Concluding Recommendations

- The success of the National Weather Service modernization requires an increased commitment of resources and personnel to the many scientific,

technical, and organizational challenges involved. Parsimony now will be expensive later.

- The National Oceanic and Atmospheric Administration, the Department of Commerce, the Office of Management and Budget, and the Congress should provide more realistic budgeting and funding for the National Oceanic and Atmospheric Administration's operational satellite systems in order to realize the full potential benefits of the National Weather Service modernization and associated restructuring.

That concludes my prepared statement, Mr. Chairman. I will be happy to answer any questions the committee may have.

Mr. SCHEUER. Thank you very much, Dr. Hosler, for a very moving and eloquent statement.

You were talking about the extension of the service down to the city or community level, the dissemination level. Is that a part of the overall schema?

Dr. HOSLER. It is part of the overall plan, but I think that because of the difficulties and the complexities of the hardware systems and the software that has to go along with it and getting the materials manipulated for the forecasters to use, there has perhaps not been as much emphasis on that aspect of it as some of the people on the committee and myself would probably advocate.

Mr. SCHEUER. I don't know how much emphasis it has received, but I think it ought to get a hell of a lot of emphasis because, from my experience, it is one thing to develop all of the sophisticated information, but it is another thing to get it out there and to have the human systems of communicating it through every communications device that we have, whether radio, television, newspapers, cable, or whatever, all of them. If we don't do that, we are failing to really take full advantage of the information that we are spending ultimately billions of dollars to aggregate, if you don't get it out there to where the people are.

Dr. HOSLER. You are absolutely right. I was even a TV weatherman for 12 years and I know a little bit about that disseminating business.

I don't think that the American public over the decades have been as well served in this respect as they might be. There is a lot of information and was a lot of information that was held relatively close to the chest, so to speak, and perhaps not as much effort was made to educate that constituency out there that does the relaying of the information to the public.

There is a free speech issue here. There are times when you would like to tell them they are not doing it right and to do it differently, but under our laws and our Constitution, they are permitted to do what they want any way they want to. I am afraid that sometimes the public is not well served by some of the communicators that are interfacing with the public.

Mr. SCHEUER. Who are the communicators that you are speaking of?

Dr. HOSLER. I am speaking of disc jockeys, of TV weatherpersons who are not always professionals, and who are not always as conscientious about the product they put out along the weather line as they are about getting the commercials correct.

The information is not always timely that is put out. They have the facility to be more timely by being in touch with the National Weather Service and getting more timely data, but sometimes that is not done as well as might be done.

There is some slippage there now, and I think this can be improved upon with a close coordination and cooperation between the weather service and these media elements that are the ultimate disseminators.

Mr. SCHEUER. That is radio, television, press, and so forth?

Dr. HOSLER. And probably cable in the future, and interactive computing systems. I foresee a day when the types of data that this system will deliver will enable you to punch in on your home com-

puter and put onto your television something that says: you are here, and will show you where the thunderstorm or the severe weather or the flooding is, and where it is going to be for the next hour or two and where you are with respect to that.

I think that is within our grasp at this time. Once we have these wonderful products that this modernization will give us access to, I think they will be seized upon by the media and by entrepreneurs and placed in our homes, in aircraft—I foresee that, in the cockpit of an airplane, they will be able to call up whatever it is they would like to see in the way of clouds, turbulence, severe weather, hail, and so forth.

Mr. SCHEUER. Boats?

Dr. HOSLER. That's right. I think we have only scratched the surface in that respect.

Mr. SCHEUER. Dr. Hosler, are the schedules realistic that are being planned by the National Weather Service for all of these development programs that you have heard about today? Are they realistic and reasonable?

Dr. HOSLER. Yes; I think they are realistic, but again, I don't think anyone can adequately foresee a software problem in a complex system like this or other complications that may develop, or the legal and financial problems that may ensue if someone underbids on a system and has trouble delivering within that price. But I think that the schedules that were laid out by the planners initially were realistic schedules and sensible schedules.

Mr. SCHEUER. I take it that you are in touch with the academic and scientific community in this country. Are they being involved? Is their expertise, imagination, and talents being involved? Have they been involved in a good scientific collaboration effort to achieve the goals, to help provide input to achieving the goals of the modernization and restructuring of the National Weather Service?

Dr. HOSLER. Yes; I would have to say that, in the science of meteorology, it is a relatively small community and there is always very close integration of the people. Transfer of information is very rapid. The American Meteorological Society meetings and the officers of that society—and many weather service personnel are involved in the science and in the professional society.

There is a very good intermingling of people and ideas. In fact, the University of Oklahoma has been thoroughly involved in the development of the prototype system in Norman, Oklahoma. Many professors and graduate students are working on and have worked on parts of this system as it came along, and they will in the future.

We have advocated in our report, and the weather service, in a foresighted manner, has tried in every area possible to co-locate these weather forecast offices with universities to make sure that the university people being trained have access to this sophisticated equipment and information and to make sure that the people in the weather service have access to the ideas and the developments as they come along within the university community.

I think that there are things we can do to promote that flow of information and interchange or to discourage it. I think that is

well recognized on the part of the weather service and the university community. There is a relatively good flow there now.

Mr. SCHEUER. Okay; thank you very much, Dr. Hosler. You were really a very effective and creative and resourceful witness. We appreciate your testimony and your patience very much.

Dr. HOSLER. This month is the 44th anniversary of my first testimony before a Congressional committee.

[Laughter.]

Mr. SCHEUER. Well, mazeltov. Thank you.

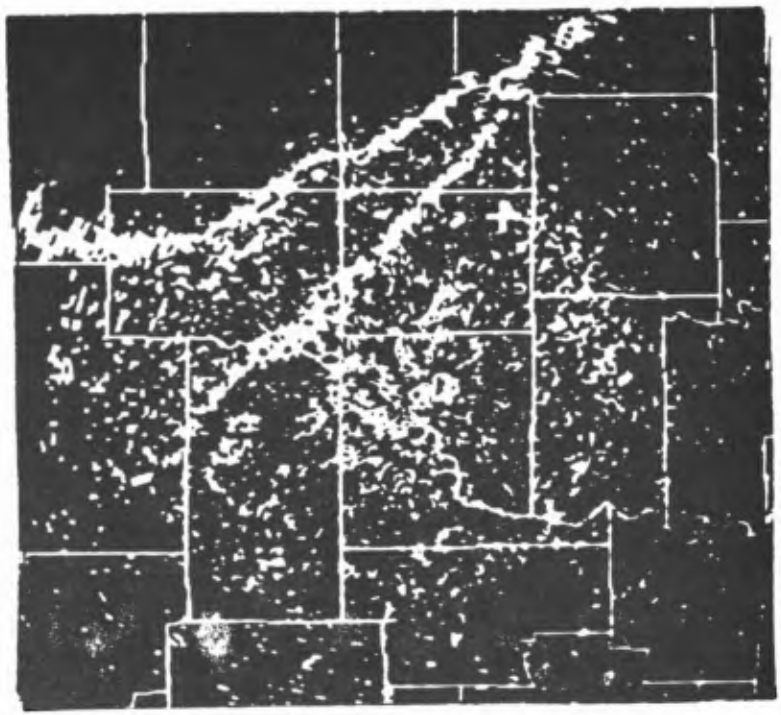
The hearing is adjourned to reconvene at the call of the Chair.

[Whereupon, at 3:55 p.m. the subcommittee adjourned, to reconvene at the call of the Chair.]

APPENDIX

TOWARD A NEW NATIONAL WEATHER SERVICE

-- *A First Report*



Cover: An image made from radar reflectivity values measured by the prototype Next Generation Weather Radar (NEXRAD) located at Norman, Oklahoma, on March 17, 1989, at 2:52 p.m. The atmosphere was free of clouds at the time of observation and demonstrates the high sensitivity of the new system. This enhanced sensitivity, compared to current operational weather radars, permits the detection of both a cold front and a moisture discontinuity (dry line) oriented NE-SW and located NW of the radar site (represented by the small circle below the center of the image). Four hours after these data were acquired, a thunderstorm developed on the cold front and produced hail the size of baseballs near Tulsa. (Reprinted with permission of the National Weather Service.)

TOWARD A NEW NATIONAL WEATHER SERVICE

-- *A First Report*

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Committee on National Weather Service Modernization

of the
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Notice

Since the completion of this report by the Committee on National Weather Service Modernization, the Department of Commerce (National Oceanic and Atmospheric Administration, NOAA, 1991b) has announced that it is "creating a new advanced system acquisition office which will provide an integrated system development and procurement capability within NOAA. Both the National Weather Service's modernization system procurement and the Next Generation Geostationary Operational Environmental Satellite (GOES-Next) system development and procurement will be the responsibility of the new office." Although details of the reorganization had not been announced by the end of January 1991, the Committee understands that the new advanced system acquisition office will report to the Commerce Deputy Undersecretary for Oceans and Atmosphere. As reflected in this report, the National Weather Service (NWS) is currently responsible for the development and procurement of systems required for the modernization. The National Environmental Satellite, Data, and Information Service (NESDIS), together with the National Aeronautics and Space Administration, is now responsible for the development and procurement of the GOES-Next satellite system. (Both NWS and NESDIS are major line components of NOAA.)

Although this reorganization undoubtedly will affect the future work of the Committee, it believes that the conclusions and recommendations in this report are still germane; however, some of them may now be applicable to the new NOAA systems office rather than to NWS or NESDIS.

Preface

The National Weather Service (NWS) is engaged in a dramatic transformation involving new sources of information about the atmosphere, new ways of using that information effectively and making it available to a wide community of users, and new ways of providing the forecasts and warnings that will lead to enhanced protection of life and property. This effort follows more than a decade of planning based on recent scientific and technological developments.

In its report *Technological and Scientific Opportunities for Improved Weather and Hydrological Services in the Coming Decade*, the Select Committee on the National Weather Service of the National Research Council (NRC, 1980) pointed out scientific and technological opportunities for substantial improvement in the quality and quantity of the nation's weather and hydrological services, including the timely warning of hazardous weather and flooding. According to the National Oceanic and Atmospheric Administration (NOAA), this report encouraged and assisted NOAA in moving toward implementation of plans to modernize and restructure the NWS. Subsequently, a study panel of the NRC (1987) reviewed the status of the development of potential technological components of a modernized NWS and the planning at that time for modernization and the associated restructuring. The report was generally supportive of both the technological developments and the plans for implementation.

In response to Department of Commerce budget requests to move ahead with the modernization and associated restructuring, the U.S. Congress (1988) passed and the President signed Public Law 100-685, Title IV of which set forth guidelines for planning the NWS modernization and restructuring, as well as for reporting and certifying proposed actions to Congress. In accordance with this law, the Department of Commerce issued a *Strategic Plan for the Modernization and Associated Restructuring of the National Weather Service*

(DOC, 1989). In July 1989, NOAA requested that the NRC establish a review committee on the modernization and associated restructuring of the NWS (Appendix A). The NOAA proposed that the review committee function throughout the national deployment of the new technology and the transition to the new structure of the NWS, a period expected to extend into the mid-1990s.

The NRC agreed to establish a committee to help ensure

- the implementation of the most cost-effective levels of technical systems and services by assessing the availability, applicability, and timing of appropriate underlying technological and scientific capabilities; and
- the successful demonstration and acceptance of the modernized and restructured NWS operations by reviewing test, demonstration, and certification plans, and by independently reviewing the data collection and interpretation processes.

The NOAA executed a contract for this activity on December 29, 1989, and the NRC established the Committee on National Weather Service Modernization.

The Committee held its first meeting on February 21-22, 1990, and a total of five meetings during that year. Its work is being supported by the Committee on Meteorological Analysis, Prediction, and Research of the NRC Board on Atmospheric Sciences and Climate (Appendix B). The two committees met jointly in June. In addition, individuals and groups of members of both committees, along with NRC staff, have held discussions on specific details with personnel and contractors of the NWS. This first report of the Committee presents the results of its work during 1990. In addition to taking a broad overview of the modernization and associated restructuring, the Committee examined in more detail selected areas in which near-term decisions by NOAA are contemplated or needed. The Committee will continue to examine the planning and implementation of the NWS modernization and associated restructuring, and will present additional conclusions and recommendations in subsequent reports to be issued at least annually during its lifetime.

The members of the National Weather Service Modernization Committee are pleased to be able to contribute to a "new National Weather Service" for this nation.

Acknowledgments

The contributions of members of the Committee, both during its meetings and in carrying out individual assignments, are acknowledged with great

appreciation. The Committee wishes to thank the members of the Committee on Meteorological Analysis, Prediction, and Research for their valuable contributions to this work. I would like to express the Committee's appreciation for the excellent support of the NRC staff in all aspects of its work. Although this report represents contributions by and deliberations of all members of the Committee, I would especially like to note the contributions to its writing by David S. Johnson, Study Director, and to its production by Mercedes Ilagan, Senior Study Assistant. Finally, the peer review by the NRC contributed significantly to the quality of the report.

Charles L. Hosler, Jr.
Chairman, Committee on National
Weather Service Modernization

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Summary

Since World War II, significant improvements have been made in the prediction of large-scale weather features (high pressure areas, large storms) owing to increased knowledge of atmospheric processes, new observational techniques such as radar and satellites, and the advent of large computers and numerical prediction models. However, improvements in the forecasting and warning of smaller-scale phenomena (hurricanes, severe thunderstorms, tornadoes, flash floods) have been less dramatic. Yet recent scientific advances in the understanding of these phenomena and new capabilities to observe and rapidly process information on these smaller scales (from a few to several hundred miles) now permit a major advance in weather service to the nation.

As a result, the United States has launched a bold and innovative program to modernize the National Weather Service (NWS), a major component of the National Oceanic and Atmospheric Administration (NOAA) of the Department of Commerce. The modernization involves new observational technology, powerful new information and forecast systems, and a new organizational structure. It promises to provide a dramatic improvement in weather services to the nation, including more accurate and timely predictions of those weather events that have regular and dramatic impact on both private and public activities.

Modernization of the NWS thus offers great opportunities to the nation, but it is also a complex undertaking. The National Weather Service Modernization Committee[1] of the National Research Council (NRC) endorses the

[1] At the request of NOAA, the National Research Council established a review committee on the modernization and associated restructuring of the NWS. This first report of the Committee presents the results of its work during 1990. The Committee will continue its review and will present additional findings and recommendations in subsequent reports.

organizational approach and implementation philosophy of the NWS, but recognizes the challenges ahead; success will depend on the continuity of strong leadership, of good management, and of adequate resources. Although the Committee is impressed with the progress made by the NWS, it is also cognizant of the commitment required by the federal government, NOAA, and the NWS to complete successfully the modernization and revitalization of the nation's weather services. The recommendations presented in this report are intended to be supportive of the national effort and to increase the possibilities of success.

