Integrated Training and Professional Development Plan for the Modernization and Associated Restructuring of the National Weather Service

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U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Weather Service
Office of Meteorology

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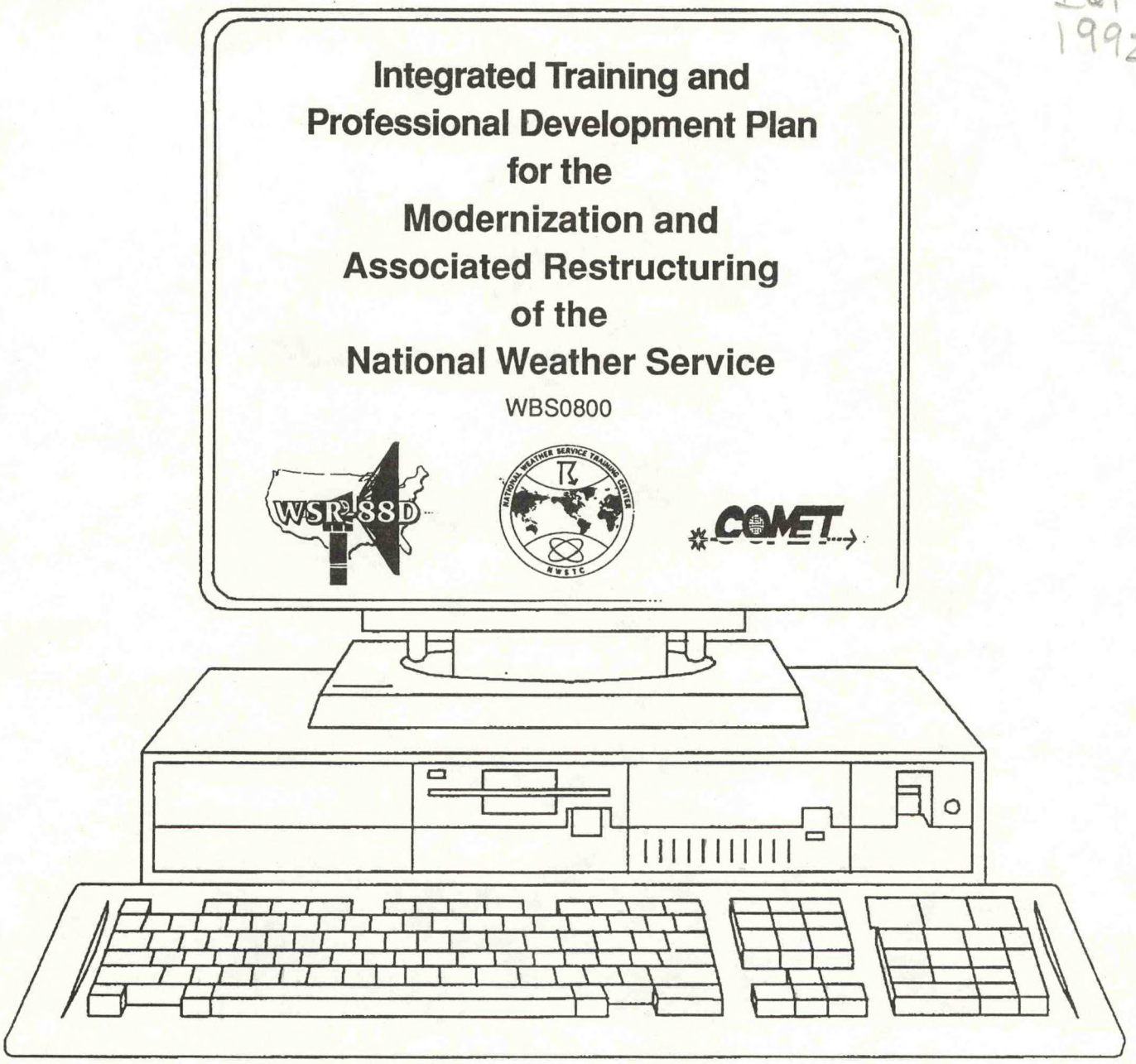

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U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Weather Service

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GLOSSARY

In keeping with the easy reference philosophy of this plan, we have incorporated a GLOSSARY to simplify the usage of acronyms.

AFOS	Automation of Field Operations and Services
ASOS	Automated Surface Observing System
ATMU	Air Transportable Mobile Unit (Fire Weather Program)
AVSM	Aviation Service Meteorologist
AWIPS	Advanced Weather Interactive Processing System
AWS	Air Weather Service (U.S. Air Force)
AWSC	Agricultural Weather Service Center
BIFC	Boise Interagency Fire Center
CBL	Computer-Based Learning (Distance Learning)
CBT	Computer-Based Training
COMAP	COMET Operational Mesoscale Analysis and Prediction Course
COMET	Cooperative Program for Operational Meteorology, Education and Training
CPM	Cooperative Program Manager
CRS	Console Replacement System (NOAA Weather Radio)
CWSU	Center Weather Service Unit
CFWSU	Central Flow Weather Support Unit
DAPM	Data Acquisition Program Manager
DAR^{3}E	Denver AWIPS-90 Requirements Risk Reduction Evaluation
DLM	Distant Learning Module
DoD	Department of Defense
DOH	Development and Operations Hydrologist
ERL	Environmental Research Laboratories
ESA	Electronic Systems Analyst
ET	Electronics Technician
FAA	Federal Aviation Administration
FDP	Forecaster Development Program
FEP	Front-End Processor (AFOS)
FP	Focal Point - an additional duty assigned to office staff member
F/W	Fire Weather
FWFC	Fire Weather Forecaster Course
HAS	Hydrometeorologic Analysis & Support function
HIC	Hydrologist-in-Charge
HMT	Hydrometeorological Technician (formerly Meteorological Technician)
HRL	Hydrologic Research Laboratory
Hydro	Hydrologist (used in Tables)

ILS	Integrated Logistic Support
IT & PDP	Integrated Training & Professional Development Plan
IVD	Interactive Video Disk
MAR	Modernization and Associated Restructuring
MARD	MAR Demonstration
MARDI	MARD Initiation
Met	Meteorologist
Met Tech	Meteorological Technician
MIC	Meteorologist-in-Charge
MLOS	Microwave Line-of-Sight course
NCAR	National Center for Atmospheric Research
NRC	National Reconditioning Center
NSSL	National Severe Storms Laboratory
NWS	National Weather Service
NWSFO	WSR-88D-equipped Weather Service Forecast Office
NWSO	WSR-88D-equipped Weather Service Office
NWSTC	National Weather Service Training Center
OAR	Office of Oceanic and Atmospheric Research
OH	NWS Office of Hydrology
OID	Operator Interface Device (ASOS)
OJT	On-the-job-training
OM	NWS Office of Meteorology
OSF	WSR-88D Operational Support Facility
OSO	Office of Systems Operation (National Weather Service)
PDW	Professional Development Workstations
PMO	Port Meteorology Officer
Profiler	Wind Profiler (Vertical Doppler RADAR)
PROFS	Program for Regional Observing and Forecasting Services
PUP	Principal User Processor (WSR-88D)
PWB	Pilot Weather Briefer
RFC	River Forecast Center
RH	NWS Regional Headquarters
RMS	Regional Maintenance Specialist
RTM	Remote Training Module (similar to CBL)
SF	Senior (WFO) Forecaster
SOO	Science & Operations Officer
SPO	System Program Office (WSR-88D)
SSD	Scientific Services Division (NWS Region Office)
Svc Hydro	Service Hydrologist
SWIS	Satellite Weather Information System

T & PD	Training and Professional Development
TBD	To be determined
TRAC	Training Advisory Committee (SPO)
Tri-Agency	NWS, DoD, and FAA cooperation on WSR-88D (SPO)
UAP	University Assignment Program
UCAR	University Corporation for Atmospheric Research
UCP	Unit Control Position (WSR-88D)
UNISYS	The contractor producing WSR-88D
USAFA	U.S. Air Force Academy
WCM	Warning Coordination Meteorologist
WFO	Weather Forecast Office
WSEO	Weather Service Evaluations Officer
WSFO	Weather Service Forecast Office
WSO	Weather Service Office
WSOM	Weather Service Operations Manual
WSR-88D	Weather Surveillance Radar [model # 88-Doppler]

Executive Summary

National Weather Service (NWS)
Integrated Training and Professional Development Plan (IT & PDP)
for the Modernization and Associated Restructuring (MAR)

During the next few years an array of new technologies will provide NWS field forecasters with an unparalleled set of observational and forecast data. The introduction of the Advanced Weather Interactive Processing System (AWIPS) will revolutionize the way forecasters assimilate these data into their daily forecast and warning routines. New mesoscale forecasting techniques will emerge as the data are combined and utilized operationally. The goal of the MAR is to enable forecasters to prepare enhanced warnings for smaller areas and to improve the overall skill in short-term forecasting. In order for this to occur, however, it is vital that forecasters thoroughly understand the new technologies and the recent scientific advances in mesoscale forecasting techniques made possible by combining the technologies.

The NWS strategy for the MAR is that all operational personnel have (1) a clear understanding of the new technological systems, (2) a better understanding of the relationship between hydrology and meteorology and, (3) an understanding of the latest theories and techniques in mesoscale meteorology and hydrology. As part of this strategy, a high priority will be placed on stressing concepts that apply to operational forecasting versus theoretical techniques.

Two distinct activities comprise the NWS strategy of preparing its personnel for the MAR: (1) technological systems training and (2) professional development (continuing education). In general, systems training tends to be a one-time effort following the installation of each new technology, while professional development (PD) continues throughout an employee's entire career.

In order to fully utilize the new technologies in the MAR, the NWS must commit to a dramatic and highly visible increase in both centralized and on-site training. For the most complex technologies that will have the greatest impact on the MAR, such as the Next Generation Weather Radar (WSR-88D), centralized training courses for all operational personnel are planned, followed by on-the-job training. For example, The WSR-88D Operational Support Facility (OSF) in Norman, OK is providing a 4-week Operations Course that will be attended by over 2000 meteorologists and hydrologists over the next five years. For other highly complex technologies, such as AWIPS system training, centralized courses are planned for those office experts who will lead structured, on-site training for other office personnel. For those technologies requiring less complex user interactions, such as the Automated Surface Observing System (ASOS), training will be primarily on-site with few, if any, centralized classes.

The systems contractors (for WSR-88D, ASOS, AWIPS, etc.) will have a major role in the development and instruction of the centralized training courses for their systems, especially for the first few classes. The National Weather Service Training Center will continue to offer centralized systems and operations courses for NWS electronics technicians and hydrometeorological technicians, as well as basic training courses for new hires. However, the major training emphasis for these technicians will continue to be on-site with materials provided by the contractors and the NWS.

Ideally, PD would be achieved by periodically sending employees to centralized courses in order to update their skills and knowledge. Unfortunately, logistical and budgetary constraints render this approach infeasible. Therefore, PD will be primarily based upon on-site activities. The two primary elements required for a successful on-site PD program are (1) an effective "expert" in the office to coordinate the program, and (2) providing interesting, informative and relevant new learning materials.

Centralized courses for PD will be conducted by the University Corporation for Atmospheric Research's Cooperative Program for Operational Meteorology, Education and Training (COMET) in Boulder, CO. For example, COMET will conduct an 8-week COMET Operational Mesoscale Analysis and Prediction (COMAP) course for attendance primarily by the Science and Operations Officer (SOO). (The Development and Operations Hydrologist (DOH) will attend the first week of the course.) The SOO and the DOH will function as the resident "experts" for PD in each Weather Forecast Office (WFO) and River Forecast Center (RFC), respectively.