- **The success of the National Weather Service modernization requires an increased commitment of resources and personnel to the many scientific, technical, and organizational challenges involved. Parsimony now will be expensive later.**[1]

- **The National Weather Service modernization requires the development and implementation of complex observation and information systems. Rigorous and creative management of the overall structure and of the individual components of each of these systems is essential for success. The system management capabilities of the National Weather Service must be strengthened through the commitment of additional resources and personnel.**

- **Modernization of the National Weather Service involves a variety of scientific and technical issues and challenges. The National Weather Service and the National Oceanic and Atmospheric Administration should create technical advisory panels for each of the major systems that contribute to the technological modernization. However, these panels cannot substitute for the additional resources and personnel recommended.**

- **Modernization must continue beyond the implementation of systems now being procured. Provision should be made to incorporate data from additional new technology, such as wind profilers and a lightning detection network, and to take advantage of scientific developments as well as improved computational and information systems as they become available.**

NEW OBSERVATION SYSTEMS

The Next Generation Weather Radar (NEXRAD) system utilizes Doppler radar technology to provide improved estimates of precipitation amounts; to detect the transition between rain and snow; to track storm

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[1] Several specific recommendations appear in the section on human and financial resources in Chapter 6.

movement and intensity; and to allow for earlier detection of the precursors of tornadic activity, thunderstorm development, and other important weather phenomena. The NEXRAD program is currently in a limited production phase. A number of software problems have been encountered and are in the process of being resolved. The Committee cannot judge how well NEXRAD will meet its technical and functional requirements until the test and evaluation phase has been completed.

■ **Steps should be taken to ensure the continued development and improvement of Next Generation Weather Radar processing algorithms as new developments and operational experience accumulate. The National Weather Service should develop a continuing comprehensive training and education program so that the skills of the Next Generation Weather Radar maintenance and operational staffs, as well as the meteorologists and hydrologists, reflect the ever-changing state of the art.**

The Automated Surface Observing System (ASOS) network will provide the basic data required for severe weather, flash flood, and river forecasting, as well as for support of aviation operations. However, although the ASOS has some clear advantages over the present surface observation method in operational weather forecasting and warning, serious concerns exist about its use in monitoring climate as discussed in the following section. The ASOS network will substantially increase the spatial resolution of surface observations, but even greater resolution will be needed for additional improvement in small-scale weather forecasting and warnings in the future.

■ **The National Weather Service should identify other local and state surface observation resources; initiate efforts to acquire existing data and, as feasible, to improve the quality and quantity of the data; and promote the development and installation of additional local and state networks in data-sparse regions.**

The Next Generation Geostationary Operational Environmental Satellites (GOES-Next), now under development, will allow higher-quality and more frequent atmospheric soundings and cloud images to be obtained simultaneously (only one or the other can be obtained from the current GOES). These advances are very important for improved prediction of severe storms and flash floods. Improvements now being developed in the free atmosphere temperature and humidity soundings acquired by NOAA polar orbiting satellites will also contribute to improved longer-range numerical forecasts.

Development and funding problems in the GOES-Next program may result in a delay until mid-1994 or later in reestablishment of the full two-GOES constellation, should there be a launch or spacecraft failure. The NOAA polar satellite system is in better condition, but continued funding constraints have decreased the availability of replacement satellites, thereby raising the threat of an interruption in observations in the event of launch or premature satellite failure.

■ **The National Oceanic and Atmospheric Administration, the Department of Commerce, the Office of Management and Budget, and the Congress should provide more realistic budgeting and funding for the National Oceanic and Atmospheric Administration's operational satellite systems in order to realize the full potential benefits of the National Weather Service modernization and associated restructuring.**

Viability and Integrity of the Climate Data Record

The nation's climate record is a valuable resource whose viability must be maintained. Climate information is used in the design of structures, drought assessments, agricultural planning and assessment, and water management. The possibility of climate change as a result of human activity emphasizes the need for a data record from which climate trends over the coming decades can be determined unambiguously (for example, see Committee on Earth Sciences, 1990; NRC, 1990b). The NWS is the primary organization engaged in observing and recording in situ weather information in the United States. It must ensure the accuracy and integrity of the weather information it gathers to fulfill its operational requirements; however, the Committee is concerned about the adequacy of NWS data to meet NOAA's climate requirements. Modernization and restructuring of the NWS will affect the viability and integrity of the U.S. climate data record, but it will also provide the opportunity to enhance this record significantly through the availability of new kinds of data; such opportunities should be examined by NOAA. Because the NWS has traditionally viewed its role as collecting observed data to prepare forecasts and warnings, data quality has been determined largely by these needs. However, the accuracy, continuity, and consistency required of observed data for climate studies are more stringent. The Committee argues that the NWS must be concerned that its data satisfy the needs for consistent climate records as well as for forecasting. Because NWS modernization plans

give little attention to the issues of data management and the quality of the climate record, the Committee recommends[1] the following:

- **The National Oceanic and Atmospheric Administration should set the requirements for the climate data to be derived from the modernized National Weather Service observations, establish the role of the National Weather Service in generating these data, and ensure the availability of the resources necessary for this purpose. The National Weather Service at all levels should recognize its responsibility to acquire a major portion of the national climate record; the preservation of data quality for climatic purposes should have equal priority with its mission of providing forecasts.**

NEW INFORMATION SYSTEMS

Improved information systems are critical to the NWS modernization and associated restructuring. The key component of each modernized Weather Forecast Office (WFO) will be the Advanced Weather Interactive Processing System (AWIPS) supported by its associated communications system. The AWIPS at each WFO will be the information system used by the meteorologist on duty to prepare warnings and forecasts and to disseminate these products rapidly to the public and other users. The Committee is favorably impressed with the prototypes of AWIPS and the capabilities that are afforded to meteorologists and hydrologists in producing warnings and forecasts. However, it is concerned with the steady slippage of the schedule for full implementation. Without this system, WFOs will be unable to use the new observational technology in an effective manner or to reduce staff through restructuring while increasing service effectiveness. Attention also must be given to providing adequate access by private meteorologists and weather services, and by universities to raw data and information from AWIPS.

- **The Administration and Congress should take the necessary steps to maintain the implementation schedule for the Advanced Weather Interactive Processing System and its associated communications. The National Weather Service, in consort with the university community and private sector users of National Weather Service data and information, should develop viable plans for broad access to the raw data and information that will become available via the Advanced Weather Interactive Processing System,**

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[1] Additional recommendations in this area appear in Chapter 2.

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keeping in mind the benefits such collaboration can provide to the government, the public, and the private sector.

Improved numerical forecast and guidance products, with higher space and time resolution, are required by the WFOs to improve their forecasts and warnings of small-scale weather features. In turn, these improvements necessitate continuing enhancement of computer capability and refinement of atmospheric models at the National Meteorological Center.

NEW STRUCTURE OF THE NATIONAL WEATHER SERVICE

A major purpose of the NWS modernization is to improve dramatically the short-term forecasts of significant weather events and warnings of severe weather. To achieve this aim, meteorologists and hydrologists must be able to observe their service domains continuously and must have a workload commensurate with the area covered, the short response time necessary for effective warning, and the effective range of available observations (e.g., Next Generation Weather Radar). These human factors must be paramount in evaluating field service structures proposed for the modernized NWS.

Weather Forecast Offices

The Committee has examined the various configurations of the Weather Forecast Office (WFO) network that have been considered and endorses the proposed network of 115 WFOs, which coincides with the expected effective coverage of the new Next Generation Weather Radars (NEXRADs), a radius of around 200 km from each unit. The efficacy of this network will be validated by the Modernization and Associated Restructuring Demonstration (MARD) to be conducted for one year in the midwestern United States around 1993, a schedule that is in jeopardy because of continued delays in implementation of the Advanced Weather Interactive Processing System. However, the Committee is very concerned about a report that the Department of Commerce has decided to modify the MARD to test the efficacy of using about one-half as many WFOs as now planned while maintaining the current proposed network of 115 NEXRADs.

Attempting to double the area covered by each WFO without a proportional increase in staff on shift could seriously jeopardize the ability of each WFO to deal effectively with small-scale weather events over such a large area. Moreover, coordination of warnings with state and local government would also be degraded by doubling the area of responsibility for each WFO. Furthermore, a two-tier test would surely increase significantly the difficulties

involved in using the MARD results in the certification process required by Congress. Finally, the need to transmit the full-resolution data from two or three remote NEXRADs to a WFO and to merge these data in "real time" for use by meteorologists, although technically feasible, would add significantly to the complexity, cost, and the time required to implement both the MARD and, subsequently, the entire modernization.

■ **The Department of Commerce should carefully reconsider its decision to have the National Oceanic and Atmospheric Administration/National Weather Service conduct a two-tiered Modernization and Associated Restructuring Demonstration because a configuration of significantly fewer than 115 Weather Forecast Offices will lead to serious degradation of weather services. Moreover, such an experiment would be much more complex and expensive, and would probably lead to a serious delay in the National Weather Service modernization.**

Hydrology in the National Weather Service Modernization

The nation's need for improved management of water resources and more accurate flood forecasting will increase during the 1990s. Modernization of the NWS presents opportunities for improving hydrological services on all time scales by taking advantage of the new observational technology and forecasting capabilities, and by enhancing the collaboration between meteorologists and hydrologists.

■ **In light of the National Weather Service modernization and restructuring, the workloads, responsibilities, interactions, and cross-training of meteorological, hydrometeorological, and hydrological personnel planned for Weather Forecast Offices and River Forecast Centers should be examined carefully and redefined.**[1]

NEW AND STRONGER COLLABORATION

Strong and effective collaboration between the NWS and the academic community, the private sector, and public institutions is necessary for the NWS to accomplish its mission to provide weather and flood warnings and public forecasts for the protection of life and property, as well as to improve its

[1] Additional recommendations are included in the section on hydrology in Chapter 4.

services. Thus, planning and fostering these collaborations must be an important part of the NWS modernization.

Universities

The success of the NWS in accomplishing its mission depends on the effective integration of the skills and knowledge of its meteorologists, on employing advancing technology for observing the atmosphere, on continued improvement in its systems for transmitting information and creating numerical simulations and forecasts of atmospheric behavior, and on effective utilization of new and basic scientific understanding of the atmosphere. Clearly then, the effectiveness of the NWS is dependent on education, on technological development, and on scientific advances. Thus the Committee believes that the federal government must take a new view of the relationship among NOAA, the NWS, and the atmospheric sciences community, especially in the universities. An important new component of modernization of the NWS should be a strong commitment by NWS and NOAA to strengthen their research partnership with the academic community.

The Committee agrees with the NWS intent to collocate, to the extent possible, Weather Forecast Offices with universities offering undergraduate and graduate education in meteorology. Unfortunately, NWS efforts to implement this ideal situation are being impeded by lack of a high-level federal policy on collocation and by ponderous procurement procedures that delay and mitigate against the necessary commitments.

- **The Administration and Congress should adopt a policy that fosters the collocation of as many Weather Forecast Offices as possible on university campuses with atmospheric science departments.**

The Committee believes that more intimate and effective collaboration between the NWS and the universities in education and research would greatly benefit both parties and the nation.

- **The National Oceanic and Atmospheric Administration and the National Weather Service should implement enhanced collaboration with universities in the atmospheric and hydrologic sciences, in both education and research.**

Private Sector

The private sector provides much of the new technology now being implemented in the NWS modernization and also contributes to the technological advances on which operational improvements are based. The primary sources of weather forecasts and warnings for the general public are the mass media: television, radio, and newspapers. Clearly, maintaining effective collaboration with the mass media is crucial, and any inadvertent actions that might impair linkages between the NWS and the media would have serious impacts on the safety and well-being of the populace and on the commercial sector as well. Private weather services, which provide a variety of services regionally, nationally, and even worldwide, constitute another major interface between the NWS and the general public or other elements of the private sector. Thus although these components of the private sector are providing many important services today, they will become even more important in the era of the modernized NWS. Increased attention to collaboration with the private sector will be required as modernization of the NWS continues.

■ **To ensure that the association between the National Weather Service and the private sector functions smoothly and efficiently to the best advantage of all parties, including the general public, the constituent affairs activities of the National Weather Service should be strengthened; the Constituent Affairs Officer should act as an ombudsman for the private sector to the Assistant Administrator of the National Oceanic and Atmospheric Administration for Weather Services, coordinate program changes with the private sector, obtain its inputs to National Weather Service planning and evaluation, and arbitrate or resolve conflicts as they arise.**[1]

Public Institutions

Community preparedness is essential to save lives and minimize property damage during severe weather situations. The critical role of the NWS is to participate actively in preparedness planning and then communicate both to state and local governments, and to the public, the seriousness of specific weather situations. A leadership role is necessary, and the Committee believes that a limited, part-time approach to this key function is entirely inadequate.

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[1] Additional recommendations appear in the section on private weather services, Chapter 5.

■ **To ensure adequate community preparedness, professional staff time equivalent to a full-time person should be provided at each Weather Forecast Office to work with state and local governments and other involved agencies in preparing plans for the community's response to severe weather. To maintain liaison with public institutions and to assist in community preparedness, the federal government should consider retaining, with limited staff, most Weather Service Offices now planned for closure.**

IMPLEMENTATION PROCESS

The NWS has done a commendable job in planning its modernization. A new matrix organization is in place and top management staffing is complete. However, both NOAA and the Department of Commerce appear to have a shortage of staff to provide administrative support, such as procurement and personnel, and to handle the external contacts with Congress, user groups, and the public that are essential for implementation of the modernization and associated restructuring. Moreover, the Committee is concerned that the project management, engineering, and support staff may not be as strong as required for an effort of this magnitude.[1]

It appears to the Committee that the NWS lacks an overall policy for configuration control of large systems and for the development and maintenance of complex software. System engineering in the NWS environment is vital because of the phased development and because NWS systems must remain operational during upgrading and modernization.

■ **The National Weather Service should establish overall policies and procedures for the development of major systems, including consideration of the interaction between systems, and establish software development and maintenance standards.**

Overall, the Committee is impressed with the progress that has been made in developing hardware and preparing for field installation. Delays in procurement and funding constraints for the Advanced Weather Interactive Processing System (AWIPS) are the most serious concerns involving hardware, although there are some troublesome delays in software and hardware for the Next Generation Weather Radar. The AWIPS situation poses a major

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[1] Several specific recommendations regarding staff increases appear in the section on human and financial resources in Chapter 6.

problem in the Modernization and Associated Restructuring Demonstration and certification process that must precede restructuring of the NWS.

The Committee's study to date has not reviewed the system security and resiliency issues involved in modernization. It is apparent, however, that the NWS has concentrated on physical security and has not paid sufficient attention to the security of electronic access.

- **The National Weather Service should satisfy itself that the security of its data systems will be adequate to preclude a breakdown of critical services in the event of improper intervention, either intentional or inadvertent, in its data and communications systems.**

The Committee is concerned about the plan to have only one meteorologist on duty during the night shift at each Weather Forecast Office (WFO). The weather is no less life-threatening and damaging at night than during the day and evening. The concept upon which the NWS bases the feasibility of the proposed night shift staffing has not been tested successfully. Therefore, the Committee recommends:[1]

- **The proposal to produce operational forecasts by computer that are equal to or better than current manually produced forecasts and warnings should be demonstrated for a variety of weather conditions and locations. The new procedures should be operational and their efficacy established before the meteorological staff at a Weather Forecast Office is reduced to the proposed one person on the night shift. An alternate operational plan for staffing the night shift should be formulated for use until the proposed concept has been fully developed and proven.**

The Committee recognizes that many of the suggestions made in this report have a potential impact on the budget for the NWS modernization and associated restructuring. The additional personnel required temporarily to assist in modernization activities could save money in the long term. Although the solution proposed for the problem of limited forecast staff on the night shift at the WFOs may reduce the overall savings visualized from restructuring the NWS until the effectiveness of automation can be demonstrated satisfactorily, the Committee believes that this would be compensated by savings to the

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[1] A related recommendation appears in the section on operational staff in Chapter 6.

public and governments from reduced loss of life and destruction of property. The phasing of funds for NOAA satellites to ensure their continuity and for rectifying the current low incremental funding of the Advanced Weather Interactive Processing System program would also require an increase in near-term budgets but would probably reduce the overall cost of implementation.

Although the Committee has not received detailed plans for certification to review, it offers two initial observations. First, specific comparisons of the quantity and quality of weather information, forecasts, warnings, and their prompt dissemination must be obtained, both during the Modernization and Associated Restructuring Demonstration and during the process of certifying the capabilities of any WFO to serve its area of responsibility. The Committee believes that carefully constructed and unbiased comparisons will demonstrate a noteworthy improvement in the quality and accuracy of service. Second, to increase the credibility of the certification process in the eyes of user groups and Congress, it may be appropriate, at some stage, to involve an independent evaluation of the statistical and analytical measures developed during the initial operations of the WFOs as applied to each specific certification.

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Introduction

BACKGROUND

The United States has launched a bold and innovative program to modernize the National Weather Service (NWS), a major component of the National Oceanic and Atmospheric Administration (NOAA) of the Department of Commerce. The modernization involves new observational technology, both at the surface and with weather satellites; powerful new information and forecast systems; and a new organizational structure. It promises to provide a dramatic improvement in weather services to the nation, including more accurate and timely predictions of those weather events that have regular and dramatic impact on both private and public activities.

Modernization of the NWS thus offers great opportunities to the nation, but it is also a complex undertaking. The National Research Council's National Weather Service Modernization Committee endorses the organizational approach and implementation philosophy of the NWS, but recognizes the challenges ahead; success will depend on the continuity of strong leadership, of good management, and of adequate resources. Although the Committee is impressed with the progress the NWS has made, it is also cognizant of the commitment required by the federal government, NOAA, and the NWS to complete successfully the modernization and revitalization of the nation's weather services.

BROAD RECOMMENDATIONS

Recommendation: *The success of the National Weather Service modernization requires an increased commitment of resources and personnel to the many scientific, technical, and organizational challenges involved. Parsimony now will be expensive later.*

Recommendation: *The National Weather Service modernization requires the development and implementation of complex observation and information systems. Rigorous and creative management of the overall structure and of the individual components of each of these systems is essential for success. The system management capabilities of the National Weather Service must be strengthened through the commitment of additional resources and personnel.*

Recommendation: *Modernization of the National Weather Service involves a variety of scientific and technical issues and challenges. The National Weather Service and the National Oceanic and Atmospheric Administration should create technical advisory panels for each of the major systems that contribute to the technological modernization. However, these panels cannot substitute for the additional resources and personnel recommended.*

GOALS AND COMPONENTS OF THE MODERNIZATION

In its *Strategic Plan for the Modernization and Associated Restructuring of the National Weather Service*, the Department of Commerce (DOC, 1989) set the following goal:

> "To modernize the NWS through the deployment of proven observational, information processing and communications technologies, and to establish an associated cost effective operational structure. The modernization and associated restructuring of NWS shall assure that the major advances which have been made in our ability to observe and understand the atmosphere are applied to the practical problems of providing weather and hydrologic services to the Nation."

The more specific goals set forth in the *National Implementation Plan for the Modernization and Associated Restructuring of the NWS* (DOC, 1990) are:

- "Operational realization of a predictive warning program focusing on mesoscale meteorology and hydrology;
- "Advancement of the science of meteorology and hydrology;
- "Development of NWS human resources to achieve maximum benefit from recent scientific and technological advances;
- "User acceptance and support of NWS modernization and associated restructuring service improvement objectives;
- "Strengthening cooperation with the mass media, universities, the research community and the private hydrometeorological sector to collectively fulfill the nation's weather information needs from provision of

severe weather warnings and general forecasts for the public as a whole, which is a Government responsibility; to the provision of detailed and customer specific weather information, which is a private sector responsibility;

- "Achievement of productivity gains through automation and replacement of obsolete technological systems; and
- "Operation of the optimum NWS warning and forecast system consistent with service requirements, user acceptability, and affordability."

Since World War II, significant improvements have been made in the prediction of large-scale weather features (high pressure areas, large storms) owing to increased knowledge of atmospheric processes, new observational techniques such as radar and satellites, and the advent of large computers and numerical prediction models. However, improvements in the forecasting and warning of smaller-scale phenomena (hurricanes, severe thunderstorms, tornadoes, flash floods) have been less dramatic. Yet recent scientific advances in the understanding of these phenomena and new capabilities to observe and rapidly process information on these smaller scales (from a few to several hundred miles) now permit a major advance in weather service to the nation.

As a result, the NWS is engaged in a dramatic transformation involving new sources of information about the atmosphere, new ways of employing that information effectively and making it available to a wide community of users, and new ways of providing the forecasts and warnings that will lead to enhanced protection of life and property. This modernization of the NWS offers great opportunity to the nation.

The successful implementation of four key components of the modernization initiative is essential to realize its full potential. Modernization requires:

- more powerful observation technology, including Doppler radar, automatic observing systems, and enhanced satellite systems now being developed, as well as new systems such as wind profilers and a lightning detection network, that together will produce unprecedented, high-resolution, continuing information on the state of the atmosphere;
- more powerful systems and concepts for transmitting this information, converting it into forecasts and warnings, and making timely information about the atmosphere available to a variety of users in the public and private sectors;

- a new organizational structure that enhances the potential for service to the public by taking advantage of the collective skills of a highly trained cadre of professional meteorologists; and
- a new commitment to collaboration with the universities and the private sector in meteorology to enhance the understanding of the atmosphere, along with the development of effective new applications of atmospheric knowledge to ensure the continuing evolution of weather service capabilities in the decades ahead.

The NWS plans for modernization, which are summarized below, provide for all four of these key components.

NEW OBSERVATION SYSTEMS

Next Generation Weather Radar (NEXRAD) units utilize Doppler radar technology to measure the radial wind velocity in severe weather elements such as thunderstorms, to provide improved estimates of precipitation amounts, to detect the transition between rain and snow, and to track storm movement and intensity. The new radars also will allow for earlier detection of the precursors of tornadic activity, thunderstorm development, and other important weather phenomena. The NWS will operate 121 NEXRAD systems, and the FAA and DOD will operate another 39, for a total of 160 systems in a national network. This is a significant improvement in coverage and quality compared to today's radar network, in which most of the units are more than 30 years old. The NEXRAD program is currently in a limited production phase; full-scale production is expected to begin in 1991,[1] with completion of all installations planned for 1995.

Automated Surface Observing System (ASOS) units will be installed initially at more than 1000 locations in the United States in a cooperative program with the Federal Aviation Administration (FAA) and the Department of Defense (DOD). These units will provide surface weather information on a nearly continuous basis and in a uniform manner. The ASOS network will provide the basic data required for severe weather, flash flood, and river forecasting, as well as for support of aviation operations. The automation will free personnel for other activities and allow future expansion of the network at much less cost than presently required with manual observations. The

[1] This and subsequent schedule dates in this chapter are from *The National Implementation Plan for the Modernization and Associated Restructuring of the National Weather Service* (DOC, 1990).

ASOS units now are being produced and installed in the field with completion expected in fiscal year 1995.

Next Generation Geostationary Operational Environmental Satellites (GOES-Next) are under development, with the first launch officially scheduled in 1992. The new GOES will allow atmospheric soundings and cloud images to be obtained simultaneously (only one or the other can be obtained from the current GOES). Both observations will also be of higher quality and resolution. New images can be provided as frequently as every six minutes during severe weather conditions. These advances are very important for improved prediction of severe storms and flash floods.

Recommendation: *Modernization must continue beyond the implementation of systems now being procured. Provision should be made to incorporate data from additional new technology, such as wind profilers and a lightning detection network, and to take advantage of scientific developments as well as improved computational and information systems as they become available.*

NEW INFORMATION SYSTEMS

The Advanced Weather Interactive Processing System (AWIPS) will be the key component of each of the new Weather Forecast Offices (WFOs) and River Forecast Centers (RFCs) of the NWS. The AWIPS unit and its associated communications will be the data integrator at each WFO, receiving high-resolution data from the observation systems; centrally collected data, analyses, and guidance products from the National Meteorological Center (NMC) in Suitland, Maryland; and products from the National Hurricane Center in Miami, Florida, and the National Severe Storms Forecast Center in Kansas City, Missouri. This integrated and continuously updated data base is the source from which all warnings and forecasts issued by the WFO will be prepared. The AWIPS, by providing fast-response interactive data analysis and display, will be the information system used by the meteorologist on duty to prepare warnings and forecasts and to disseminate these products rapidly to the public and other users.

The AWIPS also will include a new communications system to support NWS operations; it will provide for:

- Point-to-multipoint distribution of centrally collected or produced conventional and satellite data, analyses, and guidance products to the WFOs. This function is part of the NOAAPORT data access concept whereby NWS and other NOAA products, including oceanographic and environmental data, will be delivered to external users, both private and public.

- Point-to-point networking of the WFOs, RFCs, National Centers, Automated Surface Observing System, and other observation sites.
- Multipoint-to-point collection at the NMC of the locally produced data and products for use in numerical weather forecasting, international data exchange, and data archiving.

The AWIPS definition phase is drawing to a close; the two-year development phase will start in fiscal year 1992. The deployment phase is expected to begin in fiscal year 1994 and to extend well into the latter half of the decade. The key pacing item for full implementation of the NWS modernization and associated restructuring is AWIPS.

More powerful super computers at the NMC are critical to improving the accuracy of numerical weather forecasts, particularly at the smaller scales of atmospheric motion. Numerical models of the atmosphere must run on large, high-speed computers to have the spatial resolution and timeliness needed in today's weather forecasting. The requirements for computer-generated guidance products in support of forecasting severe storms are significantly increased over those previously needed. For example, a high-resolution model, with a horizontal resolution of 30 km and improved physics, is now being developed that requires a much larger computer capability than the Class VI computers previously used at the NMC for models with a resolution of 85 km. The first Class VII computer was installed at the NMC in 1990. The NWS hopes to obtain budget approval soon for a second super computer at NMC.

NEW STRUCTURE OF THE NATIONAL WEATHER SERVICE

At present the main field forecast offices of the NWS are 52 Weather Service Forecast Offices (WSFOs) whose responsibilities are organized on a geographical basis; in many cases there is one WSFO per state. In addition, there are 197 smaller offices, including Weather Service Offices (WSOs) and Weather Service Meteorological Observatories, that take manual weather observations and, in the case of WSOs, issue local area forecasts and warnings based on the products of the WSFOs. Thirteen River Forecast Centers (RFCs), which primarily provide flood warnings and river stage and water supply forecasts, are located to cover the contiguous 48 states and Alaska. Six RFCs are collocated with WSFOs. The hydrologic forecasts and warnings prepared by the RFCs are disseminated by the WSFOs and selected WSOs. The work of these operational field facilities is supported by the National Meteorological Center, the National Hurricane Center, and the National Severe Storms Forecast Center.

A fundamental change in the structure of the NWS is planned as part of the proposed modernization. There will be 115 Weather Forecast Offices (WFOs) at locations determined primarily by the coverage of Next Generation Weather Radar systems to be installed nearby and not by political (e.g., state) boundaries. All the remaining WSOs and Weather Service Meteorological Observatories, other than those that will be converted to WFOs, will be closed. The observing functions at these WSOs and Weather Service Meteorological Observatories will be automated. The forecast and warning responsibilities of the WSOs to be closed will be assumed by the appropriate WFOs using the improved observation, information processing, and dissemination systems. The NWS expects that services to be provided to areas now covered by WSOs scheduled for closure will be at least as good as those provided today. As at present, the field forecast offices will be supported by the three national centers (National Meteorological Center, National Hurricane Center, and National Severe Storms Forecast Center) and the 13 RFCs. All of the RFCs will be collocated with WFOs.

Concern about possible deterioration in local forecast and warning services with the closing or relocation of many of the existing NWS offices led the U.S. Congress (1988) to include in Public Law 100-685 the provision: "The Secretary [of Commerce] may not close, consolidate, automate, or relocate any [WSO or WSFO] unless the Secretary has certified...that such action will not result in any degradation of weather services provided to the affected area."

NEW AND STRONGER COLLABORATION

The current modernization of the NWS and its continuing improvement in the future are vitally dependent on collaboration with both the university community and the private sector.

Universities are the prime sources of new meteorologists for the NWS and play a key role in training these future meteorologists in the use of new scientific and technological developments. They are also the leading national source of the scientific and technological advances upon which future improvements in NWS services depend. To perform these critical functions, the academic community requires access to data, analysis products, and the technology used in the Weather Forecast Offices (WFOs). To facilitate this collaboration, the NWS is collocating several WFOs with university campuses. The NWS also proposes to increase collaborative development activities; however, so far these activities have not been adequately funded. The NOAA has entered into an agreement with the University Corporation for Atmospheric Research for a Cooperative Program for Operational Meteorology, Education and Training, whose stated purposes are (1) to provide mechanisms

to increase and improve the interactions between the academic and research communities and the operational services; (2) to enhance technology transfer to the operational services; and (3) to enhance the professional development of operational meteorologists, hydrologists, and hydrometeorologists.

The private sector provides much of the new technology now being implemented in the NWS modernization and also contributes to the technological advances on which operational improvements are based. The most important role of the private sector is probably the prompt and wide dissemination of NWS data, products, forecasts, and warnings, particularly to the general public. Although the private sector does provide these services today, it will become even more important in the era of the modernized NWS. Moreover, the new technology being introduced, particularly the Next Generation Weather Radar (NEXRAD) and the Advanced Weather Interactive Processing System, will require new dissemination capabilities. Therefore, the NWS is improving its communication and coordination with the private sector. It has selected three companies to collect and disseminate NEXRAD data. Increased attention to collaboration with the private sector will be required as modernization of the NWS continues.