The goal of the COMET "distance learning" program is to prepare a comprehensive curriculum through the preparation of highly interactive Computer-Based Learning (CBL) materials. Professional Development Workstations (PDWs) will be installed in each station and dedicated for CBL use. Subject matter experts throughout the National Oceanic and Atmospheric Administration (NOAA), Department of Defense (DoD), university community, Federal Aviation Administration (FAA), the OSF, and others will collaborate in producing high quality state-of-the-art CBLs.

The IT & PDP addresses all of the training and PD requirements that had been established at the time of its preparation. The Offices of Meteorology and Hydrology, in conjunction with the Director's Task Group on Training, will be responsible for planning adequate resources for and coordinating these training and PD activities. As the NWS progresses through the MAR, there will undoubtedly be some unanticipated changes in service requirements and systems delivery schedules that will impact this plan. The IT & PDP should, therefore, be considered a "living document" and will be updated accordingly. The overall strategy of this plan is sufficiently flexible to accommodate those updates.

Integrated Training and Professional Development Plan for the National Weather Service

1. INTRODUCTION

The National Weather Service (NWS) is engaged in the Modernization and Associated Restructuring (MAR) of the agency[1]. The satisfactory accomplishment of this goal requires a major transition from current operations to future operations while maintaining the current level of services. The bulk of this transition will occur at NWS field offices, where new positions, functions, and staff profiles will be established. In addition, new and more sophisticated technologies will be introduced. As a result, new knowledge, skills and abilities will need to be developed by most of the work force. This will require a tremendous training and education effort involving all NWS employees.

The requirements are largely driven by the introduction of an unprecedented amount of new technological hardware and applications software in a short time. Examples of new hardware include new Automated Surface Observing System (ASOS) technology, improved Weather Surveillance Radar systems that include Doppler capabilities (WSR-88D) and an Advanced Weather Interactive Processing System (AWIPS) that will replace the outdated communications and display consoles currently in place at NWS offices. It is vital that all users be trained in the operation of this hardware and the effective use of associated applications software to improve warnings and forecasts. Electronics technicians (ETs) also must be trained on how to maintain complex integrated systems.

1.1 Purpose

The purpose of this Integrated Training and Professional Development Plan (IT & PDP) is to combine current plans with those plans now being developed. It is necessary to integrate these plans into one document because of the close commonality between the knowledge or skills required with respect to any particular technology and those required for all others.

1.2 Scope

The IT & PDP is the result of an accumulation of individually prepared plans based on requirements dictated by particular systems, programs and services. These plans have not been

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[1]See Strategic Plan for the Modernization and Associated Restructuring of the National Weather Service.

finalized because many of the decisions driving its requirements have not been finalized.

In the main body of this overall plan, we incorporate key aspects of individual plans that have been completed and components of other plans that should not change significantly. The Appendices expand upon the material contained in the main body of the plan.

We use the terms *training* and *professional development* throughout this document. *Training* is used to designate a skill and ability improvement of a job-oriented operation or procedure. *Professional development* (continuing education at the college level) is used to signify conceptual understanding of abstract relationships, scientific theories, and their applications to operational personnel. Both are required by the NWS and are frequently difficult to separate. We abbreviate "training and professional development" as "T & PD" throughout this document, while "professional development" is denoted as "PD". Also, note that the term "meteorologist" ("hydrologist") refers to individuals performing meteorological (hydrological) forecasting duties.

The IT & PDP contains sections that duplicate information in other sections in order to provide easy reference by topic. This was deemed desirable, although somewhat clumsy, because of the complicated interrelation of T & PD activities.

Section 2, Operations T & PD, presents the activities that are necessary to maximize the utilization of new technologies and scientific advances. The operations training activities for the major new technology systems are listed in Section 3. Section 4 contains T & PD plans associated with the Modernization and Associated Restructuring Demonstration (MARD), and features an overview of how the separate efforts, described in earlier sections, fit together. Section 5 contains the Integrated Maintenance Training Plan.

Appendices are used to provide additional detail and the latest information available. It is intended that the Appendices will be updated as programs are updated.

2. OPERATIONS T & PD

As a result of technological advances, a number of new forecasting capabilities and techniques have been developed, especially in the areas of mesoscale meteorology and hydrometeorology. These techniques will require forecasters to acquire new knowledge of the meteorological and hydrological relationships made possible by new data collection, manipulation, and presentation capabilities. In addition, the large quantity of information made available by the new systems will require increased emphasis on data integration and interpretation.

2.0.1 Background

Following World War II, the U.S. Weather Bureau generally hired meteorologists and hydrologists who had obtained their scientific education (professional development) in colleges and universities. Many of these institutions were closely allied with operational meteorology, and many also taught the theory and practice of hydrology. Over the years, new advances in the science of meteorology have resulted in a redirection of academic emphasis towards understanding the basic physics of atmospheric interactions. This, in turn, has forced the NWS to direct T & PD toward more specific applications of basic meteorological knowledge.

NWS contributions in the field of operational hydrology and flood forecasting have gained recognition throughout the world. NWS hydrologists developed a training course to teach procedures for flood forecasting to foreign nationals in order to transfer this technology to their countries. This course was also designed to teach NWS hydrologic forecasters the state-of-the-art skills in flood forecasting.

In the past, the majority of meteorological technicians (met techs) were trained while serving in the military. These met techs generally had many operational skills and required only orientation and some on-the-job-training (OJT) after joining the Weather Bureau/NWS. In contrast, the number of recruiting sources for today's met techs has substantially diminished and those who remain will need to be retrained in order that they be equipped for the challenges of the modernized era.

Up until now, the influx of new staff members and new technologies was gradual and could be absorbed into the NWS with the available training resources. In addition to OJT, T & PD consisted of a limited number of residence courses at the National Weather Service Training Center (NWSTC) and some university courses on a special need basis. Workshops, seminars and other materials were developed to fulfill special needs as they arose. The NWS initiated the Forecaster Development Program (FDP) for newly hired college graduates (met interns), which consisted of a residence orientation course at the NWSTC and extended OJT. To a

large extent, it was necessary to accomplish T & PD on-site due to staffing limitations and requirements to maintain round-the-clock services.

2.0.2 Outlook

The NWS is faced with providing T and/or PD to the entire field workforce. Some of the T & PD concepts currently used in the NWS are effective and should be continued and expanded. For example, on-site workshops and seminars presented by subject matter experts from within the NWS and the academic community will continue to be utilized.

In order to achieve the required level of T & PD, the NWS will utilize not only its own capabilities, but also those of all of NOAA, the academic community and private contractors. This effort will require many resources, as well as a well-coordinated management effort.

There are several key components of the NWS strategy to expand the knowledge and skills of its work force during MAR:

- development of a new position for scientific leadership and assistance in accomplishing T & PD at each WFO and RFC;
- more effective on-site T & PD; and
- closer interaction with the academic and research community.

These components are described below.

2.1 Science and Operations Officer (SOO) Development and Operations Hydrologist (DOH)

A critical ingredient to the success of the NWS operations T & PD program is the creation of a SOO position at each WSR-88D equipped office, (eventually to become a Weather Forecast Office (WFO)) and a DOH position at each River Forecast Center (RFC).

The concept of the function of SOOs and DOHs as research scientists has historical precedent in the Weather Bureau. In particular, there existed a Research Meteorologist position at each District Meteorological Office. The Research Meteorologist positions were eliminated during a staffing realignment; however, many of the functions were transferred to the Scientific Services Division (SSD) at each NWS regional office[2]. The concept of the DOH serving as the leader for technological implementation at the RFC has evolved slowly as the utilization of nationally supported

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[2] See A Management Strategy for the Field Science Program of the Modernized NWS, currently under development, for an expanded discussion of the SOO function.

hydrologic systems has increased and the importance of local procedure development activities at RFCs has been recognized.

2.1.1 SOO and DOH Function

As the senior scientific advisor and technical leader in the WFO, the SOO will be the local manager for all on-site T & PD, local research and techniques development. The DOH will serve a somewhat similar function at the RFC, with increased emphasis on the integrated implementation and operational support for the high levels of on-site data assimilation and hydrologic forecast technologies employed at those centers.

SOOs and DOHs will assess the continuing training and educational needs brought about by new technology, and scientific advances and staff changes within the office. In conjunction with SSDs, research organizations, universities, national planning groups and their colleagues at other sites, SOOs and DOHs will develop methods to exchange, share, and transfer science and technology.

SOOs and DOHs will be provided expanded PD through courses offered by the Cooperative Program for Operational Meteorology, Education and Training (COMET). This additional knowledge will enable SOOs and DOHs to provide on-site T & PD for the office staff. They will oversee the effectiveness of such PD programs as workshops, seminars and individual study. DOHs will also receive training on how to conduct PD through activities at the Hydrologic Research Laboratory (HRL), which is a component of the Office of Hydrology (OH).

SOOs and DOHs will provide an extra impetus to PD programs, such as workshops, seminars and individual study. COMET will provide expanded PD to SOOs and DOHs to enable them to administer materials developed for self-paced learning by all forecasters. This additional knowledge will enable SOOs and DOHs to coordinate on-site T & PD and to serve as the main resource for office staff.

2.1.2 National SOO and DOH Coordinators

A National SOO Coordinator, located at Boulder, CO., has been designated to coordinate T & PD activities with COMET, NWS Headquarters, SSDs and SOOs. The DOH coordination function remains within the HRL. A formal tie between the National SOO Coordinator and HRL has not been established, but the SSDs will act to ensure completeness and compatibility among functions performed by SOOs and DOHs.

2.2 On-site T & PD

A second critical component in the NWS strategy is more effective on-site T & PD. Considering the requirements for continuous operation, minimum staffing and the cost of centralized courses, on-site T & PD is the best solution to many of the NWS' requirements. In addition, on-site T & PD is the preferred approach when requirements dictate that a large number of employees must receive small amounts of training during a short period of time. The NWS is currently involved in developing an expanded on-site T & PD program that will emphasize self-paced learning under the direction and tutelage of the SOO or DOH, and the use of materials developed by a variety of sources. The SSD will serve as the primary screening mechanism for all on-site training materials and will communicate among themselves to ensure consistency and avoid duplication.

In order to accomplish on-site T & PD goals, a SOO (DOH) will be hired at each WFO (RFC) to provide feedback to management on T & PD requirements and opportunities. The MIC or Hydrologist-in-Charge (HIC) will coordinate with the SOO or DOH to schedule T & PD time for each employee. Also, a variety of resources will be used, such as seminars or self-study materials developed by subject matter specialists at COMET and other locations.

To assist in the self-learning process, the NWS will rely more heavily on computer-based learning (CBL) modules at each office. Each NWS office will be provided a continuing supply of T & PD materials, such as CBL modules prepared by COMET, NWSTC and others on specialized subjects using experts in that particular field. A microcomputer-based system capable of displaying high-resolution graphics, designed for use in various T & PD activities, will also be provided.

Finally, the Operations Training Branch of the WSR-88D Operational Support Facility (OSF) in Norman, Oklahoma will provide modules (videotapes and workbooks) designed to prepare students for the WSR-88D Operations Training Course. See Appendix A for more details regarding on-site T & PD.