THE COMMITTEE'S ENDORSEMENT AND INTENT

The Committee on National Weather Service Modernization has examined the plans for these components in some detail, and commends the federal government and the NWS for creating a modernization plan that offers tremendous potential for enhanced service to the nation. The recommendations presented in this report are intended to support that effort; to increase its likelihood of success; and to ensure a continuing evolution of the national capability to enhance understanding of the atmosphere and to combine that knowledge with technological advances so as to ameliorate the effects of weather on both public and private activities.

2

New Observation Systems

The key new observation systems in the NWS modernization are the Next Generation Weather Radar (NEXRAD), the Automated Surface Observing System, and the Next Generation Geostationary Environmental Satellites, which were described briefly in Chapter 1. The following sections contain a preliminary assessment of these systems; the Committee will provide additional assessments as the programs evolve.

Other observational systems may contribute significantly to the modernized NWS. Two particularly important ones for forecasting and warning of severe weather events, because of the high space or time resolution of their observations, are wind profilers and a sferics[1] network for lightning detection and analysis. A network of profilers will be tested during the Modernization and Associated Restructuring Demonstration (MARD) to be conducted in the midwestern United States around 1993. The results of the MARD will contribute to a future decision on operational implementation of profilers in the NWS. A private national lightning network now exists and is used by the NWS under a contract that expires in March 1991. The NWS has initiated a competitive procurement action for the collection of lightning data through the MARD period.

NEXT GENERATION WEATHER RADAR

The first network Next Generation Weather Radar (NEXRAD; technically, the WSR-88D) has been installed near Oklahoma City. Another is located at the NEXRAD Operational Support Facility (OSF) in Norman, Oklahoma and will remain an OSF resource for use in testing, evaluating, and

[1] Sferics refers to a radio direction-finding system used to detect and locate lightning by means of the "atmospherics" (electromagnetic radiation) produced by lightning discharges.

enhancing the NEXRAD system. The rate of installation had been planned to increase gradually to one per month by the end of 1991, then eventually to four per month in 1994. Originally, a period of one year had been planned between installation of the Limited Production Phase radars and initiation of the full production phase, to allow for a thorough and complete operational evaluation. No time is currently available because of slower-than-anticipated progress in the early phases of procurement and software development problems. Thus final testing and evaluation must take place in 1991, just prior to acceptance of the NEXRAD systems at the OSF and Oklahoma City. However, neither the installation of the radar nor the engineering acceptance of the system establishes that it is actually operational in the meteorological sense. That happens, as is the case for all new elements in the NWS modernization, when the radar is operationally ready and is certified to be fully commissioned after training of the local staff.

Status of Major Components of the Next Generation Weather Radar Program

Experience with NEXRAD units suggests that the hardware (transmitter, receiver, signal processor, and antenna) is robust and will prove to be reliable in the long term. There were reports of poor reliability during the NEXRAD Initial Operational Test and Evaluation, Phase II (IOT&E-2) (Air Force Operational Test and Evaluation Center, 1989). Some of this resulted from the fact that no changes, improvements, or fixes to the system were permitted during the approximately five-month IOT&E-2 process. Because of that constraint, repetitive failures of the same nature occurred throughout the process during which corrective actions were not allowed. This is not a criticism of the process, but merely a recognition of the fact that in a normal operational environment, appropriate corrective actions would have been taken and maintenance procedures revised.

The IOT&E-2 process involves independent test and evaluation of the entire NEXRAD system to determine its operational effectiveness and suitability, to identify its deficiencies and enhancements, and to determine which items should be addressed during subsequent tests and evaluation. Following are additional comments based on the IOT&E-2 report regarding functional performance and capability, human engineering, software documentation and maintenance, and training.

In the category of functional performance and capability, significant problems were encountered regarding the ability of the radar to generate automatically critical derived data reliably. These include, for example, effective range unfolding and error-free velocity dealiasing. A software error in the system prevented the range unfolding algorithm from working correctly, and

the algorithm for velocity dealiasing was inadequate. An improved velocity dealiasing algorithm, similar to that being used in the Terminal Doppler Weather Radar application for the FAA, is being installed and the range unfolding software error has been corrected.

It is now likely that a highly reliable algorithm for hail detection and quantitative hail measurement will not be available initially, but research at the National Severe Storms Laboratory of NOAA is expected to produce an improved technique. Also, the National Severe Storms Laboratory is working on an improved mesocyclone detection algorithm.

These problems are not surprising; the development of the NEXRAD system was deficient in not providing for adequate prototype demonstrations in an operational environment similar to the experiments and programs that were undertaken as part of the Terminal Doppler Weather Radar development for the FAA. Nevertheless, the Committee is confident that these deficiencies can be corrected.

Upgrades to the Next Generation Weather Radar Technical Requirements

Another group of comments in the Initial Operational Test and Evaluation, Phase II (IOT&E-2) report dealt with human engineering aspects of the system. Most result from inadequacies in the original NEXRAD Technical Requirements; they can be overcome, either through changes in the NEXRAD prime contract with UNISYS Corporation, or through enhancements developed by the Operational Support Facility (OSF). The IOT&E-2 report included a number of additional recommendations that also extend beyond the scope of the NEXRAD Technical Requirements. About one-half of the recommendations state that the System Requirement Review Board of the NEXRAD Joint System Program Office has referred certain matters to its Service Report Enhancement Committee for recommendations. It is presumably the responsibility of the Service Report Enhancement Committee to provide advice and recommendations regarding changes to system requirements. As mentioned earlier, such changes would have to be implemented either by modification of the contract with UNISYS or by the OSF itself. The Service Report Enhancement Committee is appointed by NOAA, FAA, and the United States Air Force (USAF) to consider these recommendations and advise the NEXRAD Program Council.[1] Presumably the NEXRAD Program

[1] The members of the NEXRAD Program Council are the Assistant Administrator of NOAA for Weather Services, the Commander of the USAF Air Weather Service, and the Deputy Associate Administrator of the FAA for National Airspace System Development.

Council would then direct that specific enhancements, where appropriate, be implemented.

Adequate direction and resources will be required throughout the lifetime of the NEXRAD system to ensure the continuing development and operational implementation of new processing algorithms based on scientific developments and operational experience.

Software documentation and maintenance is another important area. A number of the IOT&E-2 recommendations related to the system's software, its documentation, and its maintenance. Ultimate responsibility for system software maintenance rests with the OSF, and its leadership understands and accepts that responsibility.

Training

Another class of Initial Operational Test and Evaluation, Phase II (IOT&E-2) recommendations concerns training. In response, the NEXRAD Joint System Program Office and the NWS have adopted a revised approach to training NWS personnel. Training for system maintenance will take place in Kansas City, Missouri; training for system operations will take place at the Operational Support Facility (OSF) in Norman, Oklahoma. UNISYS will be responsible only for the initial training of NWS instructors (and perhaps for the first one or two operator courses). The NWS instructors will, in turn, be responsible for training weather service operational and maintenance personnel. It is the Committee's understanding that the NWS instructors were selected carefully. A 14-week software course will be conducted at the OSF; UNISYS is also responsible for this course. UNISYS is currently placing considerable emphasis on its responsibilities for training and documentation, and has appointed new people for these tasks. Thus the training deficiencies identified in the IOT&E-2 report are being addressed. Whether the training will actually be effective is the subject of an evaluation process that will begin soon.

Another issue related to training is continuing education. It appears that the OSF understands and is planning for its responsibilities related to initially training operators of the system and then to providing adequate training on system upgrades and changes as they occur. What is not explicitly included to date relates to procedural revisions. As the system matures, procedures are likely to change from time to time at many of the NEXRAD sites. It is essential that the OSF standardize such changes and apprise operational staff of the most effective procedures for fulfilling its responsibilities. The NWS must develop comprehensive training and education programs such that its mainte-

nance, operational, meteorological and hydrological staffs remain current. This must become part of its ongoing long-range plans.

Outlook and Recommendations

The current state of the development of the NEXRAD hardware is excellent. Its performance, even at this stage, gives great promise of providing a major improvement in forecasts and warnings. However, problems with completion of the operational software continue. As of December 1990, the initial operating capability software is not expected to be available until July 1991. Clearly, results of the definitive engineering tests, system functional evaluations, and system reliability evaluations that remain to be completed will be very important. An essential focus of the test and evaluation phase will be the performance of the software. The Committee cannot judge how well NEXRAD will meet its technical and functional requirements until this phase has been completed.

Recommendation: *Steps should be taken to ensure the continued development and improvement of Next Generation Weather Radar processing algorithms as new developments and operational experience accumulate.*

Recommendation: *The National Weather Service should develop a continuing comprehensive training and education program so that the skills of the Next Generation Weather Radar maintenance and operational staffs, as well as the meteorologists and hydrologists, reflect the ever-changing state of the art.*

AUTOMATED SURFACE OBSERVING SYSTEM

The Committee does not have any specific comments at this time regarding the status of the development and installation of Automated Surface Observing System (ASOS) units in the NWS modernization. Although the ASOS offers some clear advantages over the present surface observation method in operational weather forecasting and warning, serious concerns exist about its accuracy, representativeness, and system performance. The Committee is also concerned about the quality and appropriateness of the ASOS data in terms of continuing the climate record and monitoring climate change. This aspect is discussed in the last section of this chapter. Finally, NOAA has not addressed the need to augment ASOS data to maintain the climate data record.

Need for Use of Adjunct Sources of Surface Observations

The ASOS network of surface reporting stations will substantially increase the spatial resolution of the current surface reporting network, but even greater resolution will be needed for additional improvement in small-scale numerical forecast models (30 km horizontal resolution) being introduced by the National Meteorological Center. Although the observational resolution of Next Generation Weather Radar, the Next Generation Geostationary Operational Environmental Satellites, and NOAA (polar orbiting) satellites is compatible with these models, quantitative surface observations are also required. Therefore, an era is beginning in which local and state observations (e.g., the Illinois State Water Survey network or the Oklahoma Climate Survey network) will become increasingly important as a cost-efficient means of improving forecasts and warnings of small-scale weather events. Also, the use of these data to verify high-resolution forecasts undoubtedly will contribute to even further improvements as systematic model errors and errors from highly localized effects are uncovered and corrected.

Recommendation: *The National Weather Service should identify other local and state surface observation resources; assess their quality and utility for operational use as adjunct data; prepare a national summary of the nation's high-resolution observing capabilities; assess the cost of acquiring and upgrading the nation's high-resolution surface observing capabilities; initiate efforts to acquire existing data and, as feasible, to improve the quality and quantity of the data; and promote the development and installation of additional local and state networks in data-sparse regions.*

ENVIRONMENTAL SATELLITES

The Next Generation Geostationary Operational Environmental Satellites (GOES-Next) will play a particularly important role in continuously monitoring clouds and weather systems from above and increasing the number of measurements of free atmosphere winds, temperature, and humidity, thus contributing to the improved small-scale, short-period forecasting and warning that is the primary focus of the NWS modernization and associated restructuring. Improvements now being developed in the free atmosphere temperature and humidity soundings acquired by NOAA polar orbiting satellites will also contribute to improved longer-range numerical forecasts.

However, these developments are in the future. Today the nation has inadequate weather-observing satellites in orbit or available for launch to guard against the loss of satellite information owing to launch failure or delays

in the construction of additional spacecraft. The GOES system now has only one satellite in orbit rather than the two required to fully cover the United States and adjacent ocean areas. This results from a launch failure at a critical time (GOES G in May 1986), as well as continued delays in the development of the GOES-Next spacecraft (GOES I through M).[1] Although GOES 7 (launched in February 1987) is operating well, it will be five years old before the earliest first launch of the new series, GOES I, in 1992. The NOAA polar satellite system is in better condition with satellites in orbit, but continued funding constraints have forced delays in the availability of replacement satellites that certainly will be needed in the future.

The GOES-Next delays resulted from serious problems in the development of two new instruments, a cloud imager and an atmospheric sounder, by ITT Corporation-Fort Wayne under a subcontract from the prime contractor, Ford Aerospace Corporation. Fortunately, development by Ford of the remaining parts of the spacecraft has gone well, but integration and testing can only proceed so far before the instruments being built by ITT are required. The delays have caused a major overrun in the Ford Aerospace prime contract to produce and test the satellites. The contract is being managed by Goddard Space Flight Center of the National Aeronautics and Space Administration (NASA) for NOAA, and all funds come from NOAA. Although NASA believes that the worst of the development problems have been solved and the principal task now is to keep instrument assembly and test efforts on schedule, the same confidence has been expressed in the past and unexpected difficulties have suddenly appeared, forcing additional schedule slippage.

The overrun situation plus the limitations in funds available to NOAA in the past have resulted in stop work and slow orders on GOES K, L, and M. As a result, the Committee is concerned that reestablishment of the full two-GOES constellation may not take place until mid-1994 or later, should there be a launch or spacecraft failure with GOES I or J. Because the NWS modernization program depends on the GOES-Next satellites, along with the Next Generation Weather Radar, the Automated Surface Observing System, and the Advanced Weather Interactive Processing System, the fragility of the GOES program has the potential to delay the schedule for completion of the full modernization and restructuring.

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[1] The spacecraft are designated serially by letter before launch; after successful launch into orbit, the letter is changed to a number representing the new satellite's position in the sequence of successful launches of that particular series of satellites (e.g., GOES H became GOES 7 after its successful launch).

The NOAA polar orbiting satellite system is in better technical condition than the GOES system. However, funding constraints in the polar program also threaten continuity problems in the event of launch or premature satellite failure. It also should be noted that NASA now procures commercial launch services on behalf of NOAA, not just launch vehicles as in the past. This means that launch schedules will be far more difficult to change due to the requirements of other users of the launch services, which will make quick replacement of failed satellites even more difficult than before.

Recommendation: *The National Oceanic and Atmospheric Administration, the Department of Commerce, the Office of Management and Budget, and the Congress should provide more realistic budgeting and funding for the National Oceanic and Atmospheric Administration's operational satellite systems in order to realize the full potential benefits of the National Weather Service modernization and associated restructuring.*

VIABILITY AND INTEGRITY OF THE CLIMATE DATA RECORD

The nation's climate record is a valuable resource whose viability must be maintained. Climate information is used in a variety of analyses and applications of economic value and importance to safety. These include the design of structures, drought assessments, agricultural planning and assessment, and water management. The possibility of climate change as a result of human activity over the coming decades is another application; observational strategies and capabilities must be developed that will provide a data record from which regional and global climate trends can be determined unambiguously. The requirements for these data have been considered by several national and international organizations (for example, see NRC, 1990b), and data programs are being planned or enhanced by a number of U.S. agencies (Committee on Earth Sciences, 1990).

Climate data come from many governmental and nongovernmental sources; however, the NWS is the primary organization engaged in observing and recording in situ weather information in the United States. It must ensure the accuracy and integrity of the weather information it gathers to fulfill its operational requirements; however, the Committee is concerned about the adequacy of NWS data to meet NOAA's climate requirements. The NOAA (which includes the National Environmental Satellite, Data, and Information Service as well as the NWS) is responsible for the acquisition, integrity, storage, and timely availability of the weather and climate data it

acquires, as well as a substantial amount of such data from other federal agencies and other nations.

Modernization and restructuring of the NWS will affect the viability and integrity of the U.S. climate data record, but it will also provide the opportunity to enhance this record significantly through new kinds of data not formerly available. For example, Next Generation Weather Radar data can be used to derive improved estimates of time-integrated precipitation over most of the United States, an important climatological parameter. Also, the wind profiler data, because of the high frequency of observation, could provide new information on wind spectra. These and other opportunities to enhance the climate record should be examined by NOAA.

The most direct impacts of the NWS modernization and restructuring will arise from changes in observing locations and instrumentation. Changes of observing locations generally induce changes in climate statistics that are larger than those arising from climate variability. Changes in instrumentation pose problems of consistency and accurate calibration between old and new sensors. In the case of automated remote measurements, these problems include the lack of manual supervision of equipment, as well as the lack of direct viewing of weather events that are an integral part of the climate record such as statistics regarding summertime convection, distant thunderstorms, lightning, virga, and variable sky conditions.

Because the NWS has traditionally viewed its role as collecting observed data primarily to prepare forecasts and warnings, data quality has been determined largely by these needs. However, the accuracy, continuity, and consistency required of observed data may depend on whether the data are to be used in forecasting or climate research. For example, a slight shift in the location of a thermometer will have little effect on weather forecasts but often produces a noticeable discontinuity in average temperatures at a station, which clearly makes determining climate trends difficult.

Given the evident need for high-quality data for climate studies and applications, the Committee argues that the NWS must be concerned that its data satisfy the needs for consistent climate records as well as for forecasting. The record should be as free as possible from avoidable bias. The slight additional costs are more than justified by the importance of the climate-related policy issues that the nation will face. Because NWS modernization plans give little attention to the issues of data management and the quality of the climate record, the Committee recommends the following:

Recommendation: *The National Oceanic and Atmospheric Administration should set the requirements for the climate data to be derived*

from the modernized National Weather Service observations, establish the role of the National Weather Service in generating these data, and ensure the availability of the resources necessary for this purpose. The National Weather Service at all levels should recognize its responsibility to acquire a major portion of the national climate record; the preservation of data quality for climatic purposes should have equal priority with its mission of providing forecasts.

Recommendation: *Criteria for the accuracy of the various data collection systems should be selected carefully with attention both to the needs of the National Weather Service and to the quality of the climate record. Limits on both random and bias errors for data systems should be determined by the requirements of science rather than by the technology of the measurement.*

Recommendation: *When new instruments are brought into operation, there should be proof that their observations are within well-defined limits of the observations over the range of the record provided by the instruments they replace. This will require that new and old systems be operated simultaneously in an operational environment, for at least one year, at many locations around the country. Ideally, this simultaneous operation should occur at every site where new equipment is installed. If the new equipment does not meet the requirements that ensure the integrity and viability of the climate record, then the National Weather Service must be prepared to modify it or find an alternative.*

Recommendation: *When instrument sites are changed, simultaneous operation at the old and new sites should occur until adequate statistics on the difference of observations between sites can be developed. These statistics should be recorded carefully and made readily available.*

Recommendation: *Authority should be given to an individual or individuals at each site to question the accuracy of any observation system, and allowance should be made for that individual or those individuals to study the problem and recommend changes. The National Weather Service and its reward system should encourage individuals to ensure continuously the accuracy of data collection systems and of the climate record.*

Recommendation: *The National Weather Service should establish a network of observation stations in natural and undeveloped areas with the sole aim of acquiring baseline data for a long-term climate record. Consistency of the record over long periods should be the first priority. Areas in which these stations are located must remain*

natural and undeveloped; national parks would be candidate sites. This network will fit within the current Automated Surface Observing System program with only modest additional cost.

The Committee plans to continue its examination of the NWS modernization as it relates to the climate record to help ensure a positive impact on that record.

3

New Information Systems

Improved information systems are critical to the NWS modernization and associated restructuring. The key component of each modernized Weather Forecast Office (WFO) will be the Advanced Weather Interactive Processing System (AWIPS) supported by a new communications system that includes the NOAAPORT data access concept. Improved numerical forecast and guidance products, with higher space and time resolution, are required by the WFOs to improve their forecasts and warnings of small-scale weather features. In turn, these improvements necessitate enhanced computer capability and refined atmospheric models at the National Meteorological Center.

ADVANCED WEATHER INTERACTIVE PROCESSING SYSTEM

Extended developmental work by the Program for Regional Observing and Forecasting Services of the NOAA Environmental Research Laboratories in collaboration with the NWS has created the foundation for the AWIPS system. The Program for Regional Observing and Forecasting Services developed the Denver AWIPS Risk Reduction and Requirements Evaluation (DAR^3E) system as an experimental prototype of AWIPS. DAR^3E units are now operating at the Weather Service Forecast Offices in Denver, Colorado and Norman, Oklahoma. The Committee was very impressed with the capabilities, versatility, and "user-friendliness" of the DAR^3E system and has a favorable impression about the equipment, the system, and the personnel developing it. The Environmental Research Laboratories and NWS personnel devoted 10 years to planning, developing, and testing prototypes and appear to have thought through all of the necessary procedures and potential problems. If unforseen problems are encountered, the personnel involved can be expected to resolve them.

The experience of the Program for Regional Observing and Forecasting Services and DAR^{3}E has provided an excellent basis for proceeding with AWIPS. The definition phase of the AWIPS development, involving two competing contractors, is drawing to a close. The Committee is pleased that AWIPS will use "off-the-shelf" hardware components and, wherever possible, a standard operating system and programming languages. This will facilitate the maintenance and future evolution of AWIPS. The two-year developmental phase with a single contractor is scheduled to begin early in fiscal year 1992.

Attention must now turn to providing adequate access by private meteorologists and weather services, and by universities to raw data and information from AWIPS. In the case of private weather services, raw data are often needed to generate unconventional but highly useful information and products. Universities provide a large pool of creative talent to derive new products and techniques, but they also require raw data to do so. Costs may be incurred in providing these data to the university community, but the returns will eclipse these costs as new information is produced.

Recommendation: *The National Weather Service, in consort with the university community and private sector users of National Weather Service data and information, should develop viable plans for broad access to the raw data and information that will become available via the Advanced Weather Interactive Processing System, keeping in mind the benefits such collaboration can provide to the government, the public, and the private sector.*

The Committee is favorably impressed with the prototypes of AWIPS and the capabilities that are afforded to meteorologists and hydrologists in producing warnings and forecasts. However, it is concerned with the steady slippage of the schedule for full implementation. This has resulted in a two-phased approach. The AWIPS is essential to the conduct of the Modernization and Associated Restructuring Demonstration. Also, without this system, Weather Forecast Offices will be unable to use the new observational technology in an effective manner or to reduce staff through restructuring while increasing service effectiveness.

Recommendation: *The Administration and Congress should take the necessary steps to maintain the implementation schedule for the Advanced Weather Interactive Processing System and its associated communications.*

SUPER COMPUTERS AT THE NATIONAL METEOROLOGICAL CENTER

To achieve the primary objective of modernization, Weather Forecast Offices will need numerical weather forecasts and guidance products from the National Meteorological Center (NMC) that have a higher space and time resolution than those now available. The first new Class VII super computer has been installed at the NMC, and an improved small-scale atmospheric computer model with a horizontal resolution of 30 km and improved physics is being developed. Funds are being requested beginning in fiscal year 1992 for a second super computer to facilitate production of more accurate numerical forecasts of smaller-scale weather elements and to provide increased reliability through backup of the most important processing. Greater sophistication in understanding the atmosphere, which will lead to improved, more complex models, and the rapidly growing volume of observations mandate the acquisition of the most advanced computational capability to realize additional forecasting improvements. Thus, computational facilities must be continuously improved.

4

New Structure of the National Weather Service

A major purpose of the NWS modernization is to improve dramatically the short-term forecasts of significant weather events and warnings of severe weather. The new observation and information systems will not merely replace antiquated equipment but, rather, will provide new insights into the evolution of small-scale atmospheric systems, as well as provide longer lead times and precision in forecasting small-scale, short-duration weather events. Details about the weather that have been lost between stations on the conventional weather map will now be as visible as the large-scale weather systems observed since the days of Benjamin Franklin. Moreover a 12- to 24-hour forecast of convective weather somewhere in a region, can be updated with observations and forecasts of precise locations, intensities, and life cycles of specific weather phenomena with lead times of 30 minutes to six hours. To achieve this aim, meteorologists and hydrologists must be able to observe their service domains continuously and must have a workload commensurate with the area covered, the short response time necessary for effective warning, and the effective range of available observations (e.g., Next Generation Weather Radar). These human factors must be paramount in evaluating field service structures proposed for the modernized NWS.

WEATHER FORECAST OFFICES

The Committee has examined the various configurations of the Weather Forecast Office (WFO) network that have been considered and endorses the network of 115 WFOs proposed in the strategic plan (DOC, 1989). The area of forecasting and warning responsibility for each WFO within a 115-station network appears to be a reasonable compromise. This network configuration will be validated by the Modernization and Associated Restructuring Demonstration (MARD) to be conducted for one year in the midwestern United

States around 1993, a schedule that is in jeopardy because of continued delays in implementation of the Advanced Weather Interactive Processing System as discussed in Chapter 3. However, the Committee is very concerned about a report that the Department of Commerce has decided to modify the MARD to test the efficacy of a "two-tiered" network having about one-half as many WFOs as now planned while maintaining the current proposed network of 115 Next Generation Weather Radar (NEXRAD) units.

Attempting to double the area covered by each WFO without a proportional increase in staff on shift could seriously jeopardize the ability of each WFO to deal effectively with small-scale weather events in the issuance of forecasts and warnings over such a large area. The Committee believes that a significant reduction in the total number of shift meteorologists will not be feasible until there are major advances in the quality and accuracy of small-scale numerical prediction models. Moreover, coordination of warnings with state and local government would also be degraded by doubling the area of responsibility for each WFO.[1] Furthermore, the 115-station WFO network configuration coincides with the expected effective coverage of the new NEXRADs, which has a radius of around 200 km from each unit. Thus, each WFO can be located at or very near its associated NEXRAD system to take maximum advantage of high-resolution Doppler radar data for severe storm forecasts and warnings without the cost and complexity of relaying and remotely processing all of the data produced by each NEXRAD. The planned NEXRAD network (Figure 1) will provide nearly total coverage of the coterminous United States, except for some gaps in the western United States where mountains block the radar signal. (Additional units will be installed in Alaska, Hawaii, and Puerto Rico.)

In the two-tiered network alternative (about 50 WFOs and 115 NEXRADs) proposed by the Department of Commerce for testing in the MARD, the Committee understands that those NEXRAD locations that are not also WFOs would perform radar observation functions and issue warnings. If the staff at the NEXRAD-only offices does not include meteorologists on each shift to utilize fully the new technology being introduced in modernization, there is a danger that these offices will not be able to produce warnings and local forecasts of the requisite quality. The certification process (see Chapter 6) requires that the quality of the forecasts and warnings for all areas of the United States, regardless of distance from a weather office, be at least as high as today even though the number of offices will be cut in half. To achieve this level of performance, the quality of the output of each office after the restructuring must be substantially increased to compensate for the reduc-

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[1] See also discussion and recommendation in the section on public institutions in Chapter 5.

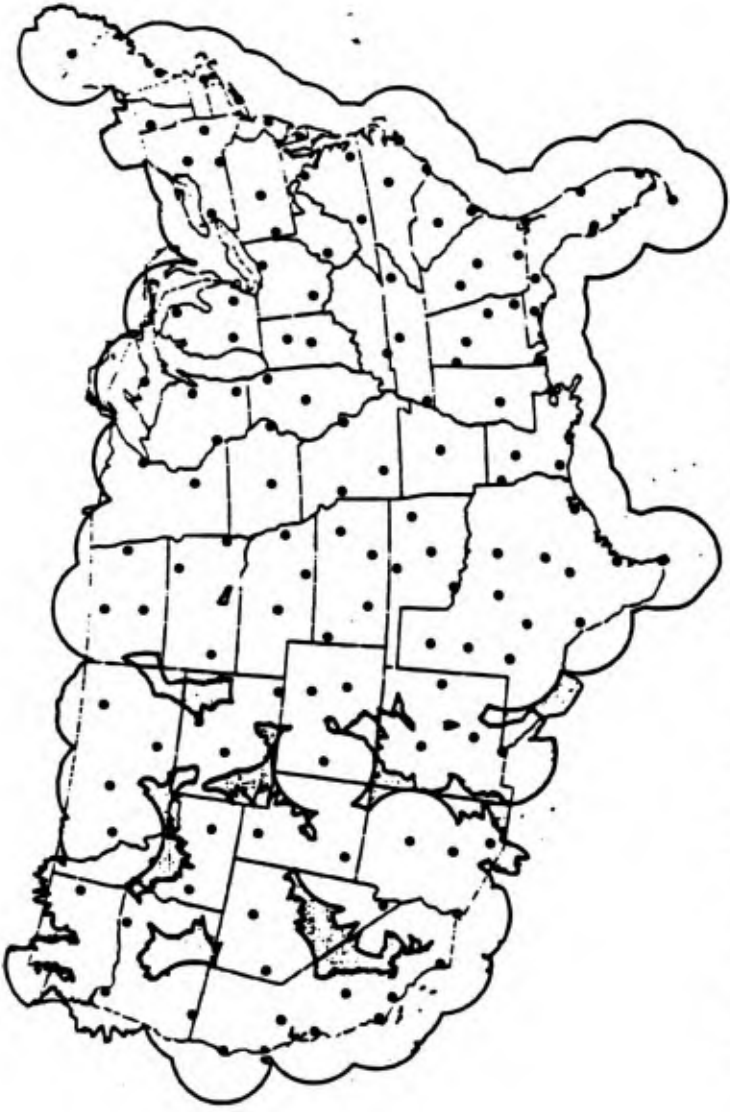

FIGURE 1 Locations and total coverage (at 3,000 m elevation) of the national NEXRAD network. Shaded areas represent gaps, mostly in mountainous areas, in NEXRAD coverage. (Reprinted with permission of the National Weather Service.)

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tion in the number of offices. Limited staffing places this requirement in jeopardy.

Conduct of the proposed test of the two-tier concept clearly would delay the MARD and add major complexities to an already difficult demonstration. For example, proper design of the demonstration would require isolating the personnel operating one kind of network being tested from those operating the other network so that the output of one would not influence the output of the other. Also, erroneous conclusions may be drawn from extrapolation of the MARD results to other geographic regions and time periods. Moreover, a two-tier test would surely increase significantly the difficulties involved in using the MARD results in the certification process required by Congress. Finally, the need to transmit the full-resolution data from two or three remote NEXRADs to a WFO and to merge these data in "real time" for use by meteorologists, although technically feasible, would add significantly to the complexity, cost, and the time required to implement both the MARD and, subsequently, the entire modernization.