As in the past, the SSDs will be an important source of technology transfer through training, techniques development and information distribution. Working with the SOOs, they will continue as an integral part of the T & PD program with such functions as training coordination, development of materials and scientific program oversight. See Appendix F for more details in this area.

2.3 Residence T & PD

A number of facilities will be used for the residence portion of the NWS T & PD program. These facilities will be located at such sites as universities, the NWSTC and other government agencies.

2.3.1 COMET

In the past, the training efforts of the NWS have been primarily job-oriented with limited opportunity to keep up with new understanding of atmospheric processes. To correct this deficiency, the NWS has enlisted the research and academic community in the largest cooperative education effort ever to assist with increasing the scientific capabilities of the NWS staff.

COMET, a multi-agency, multi-university effort, will enhance the PD and continuing education of the NWS work force. NWS involvement with COMET will be multifaceted. COMET will develop graduate-level residence courses (using university, National Center for Atmospheric Research - NCAR, Office of Oceanic and Atmospheric Research - OAR, etc. resources), CBL modules, and connections at universities and research facilities to increase the scientific knowledge of NWS meteorologists and hydrologists, especially on the storm scale (mesoscale).

Initially, COMET will develop and present; 1) an 8-week COMAP (COMET Mesoscale Analysis and Prediction) Course for all SOOs (with attendance by the DOHs for the first week), 2) a three-week Hydrometeorology course, and 3) a number of CBL modules, which will become the centerpiece of the on-site PD program. See Appendix B for the detailed COMET plan.

2.3.2 OSF

The OSF in Norman, Oklahoma was created to serve the WSR-88D training needs of the NWS, Federal Aviation Administration (FAA) and Department of Defense (DoD). The OSF will offer series of nearly continuous 4-week WSR-88D Operations Training courses that will train about 2000 students by the mid 1990's. The course will be taught by NWS instructors trained at the OSF, and will consist of lectures as well as hands-on case study material. Completion of this course is vitally important to the overall modernization effort, as current NWS policy is that no WSR-88D may be commissioned at any given WFO until all staff with WSR-88D responsibility successfully completes the Operations Course.

2.3.3 NWSTC

Job-centered residence training for NWS employees has been provided at the NWSTC since 1955. The original purpose of the NWSTC was to teach ETs how to repair meteorological equipment. Later, other training programs were created to meet specific

needs for meteorological technicians (met techs), meteorologists and hydrologists. Additionally, the NWSTC now develops and provides introductory management and supervisory training courses for NWS supervisors and office managers. As the MAR proceeds, the concept of the NWSTC will not shift greatly. Many of the current courses will change in content as the NWS introduces new technology and forecaster staffing profiles.

In the restructured NWS, there will be a greater requirement for expanding the knowledge of both meteorologists and hydrologists in the other science. This will require the development of continuing education material for current meteorologists and hydrologists. The NWSTC will be expected to increase its ability to develop materials (mostly in written and/or videotape format) for remote training in those subject areas where COMET or the OSF will not be able to adequately (or cost effectively) produce such material. See Appendix C for details.

2.3.4 Other Centers

T & PD in certain special service programs (e.g., for focal points and selected others) will continue to be presented at locations that have unique facilities and/or subject matter experts (e.g., the FAA Academy and the HRL). See Appendix D for details on special service program T & PD plans.

2.3.5 University Assignment Program (UAP)

In order to enhance the professionalism of the work force, plans are for the NWS to fund five full-time university assignments per year at the post-graduate level. No other major changes to the current UAP are expected. Over the past several years, the program has supported 40 to 50, mostly part-time, university assignments per year. Currently, there are three emphasis areas: HMT (Hydrometeorological Technician - formerly met techs) crossover training, advanced scientific/technical training, management development and ET System Training.

Full-time assignments require participants to dedicate all of their time and attention to class attendance and studies. Part-time assignments, on the other hand, entail work/study ratios (20/20, 24/16, and 32/8) in which the participants dedicate part of the work week to assigned duties, and the remainder to class attendance and studies.

Within the UAP program, the NWS (in cooperation with San Jose State University) has provided a specially developed course for met techs wishing to meet the minimum requirements to qualify for meteorologist positions. The 12-week course, presented during the summers of 1987, 1988 and 1990, features a concentrated syllabus in dynamic and synoptic meteorology. The next course is to be presented during the summer of 1992. This course is expected

to continue as long as the cross-over requirement exists. In addition to the UAP program, a number of individuals have attended work-related college courses through NWS regional support.

2.4 Meteorological Professional Development

The PD of the NWS work force will involve two major goals. The first is to increase the knowledge base of the current work force, while the second is to encourage the development of additional knowledge and skills of new employees. Both efforts will be large due mainly to the rapid introduction of new technologies and the field office restructuring.

The new technologies allow forecasters to observe and measure phenomena that in the past have been largely theoretical. With the emphasis on mesoscale meteorology and hydrometeorology, and the technology to expedite new methods and applications, the knowledge of the entire meteorological and hydrological work force must be supplemented. This enhanced PD is essential in order to utilize and build on the capabilities of the new technologies.

The NWS has envisioned two levels of T & PD within each WFO; core and special program.

2.4.1 Core T & PD

In the past, the only product common to most offices was the severe weather warnings; public and aviation forecasts were common to the Weather Service Forecast Offices (WSFOs). At some offices, certain products were produced by special groups of forecasters possessing specialized backgrounds (e.g., fire weather).

In the WFO of the future, most products and services will be common to all offices. In addition, all warnings, forecasts and products will be the result of fully integrated operations. To realize full integration, every forecaster will be required to produce all forecast products within the office. Therefore, all forecasters will need a common threshold level of knowledge, enhanced by a common set of application training experiences.

The T & PD required to develop the knowledge, skill, and abilities needed for these forecasts and services common to all offices is referred to as core T & PD, which will generally be carried out on-site. Details on the on-site T & PD effort are found in Appendix A.

In addition to the core PD there will be a need for specialized development of a limited number of forecasters in the NWS' hydrometeorology and special service programs (e.g., marine weather), as described below.

2.4.2 Special Service Program T & PD

There are some aspects of operational meteorology, especially in the special service programs, that are not common knowledge among all forecasters. The plan is for such special service functions (e.g., user contacts) within these programs to be performed by only select forecasters (focal points).

The general strategy is for focal points to be provided with T & PD materials, generally in the form of a CBL module. They will then work with the SOO to develop appropriate on-site materials for the remainder of the staff. Eventually, through COMET or other centers, modules will be developed for use by all forecasters. Plans for each of the major meteorological special service programs are presented in Appendix D. Plans for the hydrology/hydrometeorology program are presented in Appendix H.

2.4.3 Forecaster Development Program (FDP)

The Strategic Plan for the MAR NWS envisions a significant increase in meteorological positions during the 1990s. These positions will be filled by hiring meteorologists from outside the NWS, generally at the meteorologist intern entry level. However, some of the positions may be filled by assisting current NWS met techs to become qualified meteorologists (HMT Crossover Program, see Section 2.4.4).

In recent years, newly hired meteorologists (meteorologist interns) have received training through the FDP. This program assumes a substantial background in theoretical meteorology and, therefore, concentrates on applications and techniques. The obvious shortcoming of this program is that it is only for new hires and is not applied to the development of current employees.

The FDP consists of two phases. The "Intern Phase" consists of OJT at a full-service WSO, WSFO, or National Center for training and familiarization. In the "Forecaster Development Phase" employees are assigned to a forecaster position at a WSFO for OJT and further development toward a full performance forecaster position.

The residence portion of the program for meteorologist interns and converted HMTs will continue to be taught at the NWSTC. The number of these courses will increase significantly as restructuring proceeds and increased numbers of meteorologist interns are hired.

Details on the FDP are provided in Weather Service Operations Manual (WSOM) Chapter J-50 (Sequence of Forecaster Development Program Training), which we have included as Attachment C.1.

2.4.4 HMT Crossover Program

Some of the increase in the number of future meteorologists and hydrometeorologists will be due to the addition of former HMTs who have obtained the necessary college credits to qualify as meteorologists or hydrologists. The on-going effort to encourage HMTs to increase their meteorological knowledge and educational background toward the goal of qualifying for the GS-1340 Meteorologist classification (Met Tech Crossover Program) is being intensified as the MAR approaches.

One method for cross-over is for the HMT to obtain college level credit for certain prerequisite courses (e.g., math through calculus). They would attend the San Jose State University Summer Course offered by NWS to obtain the dynamic and synoptic meteorology credits. This course, combined with courses obtained through self-study or the UAP, could provide the academic requirements for a HMT to convert to a meteorologist intern.

2.5 Hydrological and Hydrometeorological T & PD

The requirement for up-to-date hydrologic/hydrometeorologic training will be much greater in the modernized NWS. Future training must account for the knowledge, skills, and abilities of the present as well as the future work force, the advancements in forecasting and modeling systems, and the new technologies that are being implemented. These changes will bring new and more complex duties, and the future work force will require special knowledge and skills to handle these duties. For some duties, new positions will be created. As a result, many new career opportunities will exist for entry and advancement in the modernized NWS hydrology program.

In addition to the major types of hydrologic/hydrometeorologic training identified in this section, the NWS will formally establish a Hydrologic Intern Program. Initially, the intern program will be described in an Operations Manual Letter (OML) filed with WSOM E-80. Eventually, however, a complete revision will be made to WSOM E-80 which incorporates the hydrologic intern program. The intern program will formally establish the process for individuals to progress to journeyman level positions (GS-1315-12 and GS-1355-12) in the NWS hydrology program at both RFCs and WFOs.

Sixteen types of T & PD will be offered to meet the requirements of the hydrology program (see Table 2-1). One of the most fundamental requirements is for hydrologists and hydrometeorologists to obtain an appropriate scientific education. This includes the university education, or its equivalent, that is needed for a basic foundation in hydrology. It also includes cross-disciplinary education in meteorology for those future employees majoring in hydrology-related disciplines as well as hydrology for those

Table 2-1. Summary of types of training that are available for the modernized hydrology program.

1. **University Education**
   College and/or university courses necessary to meet the Hydrometeorologist Qualification Standard (i.e., qualify as Type A or Type B hydrometeorologist) and to advance to higher positions in the NWS hydrology program.
2. **WSR-88D Operations Course**
   Theory of doppler weather radar technology, operational use of WSR-88D products.
3. **ASOS Training**
   Operational use of ASOS data.
4. **AWIPS User Training**
   Operational use of AWIPS.
5. **AWIPS Systems Training**
   Systems, software, and database features of AWIPS.
6. **RFC-unique Systems Training**
   Operational use of Gateway II and RJE microcomputer systems.
7. **Computer Operations and Systems Training**
   NWS-identified courses and manuals on programming languages, operating systems, Job Control Languages (JCL), telecommunications packages, and applications procedure design.
8. **Specialized DOH Training**
   First week of COMAP course (introduction to mesoscale meteorology) and intensive 3-week course at Office of Hydrology covering advanced hydrology and hydrometeorology.
9. **NWS Basic Operational Hydrology Course (NWSTC)**
   Overview of hydrometeorological networks and sensors; introduction to hydrologic modeling principles including river and reservoir routing, snowpack modeling, and model calibration; and overview of administrative reports and forms used for the NWS hydrology program.
10. **COMET Hydrometeorology Course**
    Operational application of advanced hydrometeorological analysis and forecasting techniques including Stage I, II, and III precipitation processing and QPF/temperature forecast assimilation.
11. **Advanced Hydrology/Hydrometeorology Workshops**
    Background and theory of hydrometeorological analysis techniques, hydrologic modeling systems, model calibration, interactive hydrologic forecasting, and operational applications.
12. **Meteorological Training for Hydrologic Forecasters**
    Distance learning modules covering the basic principles of operational meteorology as practiced in the NWS. Intended for individuals with hydrology backgrounds.
13. **Hydrologic Training for Meteorologists**
    Basic techniques used to perform public forecast and warning operations for rivers in a WFO area. Use of areal flash flood guidance products and flash flood forecasting tools. Characteristics of flash flood events and identification of flash flood-prone areas.
14. **Hydrologic Services (Correspondence) Course**
    History and current policies of the NWS hydrologic services program.
15. **Hydrologic/Climatologic Networks Training**
    Distance learning modules providing the basic understanding needed to maintain and operate hydrologic/climatologic networks.
16. **Field Office Managers Course** (NWSTC)

majoring in meteorology. Appropriate university education will provide new employees with the strong hydrometeorological foundation that is necessary for modernized NWS operations. The remaining 15 types of T & PD are necessary to meet the requirements of various positions involved with hydrometeorological operations in the modernized NWS. These deal with unique technological and scientific advancements in hydrology and hydrometeorology, as well as the cross-discipline training that is needed between the current meteorological and hydrological work forces.

Several major types of training, as outlined below, are being implemented to provide the work-force with training required for operational hydrology and hydrometeorology in the modernized NWS.

COMET Hydrometeorology Course

COMET will provide a 3-week course that will focus on the operational application of advanced hydrometeorological analysis and forecasting techniques, including Stage I, II, and III precipitation processing and QPF/temperature forecast assimilation. This course is specifically designed for HAS forecasters; however, the DOH and other RFC hydrologic forecasters will take this course to obtain a solid foundation in hydrometeorological processes. This course will also provide SOOs and Service Hydrologists with the ability to effectively couple the hydrological and meteorological functions at the WFO.

NWS Basic Operational Hydrology Course

A 2-week course at the NWSTC will focus on the basic principles of hydrology as applied in the NWS. An overview of hydrometeorological networks and sensors will be presented to provide a basis for a good understanding of the data that is input to hydrologic models. The course will cover the wide range of hydrologic models that will be used operationally in the modernized hydrology program, including the snow accumulation and ablation models, soil moisture accounting models, and rainfall/runoff models. Unit hydrograph theory will be covered and the various types of operational river routing models will be presented, including an analysis of the advantages and disadvantages of each of them. Modernized NWS Flash Flood Guidance and flash flood forecasting models will be covered. Some time will also be provided to cover procedures for administrative reports and forms that are used in the field program. The course is intended for new RFC forecasters, new Service Hydrologists and Hydrologic Interns. It will be a required course for all Hydrologic Interns. However some current employees will benefit from this course. This course would also be beneficial to meteorologists, especially those crossing over to the hydrometeorologist series, in order to be able to qualify (in part) for HAS forecaster positions.

WFO Operational Hydrometeorological Forecasting Course

The existing Flash Flood Forecasting course at the NWSTC will evolve into a WFO Operational Hydrometeorological Forecasting course. The course will provide the hands-on operational hydrometeorology training required by WFO meteorologists and will cover the hydrometeorologic component for WFO AWIPS. Additional material on operational applications of the WSR-88D precipitation processing system, the Area Wide Hydrologic Predictor System (AWHPS), modernized Flash Flood Guidance, local hydrologic models (e.g., ADVIS), and the Simplified Dam Break Model (SMPDBK) will also be covered. The course is intended for all Service Hydrologists, and SOOs or hydromet focal points at those WFOs not staffed with a full time Service Hydrologist, although other meteorologists will also attend.

Specialized DOH Training

Each RFC DOH will have the opportunity to attend the first week of the COMET COMAP course, where they will receive an introduction to mesoscale meteorology. Also, a 3-week course will be provided at HRL, which will allow them to have the opportunity to work one-on-one with HRL Project Area Leaders in HRL. This training will provide DOHs with: (1) an in-depth understanding of the hydrologic and hydrometeorologic techniques available in the RFC AWIPS, and (2) an in-depth understanding of the support that is available from HRL in the implementation of these techniques in the modernized and restructured NWS.

Advanced Hydrology/Hydrometeorology Workshops

This series of specialized workshops for DOHs and RFC forecasters, presented by experts from OH (and upon occasion, by university professors under the umbrella of COMET), will cover several advanced topics. These workshops will be conducted at regional centers which will usually be RFCs. Typically, the method of presentation will consist of a combination of lectures and hands-on training; however, this may vary, depending on the subject. Individuals from other NWS offices will be invited to attend as appropriate. A large selection of topics for workshops are currently identified. These include: Hydrologic Models and Calibration; NWS River Forecast System (NWSRFS) Operational Forecast System (OFS); Extended Streamflow Prediction (ESP); Reservoir Operations; Model Updating; Dam Break (DAMBRK) Model; Dynamic Wave Operational Model (DWOPER); Historical Data Analysis in Mountainous Areas; Precipitation Processing System; Flash Flood Guidance; and Interactive RFC Operations.

The complete version of the Master Training Plan for Hydrometeorological Service Operations for the 1990s can be found in Appendix H.

2.6 Hydrometeorological Technician Training

The HMT will be a vital member of the restructured WFO staff. While some of the duties will be the same as those performed by current met techs, (e.g., primarily public service functions), many new duties will evolve. New systems, such as the NOAA Weather Radio (NWR) Console Replacement System (CRS) will certainly impact the way HMTs function. Also, HMTs will be responsible for monitoring the quality of data entering and leaving the office. As the duties of the HMT are better defined, appropriate training will also be developed. For example, efforts are now underway as a part of the Norman Risk Reduction to validate the training required to transfer Cooperative Program Manager (CPM) functions to the Data Acquisition Program Manager (DAPM) and the HMT staff.

In addition to the on-site training related to all the new systems, the NWSTC will continue to be an important factor in developing and offering HMT residence courses, which will replace the Weather Service Operations Course. Appendix G contains details on HMT training.

3. NEW TECHNOLOGIES OPERATIONS TRAINING

Training programs for the new technologies that will be introduced to the NWS in the next few years will be multi-faceted. They will necessarily consist of teaching the operators {as well as personnel from the Office of Systems Operations (OSO) at NWS Headquarters} how to operate and maintain the equipment. Due to the complex nature of the technology, data interpretation and applications of the new systems will also need to be taught.

In general, training will be provided in the areas of equipment operation, maintenance and scientific development. A variety of methodologies and sources will be used. For example, most of the training for AWIPS will be provided on-site by the contractor, while WSR-88D operations training will be offered at the OSF.

The following sections will briefly describe the efforts involved with each of the new technology systems. See Appendix E for detailed plans.

3.1 Automated Surface Observing System (ASOS)

The overall plan for ASOS software and hardware maintenance training consists of five main elements. They are:

1) The ASOS User's Guide, which will be prepared by the ASOS Program Office. It is intended to acquaint users of ASOS data, such as HMTs, meteorologists, air traffic controllers and hydrologists with the operating components, characteristics and capabilities of ASOS.

2) Operator training will initially be provided by the ASOS contractor, AAI Corporation (AAI) of Hunt Valley, PA. The training will be conducted for personnel who will communicate with ASOS to either input data (such as edited or augmented observations) or to extract observed data and information on system performance through an Operator Interface Device (OID).

3) On-site training will be provided to explain both the augmentation and backup policies to be followed at each staffed ASOS site. This training will be provided through the use of self-paced workbooks and training papers.

4) ASOS Network Management Training; and

5) ASOS Maintenance Training (see section 5.3, Integrated Maintenance Training).

Details for ASOS T & PD are given in Appendix E.

3.2 Advanced Weather Interactive Processing System (AWIPS)

AWIPS operator training will be provided in four distinct segments. The first three segments will be developed by the AWIPS contractor. The contractor will also be responsible for conducting initial user and system training. The NWS will be responsible for developing and conducting the fourth segment, namely, scientific training.

1) "Initial User Training" for the entire operational office staff (meteorologists, hydrologists, and HMTs) at each AWIPS site will be conducted on-site by the contractor immediately following installation and acceptance of the AWIPS equipment. The course is designed to provide instruction to each user on "day-to-day" operational usage of the system.

2) "Routine User Training" will be automated-interactive and will be achieved via CBL. It will available at each site to allow the NWS to train new users, train on systems upgrades and to provide refresher training at any time. Initial user training is a subset of the routine user training package.

3) For "System Training," the contractor will provide the necessary equipment and manuals, and will present a 3-week course at the NWSTC. The course is designed for the AWIPS Focal Point, SOOs and DOHs, and the ESA from each AWIPS office.

4) "Scientific Training" (i.e., data interpretation, manipulation, presentation, and application) will be developed by the NWS through coordination with the regional SSDs and COMET. This form of training will include the play-back of pre-recorded case studies to allow NWS forecast personnel to either practice or demonstrate various forecast techniques.

See Appendix E for details on AWIPS training.

3.3 WSR-88D

WSR-88D operations training will be accomplished using both the on-site and residence approaches. The residence course will take place at Norman, OK and will be four weeks in duration. Operations training will consist of three phases for forecasters and two phases for HMTs. WSR-88D maintenance training will take place at the NWSTC. For each office, it will be required that all personnel who have WSR-88D operational responsibility be trained before commissioning of the WSR-88D system can take place at that office. Specific exceptions to this policy may be granted only by the Regional Director. Operations training of replacement personnel will be accomplished via class slots that will be allocated for this purpose (called "attrition" slots).

The three phases of the course for forecasters are given below:

1) Initial training will involve the completion of precursor materials and on-site remote modules under the tutelage of the SOO or DOH. These modules will consist of videotapes, workbooks and printed material, and cover topics ranging from "Doppler Radar Theory and Interpretation," to applications such as "Precipitation Estimation Techniques." In addition, the NWSTC has distributed three modules on conventional radar theory, which may serve as useful refresher material. HMTs will complete selected items from the materials available.

2) After satisfactory completion of the precursor material, all forecasters and RFC personnel whose duties require WSR-88D operation, as well as selected personnel from Regional and National Centers, will attend the 4-week WSR-88D Operations Course at Norman. The course will consist of a combination of lectures and laboratories using Principal User Processors (PUPs).

3) After returning to the office, operational personnel will complete a WSR-88D Operations Checklist, administered by the SOO or DOH. The PD Program (COMET and on-site) will encourage the development of additional skills in the integration of WSR-88D data into analysis and forecast preparation. The SOO or DOH will train site personnel as new applications and algorithms are developed.

HMTs will be provided training on the operation of the Unit Control Position (UCP) by the SOO or WSR-88D focal point, using materials developed by OSF.

Staffing plans during transition provide for staff augmentation for each WSR-88D-equipped NWS office. The assignment of new staff members [MIC, SOO, Warning Coordination Meteorologist (WCM), five core meteorologists and a Service Hydrologist at selected locations] to each NWSO will be accomplished in time for the WSR-88D training prior to WSR-88D activation. This restructuring of office staff will provide the opportunity, not ordinarily available due to limited staffing, to send staff to a central training facility.

See Appendix E for the complete WSR-88D Training Plan.