Recommendation: *The Department of Commerce should carefully reconsider its decision to have the National Oceanic and Atmospheric Administration/National Weather Service conduct a two-tiered Modernization and Associated Restructuring Demonstration because a configuration of significantly fewer than 115 Weather Forecast Offices will lead to serious degradation of weather services. Moreover, such an experiment would be much more complex and expensive, and would probably lead to a serious delay in the National Weather Service modernization.*

HYDROLOGY IN THE NATIONAL WEATHER SERVICE MODERNIZATION

The nation's need for improved management of water resources and more accurate flood forecasting will increase during the 1990s. Growth in population in the arid western United States and increasing sensitivity in all parts of the country to precipitation anomalies will result in demands on the NWS for more detailed and more timely hydrological forecasts.

Modernization of the NWS presents two opportunities for improving hydrological services: (1) The detailed quantitative precipitation measurements and forecasts that will become available through new observational technology and forecasting capabilities will significantly improve both flash flood prediction and regional runoff estimates that will also impact forecasts for larger basins. (2) The development of new forecast techniques and more

powerful communications systems will promote better cooperation between the meteorologists producing forecasts and hydrologists than now exists, a deficiency highlighted by the executive summary of *Hydrometeorological Service Operations for the 1990's* (NWS Office of Hydrology, 1989).

Each of the 13 River Forecast Centers (RFCs) will be collocated with a WFO after the NWS modernization is completed. Thus the Committee anticipates that proper integration of the new developments in hydrological science and practice (NRC, 1991) and the capabilities being created by the modernization of NWS operations could provide greatly improved hydrological services on all time scales.

Interaction of Weather Forecast Offices and River Forecast Centers

Forecasting the effects of extensive and persistent rainfall associated with large-scale weather systems requires strong collaboration between Weather Forecast Office (WFO) meteorologists and RFC hydrologists. Currently, RFC hydrologists use the temperature and Quantitative Precipitation Forecasts produced by meteorologists in the Weather Service Forecast Offices to prepare hydrological forecasts. The improved numerical weather prediction guidance expected in the 1990s should result in better utilization of Quantitative Precipitation Forecasts and temperature forecasts by hydrologists, thereby improving the quality of hydrological forecast services.

> **Recommendation:** *Incorporation of improved Quantitative Precipitation Forecasts and associated uncertainties into the hydrologic models for short-range and long-term stream-flow forecasts is essential and requires collaborative scientific investigation by the National Weather Service and the academic community.*

Cross-training of both meteorologists and hydrologists will help to ensure optimum collaboration between RFC and WFO personnel during the preparation of hydrological forecasts. The present lack of training in hydrology for meteorologists and the equivalent lack of meteorological training for hydrologists have impeded collaboration. The planned assignment of cross-trained Hydrometeorological Analysis and Support personnel to RFCs and of hydrometeorologists to many WFOs should promote this much needed interaction.

> **Recommendation:** *Training programs in meteorological practices for Hydrometeorological Analysis and Support hydrologists and in*

hydrology for meteorologists should be established to promote maximum interaction between Weather Forecast Office and River Forecast Center operational personnel.

Under the existing infrastructure of academic meteorology and hydrology programs, the development of a hydrometeorology track seems difficult. Perhaps the NWS can request that a group of universities investigate this issue further and recommend ways to implement the academic training of hydrometeorologists.

The interaction in the 1990s of WFO meteorologists and RFC personnel during rapidly developing situations, such as flash flood events, is less clear. Meteorologists are responsible for issuing flash flood warnings; this is usually done without hydrological input. Yet the hydrologist has important knowledge of river basins and the effect that given rainfall intensities have on basin runoff. Modernization of the NWS should facilitate interactions between RFC and WFO personnel during these rapidly developing situations. The result will be improved weather and hydrological flash flood forecasts.

Recommendation: *Hydrometeorological Analysis and Support functions at River Forecast Centers and the interaction of Hydrometeorological Analysis and Support personnel with Weather Forecast Office meteorologists require clarification and better definition, especially as they relate to flash flood situations.*

New techniques are emerging that can improve flood forecasting in small basins. However, NWS professionals must have the knowledge and tools to take advantage of this capability. For example, in addition to developing expert systems to select proper algorithms for converting Next Generation Weather Radar information to rainfall amounts, the opportunity now exists to use first principles and actually calculate the rainfall intensity based on divergence measurements. Such calculations, using radar and other data, can validate the use of a particular algorithm.

Current efforts to develop a hydrological computer work station are commendable and should be continued. This work station will be helpful to the WFO meteorologists as well as hydrologists. The software being developed by hydrologists will permit more efficient integration of hydrological observations (e.g., river and stream gauge data) and the meteorological data needed to produce better and more timely flash flood forecasts. However, development of the hydrological work station does not now seem to take into account the planned relationship of Hydrometeorological Analysis and Support person-

nel and WFO meteorologists. Meteorologists as well as hydrologists should be involved in this development work.

Recommendation: *Consultation with meteorologists should be included in the current and future development of software to be used at hydrological computer work stations. This software should be installed in all of the Advanced Weather Interactive Processing System work stations at the River Forecast Centers and Weather Forecast Offices so that it is accessible to all of the meteorologists, hydrometeorologists, and hydrologists.*

The improvements in both small-scale weather forecasts and hydrological basin models expected in the 1990s should result in improved anticipation of when and where flash floods will occur. This, in turn, should result in more time being available for interaction between shift meteorologist and hydrologist and longer warning lead times for the public.

Problem Areas

The anticipated needs for hydrological services in the 1990s mandate a major increase in hydrological observations. At present there are about 3000 stream gauge sites in the United States. According to members of the NWS Office of Hydrology, this is an order of magnitude lower than necessary. Meteorologists and hydrologists can only speculate what is occurring in areas devoid of gauges. The NWS modernization may mitigate inadequacies in gauge data to some extent by use of Next Generation Weather Radar (NEXRAD) and satellite observations. Current plans call for River Forecast Center (RFC) personnel to combine radar observations from multiple NEXRADs, using Advanced Weather Interactive Processing System facilities, to infer precipitation rates and accumulations. However, there is concern that the same general algorithms for estimating rainfall may not be applicable at all NEXRAD locations. These plans also raise the question of whether RFC staffing patterns will accommodate this increase in workload.

Recommendation: *The validity of using the same general Next Generation Weather Radar algorithms for determination of rainfall estimates in all seasons, in all weather conditions, and at all Next Generation Weather Radar locations should be tested.*

Because of the large number of Weather Forecast Offices (WFOs) in each RFC area of responsibility, coordination will be required to ensure consistency in the forecasts of precipitation and temperature that the RFC uses. Careful plans must be developed to ensure that improved numerical weather prediction guidance, observations, and interaction of WFO meteorologists and RFC personnel will address this problem as reorganization of the NWS proceeds.

The anticipated workloads of Hydrometeorological Analysis and Support personnel at the RFCs may be more than they can accommodate. The interaction and shared responsibilities with WFO meteorologists require clearer definition. Cross-training and full mutual appreciation of the functions and responsibilities of Hydrometeorological Analysis and Support and WFO meteorological personnel are needed to ensure optimum collaboration. Adequate training of meteorologists in hydrology and RFC personnel in meteorology is thus a major prerequisite to improved hydrological-related watches, warnings, and services in the 1990s.

Recommendation: *In light of the National Weather Service modernization and restructuring, the workloads, responsibilities, interactions, and cross-training of meteorological, hydrometeorological, and hydrological personnel planned for Weather Forecast Offices and River Forecast Centers should be examined carefully and redefined.*

5

New And Stronger Collaboration

Collaboration of the NWS with the academic community, the private sector, and public institutions is essential if the NWS is going to accomplish its mission successfully. Universities supply trained personnel for the NWS and develop much of the new scientific and technological foundation for improving forecasts and warnings. The private sector, through television, radio, and newspapers, is the primary means for the NWS to disseminate its warnings and forecasts. The private sector also provides much of the new technology used by the NWS and a wide variety of additional specialized meteorological and hydrological services that are outside the mission of the NWS. In the public sector, state and local government agencies are the critical link for the community action necessary when the NWS issues warnings of severe storms or floods and forecasts of snow storms or other hazardous weather phenomena.

Strong and effective collaboration between the NWS and these three communities is necessary for the NWS to accomplish its mission, "to provide weather and flood warnings [and] public forecasts...primarily for the protection of life and property" (DOC, 1989, page 2), as well as to improve its services. Thus planning and fostering these collaborations must be an important part of the NWS modernization. The importance that NWS places on this collaboration is reflected in one of its goals for the modernization (DOC, 1990, page 7): "Strengthening cooperation with the mass media, universities, the research community, and the private hydrometeorological sector to collectively fulfill the nation's weather information needs from provision of severe weather warnings and general forecasts for the public as a whole, which is a Government responsibility; to provision of detailed and customer specific weather information, which is a private sector responsibility."

UNIVERSITIES

The success of the NWS in accomplishing its mission depends on the effective integration of the skills and knowledge of its meteorologists, on employing advancing technology for observing the atmosphere, on continued improvement in its systems for transmitting information and creating numerical simulations and forecasts of atmospheric behavior, and on effective utilization of new and basic scientific understanding of the atmosphere.

Clearly then, the effectiveness of the NWS is dependent on education, on technological development, and on scientific advances. For example, the cloud imaging and atmospheric sounding sensor used on the present Geostationary Operational Environmental Satellite was conceived by a professor at the University of Wisconsin. Thus the Committee believes that the federal government must take a new view of the relationship among NOAA, the NWS, and the atmospheric sciences community, especially in the universities.

It is evident that universities are the sources of the professional employees of the NWS and of much of the research on which current operations are based. Yet the NWS does not have strong ties with the academic community. Most significantly, the vast majority of research and development funded by NOAA and the NWS is performed by in-house organizations and laboratories. In this arrangement, students and university researchers are not stimulated by the most pressing or most interesting NWS scientific issues and opportunities. The NOAA and the NWS are remote from the academic community and are not adequately perceived as presenting scientifically exciting opportunities for young meteorologists. Neither organization receives the stimulation and advice that would flow if it were in more intimate contact with university researchers.

The Committee believes, therefore, that an important new component of the modernization of the NWS should be a strong commitment by NWS and NOAA to strengthen their research partnership with the academic community. Some components of NOAA have very effective cooperative institutes on university campuses, staffed by NOAA and academic personnel; however, the NWS has none. Even though the NWS is a mission agency, its success depends on scientific advances and it should participate more broadly in development of the national scientific base in atmospheric and hydrologic sciences. Increased collaborative research is necessary to realize the full benefits of the modernization, for example, by developing the scientific basis for improved numerical prediction models of small-scale atmospheric phenomena. Plans for the proposed national Stormscale Operational and Research Meteorology (STORM) program are directed toward improving the understanding and prediction of these phenomena. Recent recommendations

regarding this program are contained in the report *Advancing the Understanding and Forecasting of Mesoscale Weather in the United States* (NRC, 1990a).

The relocation of Weather Forecast Offices (WFOs) provides another important opportunity for enhanced collaboration. The Committee agrees with the NWS intent to collocate, to the extent possible, WFOs with universities offering undergraduate and graduate education in meteorology. Such collocation, preferably in intimate proximity to atmospheric science departments, would enable students and faculty to be aware of NWS issues and opportunities, and would provide both motivation and opportunity for NWS meteorologists to continue their studies and to seek advanced degrees. Study of the new data made available by the modernization undoubtedly will result in scientific advances which, in turn, will lead to better forecasts and warnings. Unfortunately, NWS efforts to implement this ideal situation are being impeded by lack of a high-level federal policy on collocation and by ponderous procurement procedures that delay and mitigate against the necessary commitments.

Recommendation: *The Administration and Congress should adopt a policy that fosters the collocation of as many Weather Forecast Offices as possible on university campuses with atmospheric science departments.*

The Committee believes that more intimate and effective collaboration between the NWS and the universities in education and research would greatly benefit both parties and the nation. It would help to maintain the momentum of the present modernization initiative and lead to a greater involvement of the academic community in the success of the NWS.

Recommendation: *The National Oceanic and Atmospheric Administration and the National Weather Service should implement enhanced collaboration with universities in the atmospheric and hydrologic sciences, in both education and research.*

PRIVATE SECTOR

Mass Media

The only federally operated facility that broadcasts forecasts and warnings directly to the public is the NOAA Weather Radio network. Thus, the

primary sources of weather information for the general public, including forecasts and warnings, are the mass media: television, radio, and newspapers. Clearly, maintaining effective collaboration with the mass media is crucial. The *National Implementation Plan for the Modernization and Associated Restructuring of the National Weather Service* (DOC, 1990, page 1) states: "The NWS will continue to rely on the mass media as its major method of dissemination of weather and flood warnings and forecasts to the public."

Any inadvertent actions that were to impair the linkages between the NWS and the media would have serious impacts on the safety and well-being of the populace and on the commercial sector as well.

Private Weather Services

Private weather services provide a major interface between the NWS and the general public or other elements of the private sector. There are a few hundred such services in the United States, most of which are very small and provide specialized services, usually in a local area. The several large organizations that exist generally provide a larger variety of services nationally or even worldwide (e.g., weather or ocean forecasts in support of optimum ship routing, weather forecasts for aviation, or crop-weather information in support of agricultural operations).

The value-added services that the private meteorological community should continue to provide include

- generating data and information (forecasts and analyses) based on output from the NWS, usually collated and reformatted for clarity and convenience of use, and redistributing the resulting products to a variety of users ranging from large media organizations to individual subscribers;
- compiling and reorganizing NWS data into tailored regional or local information products for the media;
- utilizing NWS data to make specialized, highly detailed, or locally oriented forecasts for operational use by such entities as municipalities, utilities, industrial plants, agribusiness, marine and air transportation, and general aviation;
- generating and maintaining a database of observations and analyses acquired in real time from the NWS, often correcting errors in content and format, to provide the data to consumers in a more utilitarian mode than may be available directly from NOAA; and
- advising individuals or organizations, either to clarify weather information received from any source or to provide more depth, detail, or alternative

opinions regarding the information itself or its implications for a particular customer's activities.

The NWS modernization plan appropriately recognizes the contributions and responsibilities of the private sector. It mandates that meteorological data and information products be available to the private sector. The general information content now available on the "Family of Services," the principal real-time data and information transmission link today from the NWS to the private sector, will be incorporated into the NOAAPORT broadcast; however, a much larger volume of data will be involved. A detailed and definitive description of how the NWS communication system will function and evolve until the completion of modernization should be developed in collaboration with representatives of the user community.