3.4 Profiler Training

Training material developed for the Wind Profiler Assessment Program will be used at offices in or near the 30-site demonstration network in the central U.S. Materials will consist of four videotapes and accompanying workbooks. Selected personnel (focal points) at some WSFOs have been trained for the profiler

assessment program. The same training strategy will be applied to WFOs in the MARD area that will have access to profiler data. See Appendix E for details on profiler training.

3.5 GOES-I Training

GOES-I is the first of the next generation Geostationary Operational Satellites. While GOES-I is new, satellite product interpretation training is an on-going requirement that impacts the entire warning/forecast program. Training will continue to include on-site CBL modules, and workshops and seminars for all forecasters. The GOES-I training plan will be developed when the capabilities of GOES-I are defined. See Appendix D, Section 6 for details on the current plan.

3.6 NOAA Weather Radio (NWR) Console Replacement System (CRS) Training

The NWR CRS contractor will develop and administer an in-depth course for selected NWSTC instructors. The course will stress the operational use and data base management of CRS units. This training should be completed well before deployment of field site CRS units. The NWSTC will then train one NWR focal point per CRS site on the operational use, data base management and on-site acceptance procedures of CRS units.

Immediately following CRS acceptance at each office, the contractor shall provide basic on-site training in the operational use of the CRS for each NWR operator. We expect the focal point to be present for assistance whenever possible. See Appendix E for the detailed plan.

4. MAR COORDINATED TRAINING & PROFESSIONAL DEVELOPMENT

The first tests of the coordinated T & PD concept will be carried out in conjunction with the Norman WFO and Tulsa RFC Risk Reduction efforts. While this T & PD will be administered for only a small number of offices, much of it is a prototype of the larger effort. MARD will be the first demonstration of the large-scale coordinated effort envisioned in the IT & PDP. Since it might be easier to view the concept by example, we will review the MARD T & PD plan, then develop each of the components in subsequent sections. MARD T & PD consists of a number of individual efforts.

4.1 MARD T & PD

The entire operations staff at all WFOs and RFCs in the MARD area are to be given training in the operation of the new technologies. Operations training will concentrate on equipment operation and data retrieval, manipulation and display. In the case of AWIPS, this training will be conducted by the contractor.

The 4-week WSR-88D Operations Course will be part of the MARD T & PD effort. All MARD site meteorologists, hydrologists and hydrometeorologists will attend this course in accordance with a class schedule developed jointly by the Systems Program Office (SPO) and the NWS.

MARD site ETs will attend WSR-88D Maintenance Courses at NWSTC in accordance with a schedule developed jointly by the SPO and the NWS.

SOOs from the MARD offices will attend the intensive 8-week COMAP course at COMET, designed to teach advanced scientific concepts. (DOHs will attend the first week of COMAP.) Other meteorologists will attend appropriate specialized courses to prepare them for special service program focal point duties for various on-site activities.

On-site T & PD under the supervision and tutelage of the SOO, DOH, and regional SSD staff will be made available, as possible, to the entire office staff to supplement the residence PD. The on-site training will consist primarily of OJT, CBL modules and self-directed study with materials from a variety of sources. Workshops and seminars will be offered by special program focal points from other offices and Regional Headquarters.

Based on current staffing plans, MARD T & PD will involve around 200 meteorologists, hydrologists, hydrometeorologists, HMTs and ETs. The number of ETs may vary because of decisions to be made regarding contract maintenance. Other decisions that impact on the plan include: timely staff selection to permit training, knowledge and skills of newly selected staff members, deliveries

of WSR-88D & AWIPS systems, contractor or NWS training, and the availability of on-site training hardware.

Training schedules have been prepared for each MARD office. However, only a sample of these are included in this document due to the difficulty of maintaining currency as new system schedules are finalized.

4.2 T & PD by Position

This section relates T & PD to the position description and differentiates between required T & PD (scheduled official time) and desirable T & PD (time available basis). The accountability of satisfactory completion of activities will be maintained within the performance rating system.

4.2.1 WFO Staff

Table 4-1 reflects the assumption that the MIC, SOO, WCM and Service Hydrologist will be capable of performing all the duties of the shift forecasters at the WFO. As the hydrology program leader of the WFO, the Service Hydrologist will be the primary link between office hydrologic functions and the user community. Table 4-2 lists the hydrology training required. It shows the T & PD required at some future time rather than a pre-requisite level for any particular MAR event. The list is not intended to be a complete listing of all the T & PD courses available, but a general list of course categories. A more complete breakdown is contained in the Appendices.

Table 4-1 WFO STAFF

COURSES vs. POSITION	MIC	SOO	WCM	FCSTR	Intern	SH	DAPM	HMT	Plan Section
PROFESSIONAL DEVELOPMENT									
COMAP		R							Append B
On-site Met	R	R	R	R	R	R	SELECTED	SELECTED	Append A
Special Program Focal Pt.				A					Append D
Management	R						R		Sec. 2.7
SYSTEMS OPERATIONS									
WSR-88D Precursor	R	R	R	R	R	R	SELECTED	SELECTED	Append E.3
WSR-88D Norman	R	R	R	R	R	R			Append E.3
WSR-88D On-site	R	R	R	R	R	R	UCP	UCP	Append E.3
AWIPS Ops	R	R	R	R	R	R	R	R	Append E.2
AWIPS Sys		R		FP					Append E.2
ASOS Data Users	R	R	R	R	R	R	R	R	Append E.1
ASOS Ops	D	R	D	D	D	D	R	R	Append E.1
Profiler Ops	R	R	R	R	R	R	D	D	Append E.6
NWR CRS	R	R	R	R	R	R	R	R	Append E.5
Special Program	A	A	A	A	A	A	AD	AD	Append D
COMET Hydrometeorology		X		FP		X			Append B.2
WCM	X		R						Append D.6

R - Required training/PD
X - Desirable training/PD
M - Only MARD offices
FP - Focal Point
D - Data management
A - Special Service programs applicable to the WFO

4.2.1.1 Core T & PD

Most PD efforts will be common to all meteorologists. PD will consist primarily of on-site use of CBL modules, workshops and seminars. Also, some level of systems operations training will be common to everyone in the WFO.

The meteorologist intern also will eventually be required to issue all products for which the office is responsible. However, as a trainee, the period of the training will be longer and more gradual. Office management must ensure that training in a function is completed prior to assignment of those duties. The FDP provides guidelines for this intern period.

4.2.1.2 Systems Operations Training

All staff must also have an appropriate level of training in the operation and data interpretation of the new systems. This training will not necessarily be the same for the entire office staff (e.g., ASOS on-site data interpretation and augmentation/backup policies for all staff, plus ASOS OID for the HMT staff).

4.2.1.3 Special Program T & PD

T & PD for programs other than public warning/forecast and basic aviation weather are categorized as "special program T & PD." Programs such as Marine Weather and Fire Weather will have a specially trained focal point. In addition to the focal point, each forecaster and HMT within the office will require some level of T & PD in all programs for which the office is responsible. These efforts will generally be carried out on-site and are denoted collectively in Table 4-1 by an "A".

The SOO is expected to be the scientific leader of the office and, as such, should be the most highly trained and most scientifically developed staff member. Table 4-1 shows the initial mandatory courses. Additionally, it is desirable that the SOO take advantage of available hydrometeorological and focal point T & PD in all special programs. Focal point activities will generally consist of residence training given by subject matter experts and will be more intensive than the on-site special program efforts.

4.2.2 RFC Staff

Table 4-2 displays a summation of the T & PD planned for the RFC staff and the Type A Hydrometeorologist filling the Service Hydrologist position. See Appendix H for details.

Table 4-2 RFC Staff CWSU STAFF

COURSE vs. POSITION	HIC	DOH	HAS Type A	HAS Type B	Senior Hydro Fcstr	Hydro Fcstr		CWSU MIC	Met
COMAP		*							
Hydro Overview		R							
COMET Hydromet		R	R	R	R	R			
Adv Hydro Wksp	R	R	R	R	R	R			
Basic Hydro Ops	R	R	R	R	R	R			
On-site Met.	X	X	R	X	X	X		R	R
Management	R							R	
CWSU Course								R	R
SYSTEMS OPER.									
WSR-88D Precursor	R	R	R	R	R	R		R	R
WSR-88D Norman	R	R	R	R	R	R		R	R
WSR-88D On-site	R	R	R	R	R	R		R	R
AWIPS Ops	R	R	R	R	R	R		R#	R#
AWIPS Sys		R				FP			FP#
ASOS Data User	X	R	R	R	R	R		R	R
Profiler	X	R	R	X	X	X		R	R

R - Required training/PD
X - Desirable training/PD
- FAA opt.
M - Only MARD offices
FP - Focal Point
* - First Week only

Table 4-3 MAINTENANCE STAFF

COURSE \ POSITION	ESA	ET	NRC	PLAN SECTION
Management	R			Appendix C
WSR-88D Maint.	R	R	R	5.1
ASOS Maint.	R	R	R	5.3
AWIPS Sys	R			
Profiler Maint.	TBD	TBD		

E - At Responsible Office

4.2.3 CWSU Staff

The responsibilities of the forecast staff at the Center Weather Service Units (CWSUs) is directed toward aviation support (see Table 4-2). See Appendix D, Section 3, for details.

4.2.4 Maintenance Staff

Table 4-3 shows some of the maintenance training that will be required of WFO and National Reconditioning Center (NRC) ETs. The Requirement Document for PD for ESAs is to be written by OSO, NWSTC and the Regions, and is not yet available for inclusion in this plan.

4.3 Additional Staff for Training

The MARDI (MARD Implementation) Initiative is funding ten additional personnel to be utilized for the support of MAR training and professional development. Tentative plans are to assign these personnel as follows:

- 1 person in the Services Evaluation Branch in the Office of Meteorology to assist with the management of MAR training;
- 1 person at the US Air Force Academy as a Visiting Professor who will work closely with COMET in the development of CBL modules;
- 2 people at Central Region SSD to develop and offer workshops;
- 2 people at Southern Region SSD to develop and offer workshops;
- 1 hydrologist and 1 meteorologist at NWSTC to coordinate the development and implementation of courses in hydrology and management, and oversee AWIPS systems training;
- 1 hydrologist in Boulder, assigned to OH/HRL, to assist COMET in the development of hydrometeorology training;
- 1 meteorologist at WSFO Norman to assist with Risk Reduction Training.

5.0 Integrated Maintenance Training Plan

The MAR will have a profound effect on the NWS maintenance work force. The new technologies (WSR-88D, ASOS, AWIPS, perhaps Wind Profilers) will require increased computer hardware and software, telecommunications and systems management expertise. It will create the critical need for a new support discipline that will be provided by the ESA position. Organizational restructuring will result in a change in maintenance program supervision. It will eliminate the area management concept and will place the electronics work force under the MICs at future WFOs. These changes will have a significant impact on maintenance training.

This section describes an integrated maintenance training approach which addresses current, transition and MAR maintenance training planning covering all NWS operational equipment programs.

5.1 Background

Maintenance training is a critical part of the development program for NWS field maintenance technicians. Its requirement for new or changed systems is specified in Weather Service Operations Manual Chapter A-31, Integrated Logistics Support (ILS) Planning. NWS policy for engineering training is contained in Engineering Handbook 2.