> **Recommendation:** *The National Weather Service should develop detailed plans for evolution of the communication of data and products to the private sector (including the academic community) during modernization; such planning should be undertaken in collaboration with the user communities.*

Outlook

The Omnibus Budget Reconciliation Act passed in October 1990, authorizes NOAA to sell its data, information, and products at fair market prices, rather than for only the added cost of provision as in the past. The Act calls for the collection of fees NOAA-wide not exceeding $2 million in each of fiscal years 1991 to 1993 and $3 million in 1994 and 1995. Certain products can be excluded from added fees, such as warnings and watches, exchanges under international agreements, and those for noncommercial use of government and nonprofit institutions. The NOAA is conducting a market analysis for a wide variety of its outputs that appear to have commercial value, to provide a basis for setting their cost. The proposed fee structure will be published in the *Federal Register*; 30 days will be allowed for comments prior to implementation.

The Committee is concerned that a significant increase in fees could put vital NWS weather information beyond the financial reach of the majority of private weather organizations, potentially resulting in a significant loss of quality, service, and economic utility to the ultimate user and the public at large. This may vitiate the policy that the private sector should be the primary means for disseminating official forecasts to the public and for providing all specialized weather services (many formerly provided by the government).

Recommendation: *The Department of Commerce, in implementing the law to increase payments of user fees, should consult with the affected user community to minimize the impact such increases will have on the vital weather services of this nation.*

The NWS Constituent Affairs Officer in the NOAA Office of Legislative Affairs has been serving as the primary point of contact for consultation and coordination with the private sector on matters of mutual interest or concern, such as the issue of user fees discussed above. In recent years, this function has been handled commendably by the Constituent Affairs Officer. However, with the growing complexity of the NWS systems and the increasing amount of legislation impinging on collaboration with the private sector, a strengthening of the office appears necessary.

Recommendation: *To ensure that the association between the National Weather Service and the private sector functions smoothly and efficiently to the best advantage of all parties, including the general public, the constituent affairs activities of the National Weather Service should be strengthened; the Constituent Affairs Officer should act as an ombudsman for the private sector to the Assistant Administrator of the National Oceanic and Atmospheric Administration for Weather Services, coordinate program changes with the private sector, obtain its inputs to National Weather Service planning and evaluation, and arbitrate or resolve conflicts as they arise.*

The National Implementation Plan (DOC, 1990, page 43) states that "the Transition Program Office has drafted a national plan to design, execute, monitor and evaluate a systematic NWS program to provide for communications exchange and technical coordination with both the internal and external communities either affected by, or interested in, modernization activities." The Committee assumes that the plan embraces all sectors of the external community and looks forward to examining the adequacy of the plan during the coming months.

PUBLIC INSTITUTIONS

Community preparedness is essential to save lives and minimize property damage during severe weather situations. The critical role of the NWS is to participate actively in preparedness planning and then communicate both to state and local governments, and to the public, the seriousness of specific

weather situations. A leadership role is necessary, and the Committee believes that a limited, part-time approach to this key function is entirely inadequate. Many of the expected improvements in the forecasting of storms and severe weather will go to waste if there is inadequate planning for response to the improved watches and warnings.

The flash floods on June 14, 1990, in the vicinity of Shadyside, Ohio caused 26 fatalities and extensive property damage. Anticipating the flood event, the Weather Service Forecast Office in Cleveland issued a Flood Watch about two hours prior to the flood (NOAA, 1991a). Although the Flood Watch was promptly broadcast by local television and radio stations and the Flood Watch message was successfully received by the Belmont County Sheriff's office, it was not relayed from that office to the Shadyside police or the county emergency management coordinator. This example points out the need for close and frequent coordination between the NWS and public institutions. This will become even more important with the advent of new technology in the NWS modernization whereby a major improvement will occur in the continuous monitoring of weather phenomena that pose a threat to life and property. Effective warning and preparedness require adequate planning, coordination, and education at the national, regional, and local levels.

Recommendation: *To ensure adequate community preparedness, professional staff time equivalent to a full-time person should be provided at each Weather Forecast Office to work with state and local governments and other involved agencies in preparing plans for the community's response to severe weather. To maintain liaison with public institutions and to assist in community preparedness, the federal government should consider retaining, with limited staff, most Weather Service Offices now planned for closure.*

6

Implementation Process

MANAGEMENT AND SYSTEM ENGINEERING APPROACH

The Committee has reviewed the NWS plans, management strategies, and system engineering approach for implementing its modernization, including the three systems essential for improved weather services and planned restructuring in the field: Next Generation Weather Radar (NEXRAD), Automated Surface Observing System (ASOS), and Advanced Weather Interactive Processing System (AWIPS).

Management

The NWS has done a commendable job in planning its modernization. A new matrix organization is in place and top management staffing is complete. Under the NOAA Assistant Administrator for Weather Services (the head of NWS), deputies have been appointed for operations and for modernization. The Deputy Assistant Administrator for Modernization oversees the NEXRAD Joint System Program Office, Office of Systems Development (which includes the ASOS and AWIPS projects), Office of Systems Operation, Office of Hydrology, and the Transition Program Office. All of the other NWS headquarters and field offices are also involved in the modernization effort to varying degrees. Using a matrix approach to management, the Deputy Assistant Administrator for Modernization also oversees and coordinates the modernization roles and activities of these other NWS offices as well. The Transition Program Office supports the coordination function. Support functions, such as contracting, personnel management, external relations, and facilities construction, are provided by NOAA headquarters and the Department of Commerce.

The NWS has developed a number of innovative procedures intended to facilitate effective implementation of the modernization concept. Techniques

such as risk reduction through prototyping and strong user involvement help ensure that the products of modernization will be useful and will accurately embody the original requirements. A new system was created recently to ensure adequate internal communications, reporting, and coordination; all offices of the NWS are now aware of the plans and status of the modernization. However, NOAA and the Department of Commerce appear to have a shortage of staff to provide administrative support, such as procurement and personnel, and to handle the external contacts with Congress, user groups, and the public that are essential to implementation of the modernization and associated restructuring. Moreover, the Committee is concerned that the project management, engineering, and support staff may not be as strong as required for an effort of this magnitude.

System Engineering and Integration

It appears to the Committee that the NWS lacks an overall policy for configuration control of large systems and for the development and maintenance of complex software. Even though government policy wisely expects contractors to provide their own well-understood and tested standards and methods, it is in the government's interest to monitor carefully and to manage development and maintenance contracts. An overall NWS guiding policy is needed to set forth minimum requirements to be met by contractors in the process of developing and maintaining software and in reporting progress through specific process-sensitive metrics. Such a policy would mitigate against problems in multicontractor development and maintenance, and would protect the government against undue cost and hardship should a contractor be unable to complete a contractual commitment or should a subsequent change in contractors occur.

System engineering in the NWS environment is vital because of the phased development and because the NWS systems must remain operational during upgrading and modernization. It appears that some elements of the systems now being procured may be abandoned during subsequent phases of modernization. For example, the functions of the Principal User Processor, a part of the Next Generation Weather Radar system, eventually will be performed by the Advanced Weather Interactive Processing System. Although this change may be appropriate and necessary, it might have been avoided if an overall system design or configuration control process had been in place several years ago. Communications and interfacing standards or planned evolution toward such standards is currently lacking.

In a related issue, the NWS may be reticent to apply resources to the development of formal standards and methods because of the lack of adequate funding. Whereas this may reduce near-term costs, it probably will increase

life-cycle costs by making long-term maintenance and enhancement more difficult. Despite these near-term funding pressures, preserving the viability of the NWS systems suggests that a stronger commitment to formal methods is in the national interest.

Recommendation: *The National Weather Service should establish overall policies and procedures for the development of major systems, including consideration of the interaction between systems, and establish software development and maintenance standards.*

Hardware Status

The NWS plans for its contractors to install as well as construct hardware. Both Next Generation Weather Radar (NEXRAD) site preparation and Weather Forecast Office (WFO) building construction are being handled by a special Department of Commerce activity and appear to be under control. The Advanced Weather Interactive Processing System (AWIPS) and Automated Surface Observing System (ASOS) contractors are also expected to handle site preparation for their systems. Overall, the Committee is impressed with the progress that has been made in developing hardware and preparing for field installation. Delays in procurement and funding for the AWIPS are the most serious concerns involving hardware.

The NEXRAD, a joint program with the USAF and the FAA, is well along, with initial production units already being installed, although some troublesome delays have occurred in software and hardware delivery. Cooperation among agencies seems excellent. There is no question that the system will constitute a major step forward in severe weather warning.

The ASOS is now in the production phase. Because at least 1000 ASOS units are to be built, installing the system will be a major effort involving the NWS, the FAA, and airport authorities. Indeed, at full production, one or two ASOS units will be installed every day for four years.

The AWIPS and its associated communications, essential for the integration and operation of the modernization systems, are not as far along in development because of external delays in the approval of contracting steps and continuing funding constraints. This situation poses a major problem in the Modernization and Associated Restructuring Demonstration (MARD) and certification process that must precede restructuring of the NWS. Present plans call for a two-step implementation of AWIPS, an initial configuration followed by a software upgrade after certification. Even with this approach, there is very little time to commission the initial operational configuration of AWIPS before performance confirmation, MARD, and certification. It is

essential that AWIPS move forward expeditiously in fiscal years 1991 and 1992 if the NWS schedule for restructuring is to be met.[1]

The systems discussed above must be integrated, which in itself is a major project. The NWS management is aware of this and has several support service contractors assisting in both planning and in the integration of NEXRAD, AWIPS, and ASOS.

System Security

In the broadest sense, system security embraces all elements that can influence overall system resiliency. These include such diverse factors as satellite continuity, availability of backup power, and access security of communications, computer, and software systems. The Committee's study to date has not reviewed the security issues involved in modernization. It is already apparent, however, that the NWS has concentrated on physical security and has not paid sufficient attention to the security of electronic access. Meeting the needs of public and private users of NWS data requires "connectivity." This must be balanced by the provision of adequate security to ensure the continuity, integrity, and accuracy of the data and information being distributed.

> **Recommendation:** *The National Weather Service should satisfy itself that the security of its data systems will be adequate to preclude a breakdown of critical services in the event of improper intervention, either intentional or inadvertent, in its data and communications systems.*

The Committee plans to examine in greater detail those aspects of modernization related to system security and resiliency.

HUMAN AND FINANCIAL RESOURCES

Temporary Management and Project Staff

Over the past several years the NWS has assumed an increasingly large workload associated with modernization and restructuring. Additional management workload has been undertaken both at NWS headquarters and in

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[1] See also Chapter 3, page 33.

NWS regions with essentially no increase in total staff. Several people have been shifted entirely to planning and implementing the modernization, whereas others have modernization duties in addition to their former workloads. The NOAA and the Department of Commerce also provide administrative support and assist with constituent and congressional affairs.

Management of some operations has been curtailed or eliminated to prepare for the modernization and restructuring. The following are two examples:

- The branch at NWS headquarters concerned with the management of warning and coordination was eliminated and the work distributed to other offices; the individuals thus made available are now working on the modernization. However, the ability of NWS headquarters to manage properly an important ongoing warning operation and to formulate plans for carrying out this function under modernization has been impaired. For example, there now is no leadership in planning the way in which the warning and coordination functions will be conducted by the 115 Weather Forecast Offices whose responsibilities will cross state boundaries versus today's 50 offices that operate within state boundaries.

- Management workload at NWS headquarters and in the field is increasing as maintenance problems increase with the aging of current equipment and facilities. At the same time, the installation and maintenance of new systems must be planned and managed.

Other areas are understaffed, particularly at NWS headquarters, as indicated by the following examples:

- The Committee, as of January 1991, had not received from the NWS a draft of its detailed plans for the certification process, even though NWS management had placed a high priority on early review of the plan by the Committee. This is indicative of the work overload in the Transition Program Office.

- As mentioned in the previous section, the size of the project management, engineering, and support staff appears to be insufficient. This is of particular concern with regard to the length of time required to initiate procurements, the provision of appropriate oversight of contractors, and the ability to respond properly to the inevitable difficulties that arise during development and implementation of complex hardware and software systems.

- There is rapid growth at NWS headquarters and in the field in the need to communicate with the external world—government officials at all levels, user groups, and the general public. This external community is very concerned about the restructuring associated with modernization; lack of adequate communication could jeopardize the plan to restructure the NWS. The

constituent affairs staff assisting the NWS headquarters should be increased[1] and a Constituent Affairs Officer added to each of the four regional offices in the contiguous 48 states.

- Development by NWS headquarters of plans for transition of service activities (e.g., agriculture, aviation, fire weather, and marine programs) to the era of the modernized NWS is behind schedule.

> **Recommendation:** *A Constituent Affairs Officer should be assigned to each of the four National Weather Service Regional Offices in the contiguous 48 states until the completion of modernization and restructuring.*
>
> **Recommendation:** *The management and project staffs at National Weather Service headquarters, National Oceanic and Atmospheric Administration, and Department of Commerce administrative support should be increased temporarily during the implementation of modernization by at least 20 to 40 well-qualified people.*

At the regional level, staffing is marginal to cover ongoing operations and the new work associated with modernization. The latter, for example, includes the logistics of acquiring property for new offices, placement and surveys for the installation of new equipment, analyzing the meteorological aspects of the workload, and planning staffing and training. The intensity of this activity is increasing rapidly to the point that serious problems may arise unless the staff is increased.

> **Recommendation:** *The staff at each National Weather Service regional office should be increased temporarily during the implementation of modernization by one to four people as required.*

Operational Staff

The Committee's review has identified a number of areas in which staffing could be insufficient. Some of these are discussed elsewhere in this report:

- Workloads at the River Forecast Centers (Chapter 4, page 42).

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[1] See also discussion of Constituent Affairs Officer in Chapter 5, page 48.

- Weather Forecast Office (WFO) staffing to handle community preparedness activities (Chapter 5, page 48).

In addition, the Committee is concerned about the plan to have only one meteorologist on duty during the night shift at each WFO. The weather is no less life-threatening and damaging at night than during the day and evening. It is doubtful that a single meteorologist can adequately monitor and forecast changes and issue timely warnings under bad weather conditions.

The Committee understands that the concept of one meteorologist covering the night shift is based on the premises that

- a single meteorologist can properly review, modify, and keep up to date a four-dimensional database in the Advanced Weather Interactive Processing System (AWIPS) which covers at least 48 hours and from which all operational forecasts will be produced automatically and disseminated with no manual activity involved; and

- the meteorologist's main role during bad weather situations will be to concentrate on only the first 12 hours of the forecast period using the AWIPS database, and relying on computer-generated forecasts beyond 12 hours.

A major problem with this concept is that it is based on the untested and questionable idea of producing all operational weather forecasts by computer, a deferred capability of the AWIPS system. The concept of machine-produced operational public weather forecasts based on a meteorologist modifying or accepting computer-generated Model Output Statistics is to be tested at Norman, Oklahoma in the near future. However, this will involve the shift meteorologist merely accepting or changing numerical values in the Model Output Statistics guidance.

The NWS needs to determine whether restrictions inherent in the new concept will prevent shift meteorologists from incorporating their expertise and evaluation of the synoptic situation and its expected evolution into the final forecast. For example, the ability to add manually significant detail to automated analyses, by using additional data not employed in the automated analyses, appears to be eliminated. Antecedent weather conditions, current radar and satellite data, and locally acquired observations can be important in producing correct analyses. The Committee questions whether all of this can be done by one meteorologist who merely changes the geometry of some lines in guidance graphics or the numbers in a Model Output Statistics matrix.

It is certainly advisable to have a minimum number of people working at night, especially when the weather is expected to be benign. The problem of minimum night staffing arises when bad weather is expected or develops unexpectedly. Perhaps flexibility can be incorporated into the one-person staffing when significant weather and associated forecast problems are antici-

pated during a night shift. For example, the Science and Operations Officer or the Warning Coordination meteorologist, who normally works in the daytime at Weather Forecast Offices, could be responsible for assisting the night shift meteorologist. Such persons may be needed to provide special interpretation and advice to emergency management centers regarding specific local warning and community response problems.

Recommendation: *As a part of the Modernization and Associated Restructuring Demonstration, the National Weather Service must thoroughly test the concept of forecasts being automatically produced at night by using a final four-dimensional database.*

Recommendation: *The proposal to produce operational forecasts by computer that are equal to or better than current manually produced forecasts and warnings should be demonstrated for a variety of weather conditions and locations. The new procedures should be operational and their efficacy established before the meteorological staff at a Weather Forecast Office is reduced to the proposed one person on the night shift.*

Recommendation: *An alternate operational plan for staffing the night shift should be formulated for use until the proposed concept has been fully developed and proven.*

Financial Resources

The Committee recognizes that many of the suggestions made in this report have a potential impact on the budget for the NWS modernization and associated restructuring. For example, the Committee is aware that the limiting factor in the employment of additional personnel is money, not authorized positions. However, in most cases, the additional personnel required temporarily to assist in modernization activities could save money in the long term by reducing future development, implementation, and maintenance problems and their attendant costs. Although the solution proposed for the problem of limited meteorological staff on the night shift at the Weather Forecast Offices may reduce the overall savings visualized from restructuring the NWS until the effectiveness of automation can be demonstrated satisfactorily, the Committee believes that this would be compensated by savings to the public and governments from reduced loss of life and destruction of property.

The Committee recommendation with the largest cost impact is undoubtedly that concerning the phasing of funds for NOAA satellites to ensure their continuity (see discussion of environmental satellites in Chapter 2). This requires early funding rather than an increase in total cost over the life of the

program. Satellite data have become such an important part of the nation's weather forecasting and warning services that the continuity of observations must be ensured to avoid a major degradation or interruption of these services. Rectifying the current low incremental funding of the Advanced Weather Interactive Processing System program (discussed on pages 33, and 52) would also require an increase in near-term budgets, but would probably reduce the overall cost of implementation.

The network of observation stations required in natural and undeveloped areas to preserve the viability and integrity of the climate record (see Chapter 2), will also lead to additional costs; these might properly be borne by the U.S. Global Change Research Program.

CERTIFICATION REQUIREMENTS AND APPROACH

Congressional concern about the impact of the changes in existing weather stations, as proposed in the restructuring of the NWS associated with modernization, resulted in the certification requirements in Title IV of Public Law 100-685 (U.S. Congress, 1988). The relevant parts are

- Section 408 which requires the Secretary of Commerce "not to close, consolidate, automate, or relocate any...office" unless the Secretary certifies to the Congress "that such action will not result in any degradation of weather services provided to the affected area." It further states, "Such certification shall include—

  "(1) a detailed comparison of the services provided to the affected area and the services to be provided after such action;

  "(2) any recent or expected modernization of National Weather Service operations which will enhance services in the affected area; and

  "(3) evidence, based upon operational demonstration of modernized National Weather Service operations, which supports the conclusion that no degradation in services will result from such action."

- Section 407 (b) states that "...the National Implementation Plan shall include... (2) special measures to test, evaluate, and demonstrate key elements of the Modernized National Weather Service operations prior to national implementation, including a multistation operational demonstration which tests the performance of all components of the modernization in an integrated manner for a sustained period;..".

The latter is the Modernization and Associated Restructuring Demonstration (MARD) that is being planned for a period of one year in the Midwest. The NWS considers MARD to be the cornerstone upon which the certification process will be based.

Clearly, the need to certify expected performance before each step in the modernization and associated restructuring is implemented places a major burden and responsibility on the NWS, the NOAA, and the Secretary of Commerce. Because of the large temporal (daily, seasonal, and annual) and geographical variations in the weather, it will be difficult to establish certification procedures to demonstrate conclusively "that no degradation in services will result from [any] action." Clearly, the certification procedure must assess objectively the quality and timeliness of the forecasts and warnings.

Although the Committee has not received the proposed detailed certification plans for review, its following initial views are offered for consideration. First, specific comparisons of the quantity and quality of weather information, forecasts, and warnings, and their prompt dissemination must be obtained, both during the MARD and during the process of certifying the capabilities of any Weather Forecast Office (WFO) to serve its area of responsibility. The comparison process must be designed to be an end-to-end verification of the capabilities of the NWS and the WFO to acquire information; convert it into useful analyses, forecasts, special weather statements, and warnings; and transmit these products in a timely manner to users in the public and private sectors. The Committee believes that carefully constructed and unbiased comparisons will demonstrate a noteworthy improvement in the quality and accuracy of service. Second, to increase the credibility of the certification process in the eyes of user groups and Congress, it may be appropriate, at some stage, to involve an independent evaluation of the statistical and analytical measures developed during the initial operations of the WFOs as applied to each specific certification.

The Committee intends to give careful and thorough attention to the proposed NWS certification plans as soon as they are received.

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[1] National Research Council

Acronyms

ASOS	Automated Surface Observing System
AWIPS	Advanced Weather Interactive Processing System
DAR^{3}E	Denver AWIPS Risk Reduction and Requirements Evaluation
DOC	Department of Commerce
DOD	Department of Defense
FAA	Federal Aviation Administration
GOES-Next	Next Generation Geostationary Operational Environmental Satellite
IOT&E-2	Initial Operational Test and Evaluation, Phase II
MARD	Modernization and Associated Restructuring Demonstration
NASA	National Aeronautics and Space Administration
NESDIS	National Environmental Satellite, Data, and Information Service
NEXRAD	Next Generation Weather Radar
NMC	National Meteorological Center
NOAA	National Oceanic and Atmospheric Administration
NRC	National Research Council
NWS	National Weather Service
OSF	Operational Support Facility
RFC	River Forecast Center
STORM	Stormscale Operational and Research Meteorology (program)
USAF	United States Air Force
WFO	Weather Forecast Office
WSFO	Weather Service Forecast Office
WSO	Weather Service Office

Appendix A

Letter from the National Oceanic and Atmospheric Administration to Dr. Frank Press requesting establishment of a National Research Council committee to review the National Weather Service modernization and associated restructuring

UNITED STATES DEPARTMENT OF COMMERCE
The Assistant Secretary
National Oceanic and Atmospheric Administration
Washington, D C 20230

JUL 7 1988

Dr. Frank Press
Prasidant, National Academy
of Sciancas
2101 Conetitution Avenue
Washington, D.C. 20418

Deer Dr. Prasa:

I am writing to requeet tha support of tha National Research Council (NRC) as the National Oceanic and Atmospharic Administration (NOAA) movas toward implamentation of plans to modarniza and restructura the National Weather Sarvica. Tha formulation of thasa plans was both encouraged and assistad by tha saminal study of NRC'a Select Committee on tha National Weathar Sarvice, whosa raport, Technological and Scientific Opportunities for Improved Weather and Hydrological Service in tha Coming Decada, wee published in 1980. Subsequantly, the NRC formad a study panal that reviawed plans of Fadarel agancies to upgrada tha Nation'a weathar obaerving and procaasing eyatams. Its raport, sant to tha Adminietretor of NOAA by tha Panal Chairman, John W. Townsend, Jr., in Auguet 1987, also was helpful in assaasing priorities and coordinating Fadarel efforts.

After saverel yeere of internal planning within the Exacutiva Branch, tha Departmant of Commerca recantly issued a Strategic Plan for the Modernization and Associated Restructuring of the National Weather Service. Tha Stretegic Plan raprasants a first etap in the planning procass prescribed by Public Law 100-685, which was aigned by the Preeident in Novamber 1988. Thie law eetabliehes guidelinee for planning, reporting, and certifying tha modernizetion and restructuring.

To support our efforts, I propoea tha astabliehment of an NRC reviav committaa on tha modarnization and associated restructuring of tha National Waather Sarvice. As I envision it, the committee would have two broad araas of responsibility: (1) to halp ansura tha most cost-affective levale of syetams and sarvicas by assaseing the availability, applicability, and timing of appropriata undarlying tachnological and scientific capabilitiea and (2) to halp ansura the succassful demonatretion and accaptanca of modernized and restructured Weather Sarvice operations by reviewing tast, demonstration, and cartification plans and by independently raviewing tha data collection and intarpretetion processes.

Soma specific areas for analysis and study include:

1. projectione of the extent and timing of emerging scientific foundations of improved services and the

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techniques and technologies needed to apply them operationally;

2. trade-offs of functional capabilities of the Advanced Weather Interactive Processing System for the 1990's in terms of feasibility, risk, service impact, and cost;

3. review and assessment of performance, operational readiness, and value of radar wind profilers;

4. assessment of the availability and timing of automated, remote sensing, thermodynamic profilers;

5. review of the validity and effectiveness of methodologies for demonstrating that services are improved and not degraded when the new technological and organizational configurations are introduced; and

6. review the validity of the collection, analysis, and interpretation of data for demonstration and certification of service operations.

These areas involve a very broad range of scientific and engineering issues, so I am writing both to you and Dr. White with this request. Individuals selected for the review committee should possess skills and experience in disciplines represented in both communities.

I welcome your additional thoughts and suggestions on this proposal. I have asked Dr. Elbert W. Friday, Jr., Assistant Administrator for Weather Services, to assist me in working with appropriate persons representing the Academies in developing an action plan. I am anxious to establish an arrangement as soon as possible because significant decisions and actions are beginning to occur ever more frequently. The proposed review mechanism would serve a useful purpose throughout the national deployment of new technology and phaseover to the new structure, a time period extending into the mid-1990's.

I look forward to developing another productive collaboration with the Academies that serves the best interests not only of the Government but of the Nation. Thank you for your cooperation.

Sincerely,

D. Kent Burton

Appendix B

Members of the Committee on Meteorological Analysis, Prediction, and Research

Board on Atmospheric Sciences and Climate

COMMITTEE ON METEOROLOGICAL ANALYSIS, PREDICTION, AND RESEARCH

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**WARREN H. WHITE, Washington University

Staff

John S. Perry, Staff Director, Board on Atmospheric Sciences and Climate
Kenneth H. Bergman, Staff Officer until 8/90
Richard Kelley, Staff Officer beginning 11/90

* Term expired 6/30/90.
** Term began 7/1/90.

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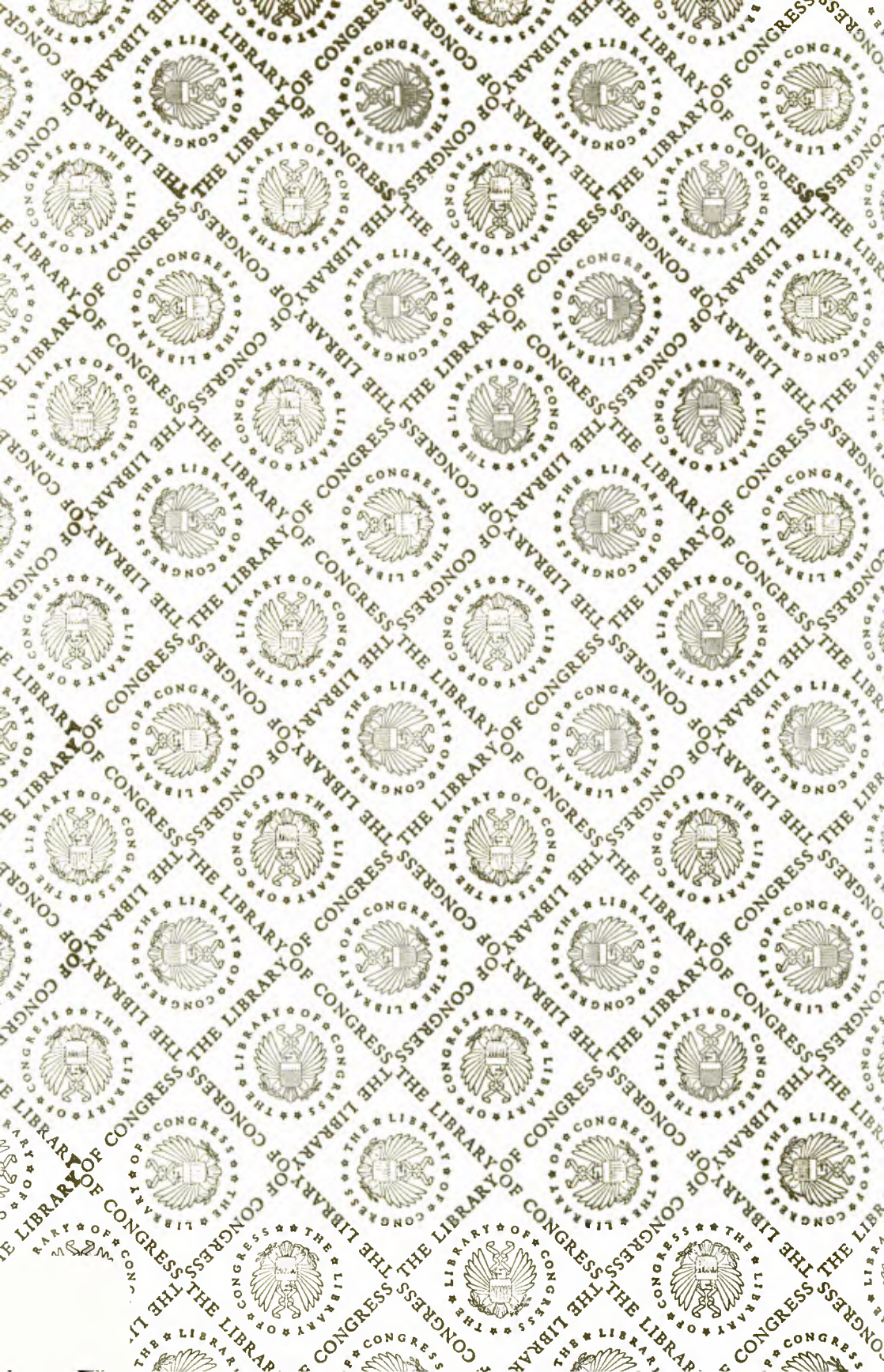
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