Maintenance training for more complex NWS equipment and systems is generally provided at the NWSTC. As a cost saving measure, much effort has been applied at the NWSTC to develop non-residence training courses. Still, more complex systems require on-site training at NWSTC due to the critical need for hands-on laboratory sessions.

In this section, maintenance training is discussed for both current and future operational systems. Maximum reference is made to other documents that contain training planning details. Current systems include AFOS (Automation of Field Operations and Services), communications, hydrological and surface observations, radar (including adjuncts), Satellite Weather Information System (SWIS), and upper air. Future systems will include ASOS, WSR-88D, AWIPS, wind profiler and the NWR CRS.

Portions of the plan (e.g., AWIPS) contain less detail, due in large part to the fact that the contractor and Government roles are still being defined. As relevant information becomes available, affected portions of this document will be updated.

Training for NRC personnel will generally be provided by original equipment manufacturers or system integrators. To support the NRC depot repair function, additional training will be obtained from multiple sources including the NWSTC, vendors and OJT.

Maintenance services (i.e., Government vs. contract) for AWIPS are in the process of being cost compared with industry; management decisions are some time away. Where maintenance services are being cost compared, training related planning information is somewhat less defined.

Topics of discussion in this section include future maintenance personnel, residence training, non-residence training, modernization of current NWSTC courses, new technologies maintenance training, remaining current training (e.g., after modernization) and training problems. Details of the maintenance training plans for the major new systems are contained in Appendix E.

5.2 Future Maintenance Personnel

In order to successfully accomplish the change from the present to the future maintenance organization, we must be able to bridge today's maintenance responsibilities through the transition period (of several years) to that which is defined for the MAR. The following positions are required in the future NWS maintenance organization.

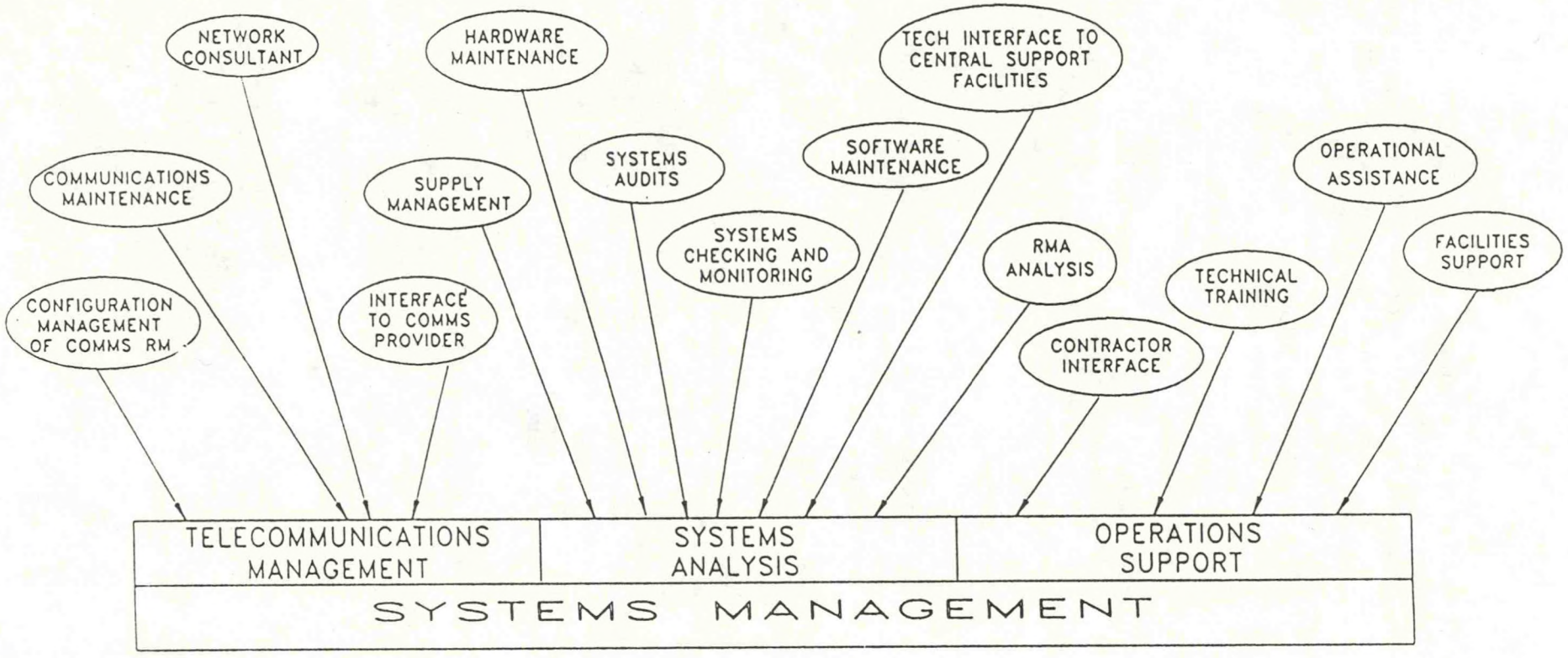
5.2.1 Electronics Systems Analyst (ESA)

The ESA will have systems management responsibility as illustrated in Fig. 1. This includes systems analysis of hardware and software failures, telecommunications management, and operations support for equipment in the WFO or combined WFO/RFC area of responsibility. The ESA will be supervised by the MIC of the WFO or WFO/RFC and will serve as first line supervisor of all ETs at the WFO or WFO/RFC. Training of the ESA is critically important. Our current ET work force must be transformed to computer equipment analysts (GS-334-13 personnel classification) that are required for MAR.

The ESA will be a systems manager for assigned equipment. As such, he/she will perform analyses on problem symptoms (hardware, software, telecommunications, etc.), run local diagnostic software, reconfigure hardware, provide operator assistance, interface either to the contractor for support in the event of contractor maintenance or Government technicians for support in the event of in-house maintenance, and evaluate performance of service technicians.

5.2.2 Regional Maintenance Specialist (RMS)

The RMS will be responsible for coordination of maintenance activities between Regional Headquarters and field offices, quality control of equipment and calibrations, management of training and budget allocations, coordination of installation and activation of new NWS equipment, COTR functions, and extensive involvement



FIGIURE 1 - SYSTEMS MANAGEMENT DUTIES OF ELECTRONIC SYSTEMS ANALYST(ESA)

in management of the facilities maintenance program. This position will report to the regional Systems Operations Division. In order to provide a smooth transition to the new maintenance organization, it will be necessary for today's Area Electronics Supervisor (AES) to serve in both an AES and RMS capacity in the future. An AES will need to serve in the AES capacity at offices without an ESA, and as an RMS at offices with an ESA. Fortunately, there is great similarity between the AES and RMS job responsibilities, and it is possible for someone to perform both the AES and RMS functions at the same time.

5.2.3 Electronics Technician (ET)

The ET will have equipment maintenance responsibility, similar to today, under the direction and guidance of the ESA. Equipment to be maintained includes WSR-88D, AFOS and perhaps AWIPS, MicroART, NWR, and surface/hydrologic. This position will be supervised by the ESA.

5.2.4 ASOS ET (AET)

The AET will primarily be responsible for maintenance and repair of ASOS systems but will also participate in the general maintenance programs of the assigned station. This position will be supervised by the ESA.

5.3 Residence Training

Traditionally, most of the residence training for NWS employees has been provided at the NWSTC. Maintenance training (engineering and electronics) has been available at the NWSTC since 1955. The American Council on Education (ACE) has evaluated NWSTC courses and most have been recommended for college credit. Students pursuing college degrees will find ACE recommendations very helpful. With them, it is more likely that NWSTC training will be accepted by a college or university as credit towards a formal degree.

Maintenance training for new systems for which NWS personnel will perform maintenance services will also be provided at the NWSTC. However, the NWSTC will not provide maintenance training for systems that are maintained by contract personnel. Details on present NWSTC courses are contained in the current version of the NWSTC catalog.

Engineering training in specialty areas where only a few NWS personnel are required to have in-depth knowledge is obtained under contract at unique facilities or from subject matter specialists. Samples of related training include lightning protection and depot-level repair.

The NWS engineering community is also taking increased advantage of the UAP. Application has generally been for undergraduate study with emphasis on expansion of the number of staff with bachelor degrees in engineering, computer science and engineering technology.

The NWS also sponsors an ET cooperative education program. Participants in this program alternate full-time school and work assignments with a goal of obtaining an associate degree in electronics/engineering technology as well as comprehensive OJT. About 15 percent of the current ET work force has been obtained through this program.

5.4 Non-Residence Training

There are a number of approaches being used to varying degrees to provide non-residence maintenance training. These independent study courses result in less cost and less time away from the office, and are flexible, convenient and personalized. Students can enroll at any time, study at home, and set their own pace. More commonly applied non-residence courses include correspondence, computer assisted instruction (CAI), and videotapes. A "train-the-trainer" concept is also used, but much less often.

Correspondence study is individual instruction by mail. Modern correspondence methods permit the use of other materials in addition to the textbook, study guide and the exchange of lessons through the mail. Recording tapes, cassettes and records, group study, telecourses, video tapes, films, slides, and computer disks are now available to increase the effectiveness of this training approach. The Correspondence Program at the NWSTC was created to help employees acquire certain job-related skills. The program provides employees a method to update and improve job performance without traveling or leaving the work place. Prerequisites for some of the NWSTC courses are also offered through this program. Some NWS regions have assembled comprehensive information for their ETs on colleges and universities that offer pertinent correspondence courses.

CAI courses execute on a personal computer-based system. CAI software contains technical information that is provided to the user in interactive sessions. Generally, testing or question and answer capabilities are included to reinforce the learning process. The NWSTC has the in-house capability to develop CAI courses. Original application of CAI at the NWSTC was to supplement lecture courses; students used CAI during free time while attending residence training. Recently, the CAI approach has proven effective in providing non-residence maintenance training both on less complex equipment and as prerequisite training prior to attending residence courses.

With the current availability of video cassette recorders, the use of videotapes to accomplish training is becoming quite common. Courses usually consist of a textbook supplemented with videotapes. The student typically views a portion of the video tape then is instructed to stop the tape and study a portion of the textbook. This process continues until the course is complete. The NWSTC has the in-house capability to develop training courses on videotape. There has been some success in providing maintenance training on videotapes for less complex equipment. In addition, one NWS region has applied this concept for instructing field technicians on procedures for installation of the complex FEP upgrade to AFOS.

There are occasions when it is necessary to train an instructor and send the instructor to the field to provide local training (train-the-trainer approach). The NWS regions have found it necessary to use knowledgeable regional specialists to provide maintenance training to new employees when NWSTC courses are in short supply. This type of training is difficult if equipment is needed operationally and not available for instruction.

5.5 Modernization of Current NWSTC Courses

The NWSTC has developed several new maintenance courses and restructured others in preparation for NWS modernization systems. Recent changes are described below.

5.5.1 NWS Engineering Fundamentals

This course was added to provide newly hired ETs (e.g., ASOS techs) with varied skills and information necessary for their positions. Course topics will include engineering management structure, use and updating engineering handbooks, the Engineering Management Reporting System, personal computer maintenance and DOS, introduction to data communications and the Consolidated Logistics System.

5.5.2 Data Communications

The Data Communications course was added to provide NWS maintenance personnel with the knowledge necessary to perform comprehensive troubleshooting on telephone circuits resulting in local repair or passing on of trouble calls to the appropriate vendor. In addition, the student will be prepared to attend future courses that contain communications equipment for data transfer among system components for the new technologies.

This course will cover basic telephone principles and terminology, data communications including interface standards, modems, data communication circuits, circuit testing, and an introduction to networking principles and terminology. Actual NWS equipment

and applications will be used as much as possible to aid in understanding and to provide hands-on experience.

5.5.3 AFOS Z

The AFOS I, AFOS II, and AFOS Systems Management courses have been modified and integrated into the single AFOS Z course. The new course provides more systems-level training. Course objectives will include providing maintenance personnel with the knowledge and skills necessary to maintain and align the hardware associated with System Z; providing an overview of the hardware and software relationships within System Z; and providing an understanding of the techniques necessary to initialize and reconfigure System Z in an operational setting.

This course will cover System Z physical configuration, corrective and preventive maintenance procedures and techniques, system degradation techniques, the use of diagnostic resources and maintenance aids, removal and replacement procedures, and alignment procedures on all subsystems. In addition, the student will be given an overview of the interaction between hardware and software within System Z and the use of DG Command Line Interpreter (CLI).

5.5.4 System Z Analysis Techniques

This is a new course intended to provide introductory systems analysis training to ESAs and is structured around System Z. It will allow ESAs to diagnose all aspects of System Z performance including hardware, software and communications. In addition, it will prepare them to train and supervise other individuals in the operation and maintenance of the system.

This course will provide an in-depth study of System Z from the "total system" viewpoint. It will include topics on system operation, hardware, diagnostic and operational software, data base management techniques, communications, back-up, recovery, and reconfiguration procedures. The emphasis of instruction is on analytical troubleshooting and system evaluation techniques which minimize system degradation.

5.6 New Technologies Maintenance Training

5.6.1 ASOS Maintenance Approach and Training Plans

It has been decided that direct Government maintenance rather than contractor-provided maintenance will be used to support ASOS. The NWS will maintain all NWS and FAA-sponsored systems and provide depot repair of all systems, including the Navy's. An overview of the ASOS maintenance approach including maintenance training is provided below.

The NWS will mobilize a staff of ETs who will specialize in ASOS maintenance. Based at most weather offices around the country, ETs will be strategically placed to optimize response to most critical sites. Each ET will service approximately 20 ASOS sites. This work force will be outfitted with vans and equipped with pagers or cellular telephones for rapid communication. The vans will house most-needed spare assemblies for on-site replacement. Other NWS technicians will back up the ASOS ETs about 10 percent of the time. In Alaska, most ASOS ETs will be stationed at Anchorage, from where they will fly to remote sites as needed.

Depot repairs will be handled by the contractor initially, with the NRC providing warranty tracking. The NRC will, within the initial 30 months, assume all depot repair and quality control functions, possibly continuing to use the vendor as a repair contractor. NRC personnel will receive contractor-provided depot-level training.

The contractor will provide initial maintenance training, with the NWSTC assuming this role afterwards. Two levels of training will be provided, with a more advanced course for selected specialists. Detailed discussions of ASOS maintenance training are provided in Appendix E, Section 1.4 and in the ASOS Training Plan prepared by the ASOS Program Office. The contractor will also provide equipment manuals with information tailored to each specific site.

Failure notification will normally be done by the ASOS Operations and Monitoring Center (AOMC). The AOMC will identify problems by monitoring the messages (or lack thereof) from ASOSs on national communications circuits. They will also monitor a toll-free number for trouble reports from users (special procedures will be established for NWS and FAA call-in). Upon identification of trouble, AOMC will call the responsible NWS oversight office. That office will determine the priority of the trouble and dispatch the ASOS ET.

The ASOS has extensive self-test features and remote maintenance monitoring capabilities. ASOS ETs will be able to dial into a remote ASOS, check its status and perform various maintenance functions in "background." In many instances, the first action will be to set a parameter "missing" in the output message. For most failures, the ET will know which Field Replaceable Unit (FRU) is malfunctioning before going to the site.

Each ASOS will require quarterly preventive maintenance (PM). We expect to conduct PM during repair visits whenever appropriate. ASOS sensors require only minimal calibrations.

AESs will provide overall field quality control of maintenance.

Current surface maintenance training will be de-emphasized in the coming years as ASOS equipment replaces much older surface equipment.

5.6.2 WSR-88D Maintenance Training

The following discussion was made based on the presumption of in-house performance of maintenance services. Detailed WSR-88D maintenance training information is contained in Appendix E, Section 3.2. In the event of contract maintenance, responsibility for presentation of NWSTC maintenance courses will transfer to the contractor performing maintenance services. The WSR-88D unit {equipment e.g., RDA, PUP, RPG, and Microwave-Line-of-Sight (MLOS)} will be Government-owned but will be used and maintained by the contractor for training.

Current maintenance training plans accommodate the training of at least the minimum staff needed to meet operational requirements through the transition period plus turnover. Due to the heavy initial training load, all WSR-88D sites will not be fully staffed with trained personnel until approximately FY 97. Training resulting primarily from ongoing staff turnover will continue at a reduced rate after FY 97.

Currently, the NWS is planning to offer the following courses:

COURSE	LENGTH	MAXIMUM CLASS LOAD
Cadre Training	9 weeks	12 students
Maintenance Training	6 weeks	9 students
PUP Training	2 weeks	9 students
MLOS Training	2 weeks	9 students
Management Overview Course	2 weeks	9 students

Initial WSR-88D training will be conducted by the contractor. This contractor-furnished training will consist of one Cadre class, four maintenance classes, three PUP classes, one manager's class, and one MLOS class. Contractor-conducted training will cover a period of approximately 9 months.

NWSTC-conducted training will commence approximately 6 months after completion of Cadre training. For any 12-month period during the transition period, NWSTC-taught classes will consist of six maintenance classes, three manager's classes, two PUP classes and two MLOS classes. The recurring course load after FY 97 will consist of three maintenance classes, one manager's class, one PUP class, and one MLOS class.

The contractor will conduct all tri-agency training during approximately the first 9 months of training. After the Cadre course, this training will take place at the NWSTC facility in Kansas City. All tri-agency training will continue at the NWSTC

course, this training will take place at the NWSTC facility in Kansas City. All tri-agency training will continue at the NWSTC facility until the DoD facility at Keesler AFB is completed. Thereafter, DoD and DoT personnel will be trained at Keesler AFB. The date training will commence is dependant on the following factors:

- o completion of course preparation by contractor,
- o upgrade to limited production phase (LPP) configuration of the WSR-88D unit at the OSF (Cadre course),
- o acceptance of the WSR-88D unit and facilities, material, and personnel in place at NWSTC (all courses except Cadre course),
- o release of WSR-88D Technical Manuals (NWSTC conducted training), and
- o completion of course preparation by NWSTC (approximately 6 months after NWSTC instructors attend Cadre training).

Current radar training will be de-emphasized as WSR-88D units are deployed.

5.6.3 AWIPS Maintenance Training

Performance of AWIPS maintenance services will be cost compared among AWIPS Definition Phase contractors and the Government. The following discussion is based on the presumption of in-house performance of maintenance services. If contractors are used to perform maintenance, the contractor will be responsible for maintenance courses.

If maintenance is performed by the Government, the traditional NWSTC maintenance training approach will be considered first. Training equipment (e.g., extra AWIPS units), training course materials and initial course presentations would be procured from the AWIPS contractor. Emphasis would be on reducing the amount of time spent at residence training facilities. The contractor would be asked to investigate novel training approaches that might be time and cost efficient for training Government engineers and technicians. Related discussion is contained in Appendix E, Section 2.

Independent of the AWIPS maintenance decision, the ESA will be a systems manager for the assigned AWIPS unit. The ESA will perform analyses on problem symptoms (hardware, software, telecommunications, etc.), run local diagnostic software, reconfigure hardware, provide operator assistance, interface either with the contractor for support in the event of contractor maintenance or with government technicians for support in the event of in-house maintenance, and evaluate performance of service technicians. Additional information on training for ESAs is provided in Appendix E, Section 2.1.

5.6.4 Systems Management--Special ESA Training

After being selected for an ESA position (approximately 9 months before delivery of the assigned WSR-88D), an ESA will receive both WSR-88D and ESA-specific training at the NWSTC. ESA-specific training requirements will be specified in early FY 92 and course preparations will start later in the same fiscal year period. AWIPS training will be provided before system delivery to the assigned site.

5.6.5 Wind Profiler Maintenance Training

The wind profiler is not an operational system/network at this time. Rather, it is a demonstration network covering large portions of the Central and Southern Regions. Current plans call for 33 systems to be distributed operationally as follows: 31 across the contiguous states, one in Alaska and one support system at the production contractor's factory. The evaluation program is scheduled to extend through the year 2000 in order that both operational and support factors be properly assessed. Organizational maintenance is at the FRU level. Therefore, required maintenance training can be minimized.

Initial training will consist of a limited number of regional focal points and selected field ETs attending a one-time, one-week factory course. As additional units are deployed, plans call for 3 days of on-site contractor-provided instruction for local ETs.

Recurring training methods are still being evaluated. Under consideration are:

- An annual factory course
- An annual course taught by the Environmental Research Laboratory
- NWS providing maintenance instruction to ETs either regionally, via OJT or by the NWSTC on an as-needed basis or by an annual course
- Any combination of the above

5.7 Remaining Current Training

Commissioning of new technologies will result in the deemphasizing or total elimination of courses in the respective equipment areas. Modern organizational maintenance plans emphasize a modular FRU approach. Support goals are literally to do more with less--including training. After deployment of the new systems and a stabilization period, current upper air, hydrologic, communications (e.g., NWR), and a few residual surface program sensor courses will remain at NWSTC. Where possible, increased use of non-residence maintenance training will be substituted for these courses. When NWR replacement components are deployed, related maintenance training will be provided at NWSTC.

5.8 Other Training Issues

There are several issues related to maintenance training that warrant discussion.

Budget cuts are always a possibility and result in the reduction of training courses, often in the last quarter of the fiscal year. NWS policy is to provide only necessary and sufficient training. The training budgets are generally set at the minimum required to accomplish the task at hand. When training courses are eliminated, the result often is that OJT must be provided to new employees. This will be somewhat less disruptive in the future when all offices have multiple technicians. Presently, many offices have only one ET and new, untrained employees must often get on-site assistance from off-site technicians, which involves costly travel.

Another goal of the new training plan is to minimize time spent on training away from the station. This will not always be possible; for example, complex systems, such as the WSR-88D and AWIPS will require lengthy residence courses. Where possible, on-site video/CAI training will be developed and used for less complex systems and for instruction on system changes.

Funding qualified maintenance personnel during the recruiting process is an ever-present problem; lesser qualified staff require increased prerequisite training. The NWS is developing promising personnel through its internally funded ET Cooperative Education Program with participating accredited schools of higher education in the electrical/electronics/computer technology curricula.

On-site Training & Professional Development

1. Introduction

The NWS has been investigating various means of delivering training and education to operational personnel in field offices. Considering the requirements for continuous operation, minimum staffing and the cost of centralized classes, on-site T & PD is the best solution to many of the NWS requirements.

The on-site approach is especially desirable when a requirement dictates that a large number of employees must receive T or PD during a short period of time. The NWS is currently involved in developing an expanded on-site T & PD program that emphasizes self-paced learning under the direction and tutelage of the SOO or DOH and using materials developed by a variety of sources.

On-site T & PD will consist of a number of methods, including OJT, seminars, workshops and self-study materials developed by subject matter specialists at COMET and other locations. In addition, the NWS will rely more heavily on CBL at each office. Each NWS office will be equipped with a Professional Development Workstation (PDW), which is a micro-computer-based system capable of displaying high-resolution graphics.

The MIC, working with the SOO, will schedule time dedicated to mandatory on-site T & PD. In addition, time will occasionally be available for self-study of available materials during normal operational duty shifts. A similar situation will exist with the HIC and DOH at each RFC.

In the final analysis, the success of any T & PD program is measured by the ability of the student to perform to a higher level of expectation. Therefore, the effectiveness of the NWS' program will be inferred from the students' performance. The NWS has in place a performance rating mechanism called the General Workforce Performance and Recognition System (GWPAS). The accountability of the employee for satisfactory completion of training is a part of the GWPAS system. The supervisor, with advice from the SOO or DOH for on-site efforts, and instructor staff for residence classes, will be responsible for evaluating the effectiveness of all efforts.

Finally, while the performance rating mechanism will be one way to motivate students, supervisors should stress to each employee that their pursuing PD activities benefits both them and the NWS.

2. Past Methods

In the past, some on-site activities were very successful, while others were not as effective. A well-organized PD program did not exist. T & PD during the MAR will incorporate those methods that worked well, along with new methods.

2.1 On-the-Job Training (OJT)

The supervisor had the responsibility to ensure that the staff knew the procedures for performing each assigned task. A commonly used method was OJT, in which another staff member trained the "student" directly. Office drills, in which some particular aspect of the warning and forecast program was practiced and critiqued, exemplify OJT. This approach was very effective in cases where: 1) the student was motivated, 2) relevant materials were used, and 3) the instructor was capable and prepared.

2.2 On-site Seminars and Workshops

Other on-site T & PD methods included seminars and workshops. Subject matter experts from the NWS Techniques Development Laboratory, National Meteorological Center, NOAA National Environmental Satellite, Data and Information Service (NESDIS) Satellite Applications Laboratory, and other units presented seminars and workshops at field offices. Also, presentations were frequently made by members of the office staff. Some offices held successful seminars by assigning papers for review to individual staff members who then researched the problem and presented the findings.

Regional SSD staff visited field offices to present seminars or training, often staying a number of days to present the same material a number of times to ensure that all staff would be trained.

Some large-scale workshops, such as a "Winter Weather Workshop," attracted forecasters, managers and university personnel from the entire country. These were quite expensive, however.

There were some drawbacks to these past on-site T & PD methods. For example, the person who attended a class, workshop or conference at a location outside the office was expected to instruct the other staff members upon returning. This procedure worked in some cases, but was minimally successful in other cases. Difficulties in reprinting satellite images, radar displays and charts often precluded the returning staff member from conveying critical information. Further, the original presentation was given by an expert in the field who could answer questions. The returning staff member often did not have the background to explain difficult concepts.

Another problem was that most of the available staff attended the seminars; however, staff on other shifts may not have been able to attend. Regulations prevented some staff members from attending even voluntarily unless overtime pay was authorized.

2.3 Remote Training Modules (RTM)

The NWS, most notably the NWSTC, has been successful in the production of a number of RTMs, which are essentially correspondence courses on topics for review or primary training. These RTMs have been successful in significantly reducing the time (and hence costs) necessary for attendance at the NWSTC residence courses. At present the RTMs use a printed format. Because of duplication costs, the NWS has avoided developing RTMs for any topics for which multiple-color images would be required.

2.4 Videotape Training Network

Each WSFO and most WSOs have the capability to play 1/2 inch VHS videotapes. Centrally produced material is duplicated and sent to the regional SSDs for distribution. Videotapes accompanied by textual materials such as workbooks, papers or other reference materials are called videotape modules and have been successful in the past. These VHS units also support college level videotape courses.

2.5 Reading and Reference Materials

Each office has developed a library of technical books, videotapes, preprints to selected conferences, journals and other scientific materials. The NWS initiated a marked increase in procurement in the early 1980s in preparation for MAR. The NWS also has prioritized lists of the many good documents in press and has selected a few to purchase centrally in large lots, often at substantial discount, for distribution to WFOs. These, together with the basic handbooks and standard reference material, form the base of the station libraries. Other local and regional purchases have augmented these materials.

NWS SSDs in the contiguous regions arrange for loans of books and periodicals through the NOAA library system. When the PDW workstations are deployed, the SSDs will be able to utilize the NOAA Library CD-ROM catalogue collection. Materials not in NOAA are usually obtained from inter-library loan arrangements made through the NOAA library.

3. General Plans for Modernization

Most of the current on-site methods are useful but, with improvements, could be made much more successful. Three efforts are underway that will provide more structure and capabilities than previously available. These efforts include: 1) the creation of the SOO and DOH positions, 2) an augmented level of T & PD material development, and 3) a dedicated, computer-based system capable of color animation, such as the PDWs.

3.1 On-the-Job Training

OJT will continue to be very important in the modernized NWS. The most noticeable change will be the presence of the SOO and DOH. The SOO, working with the MIC (and the DOH working with the HIC and the HRL) and the SSD will plan, schedule and manage the office OJT program. The SOO or DOH will be available as a source of subject matter expertise, even though he/she may not be the actual trainer. A second difference will be the availability of structured materials.

Early in the MAR, OJT will be the most intense on-site activity. Such activities as familiarization with office procedures and forecast responsibilities at new offices, operations proficiency on new systems and practicing new application techniques will be time consuming OJT activities. An example of an early encounter with OJT will be the period of WSR-88D proficiency development upon returning from the WSR-88D Operations Training Course, using the checklist for guidance. Later in the MAR, OJT will become a routine activity for updating current skills, developing new skills and abilities, and for new staff (e.g., FDP).

3.2 On-site Seminars and Workshops

SOOs and DOHs, working with the SSDs, will facilitate the use of seminars and workshops in the MAR. Additionally, attendance of mandatory seminars and workshops will be scheduled official time. Another factor that will improve the success of the on-site effort is the development of structured presentations supported by in-hand materials. For example, seminars and workshops presented by the SOO, DOH or SSD staff will initially be used in the MARD to substitute for those activities that have not been fully developed or are not available by other methods.

3.3 Computer-Based Learning (CBL)

In a one-on-one or self-taught situation, the instructor or individual uses any of the equipment on hand to accomplish the goals. If the equipment is not available, materials that simulate the real activity are required. There is a definite need for providing color imagery that can be animated in the same manner as presented by the new NWS systems. Conventional pub-

lished material cannot present color image information in an appropriate form. Thus, the NWS plans to implement a CBL system that has the desired capabilities (see Attachment A.1).

The NWS, Air Force, and the university community through COMET are developing computer-assisted instruction. The Air Force and some segments of the university community have systems and production experience.

The NWS plans to place a PDW in each WFO, RFC, National Center, NWSTC, SSD, NWS Headquarters, NWSTC and OSF. Among other capabilities, the system will have a video-disk capability to provide high resolution color graphics that can display satellite images and WSR-88D information.

4. System On-site T & PD Plans

4.1 WSR-88D

On-site modules are being developed as an introduction to the WSR-88D Operations Course. These "precursor" modules provide the background information needed to make the course more understandable and to provide all WSR-88D operators with a similar background prior to attending the course. A list of the modules is given below.

Precursor Modules for WSR-88D Operations Course

Principles of Weather Radar
Hydrometeorological Precipitation Processing
Basic Convection
Multicell Convection
Supercell Convection

When the forecaster returns from Norman and the WSR-88D is installed, each forecaster will be provided a checklist to use as guidance during hands-on familiarization practice. The SOO and WSR-88D focal point will be available to answer questions and to provide additional information on data interpretation.

HMTs will be provided on-site training by the SOO and focal point for their assigned WSR-88D duties, with materials developed by the NWS WSR-88D instructor staff at Norman. The contents of this training are still under development.

Offices with early WSR-88D installation will be responsible for a substantial OJT effort because they will need to integrate the information from the PUP displays with AFOS displayed information. Once the WSR-88D information is integrated into the AWIPS, this particular effort will become less difficult.

As new algorithms are developed, training on their application will be accomplished on-site. It is premature to determine the best approach to accomplish this training, but certainly OJT, CBL and workshops are viable candidates.

4.2 AWIPS

AWIPS operations training will be done entirely on-site. Every user available at installation will be trained by the contractor. In addition, a system CBL module will be provided for review and practice. Those individuals who miss the on-site contractor training will be taught by the SOO or DOH, or the AWIPS focal point. The AWIPS system will be able to run the training CBL while the AWIPS is being used operationally, and not in the Alert or Warning mode. Scientific training will be done mostly on-site

by the SOO or DOH using CBL modules developed by COMET. More details will become available once the AWIPS contract is awarded.

4.3 ASOS

ASOS training will consist of on-site self-paced study using the ASOS User's Guide for all ASOS data users. Initially, at ASOS-equipped sites, on-site contractor training will be provided to those ETs and HMTs who are required to use the OID. The ASOS Program Office and OSO will develop self-paced study guides and workbooks for on-site training. More specific plans are contained in Appendix E.

4.4 Profiler

When a Profiler is installed in the area of concern, all forecasters will utilize manuals and videotapes as a basis for self-learning. The SOO or a focal point will provide expert assistance if necessary. The Environmental Research Laboratory (ERL), under contract with the NWS, has developed four manuals and videotapes to prepare the NWS staff to use Profiler data. The manuals and videotapes are complete and have been implemented at offices where Profiler data are presently being used in the preparation of products and services.

4.5 GOES-I

The GOES-I T & PD will be accomplished on-site, although the specific plan is not yet well enough developed to determine the nature of the on-site component.

5. On-site Scientific Development

On-site scientific development consists of two major components. The first component will be the continuation of seminars and workshops designed for all scientific staff. Also, COMET is in the process of developing a series of CBL modules, as described in Section 3.3 of Appendix A, for on-site use. The presence of SOOs and DOHs will ensure a more consistent and better organized on-site scientific development program.

The second component, individually designed at each office, will involve the utilization of research connections to foster the development of individual research initiatives. See the COMET T & PD plan in Appendix B for additional details regarding on-site scientific development.

A. Advantages of Interactive Learning (CBL) Technologies

The learning benefits of interactive technologies[1] are numerous. Those benefits include: reduced learning time, reduced cost, instructional consistency, privacy, increased retention, increased safety, increased motivation, increased access and learner enjoyment.

In his report to Congress[2], Fletcher concluded by saying, "The 47 studies reviewed here indicate that interactive videodisc instruction is both more effective and less costly than conventional instruction.

They suggest, therefore, that interactive videodisc instruction can have a significant positive impact on the productivity of resources allocated to military training and education and on the availability of people to operate and maintain military systems. Although more needs to be learned about how interactive videodisc instruction should be designed and employed, it should now be routinely considered and used in military training and education."

B. CBL System Requirements

The NWS has a number of requirements for a CBL system:

1. The NWS should be able to share instructional material prepared by the Air Force, Navy, and universities cooperating with the UCAR through COMET and NESDIS.

2. The system should:
   - be available at the workplace at any time of day or night.
   - require no special computer experience of the student.
   - allow the student/employee to take random lessons.
   - be relatively inexpensive.
   - must be able to display sequential graphics (animation) or time lapse without significant detriment to learning.
   - be able (with the addition of the appropriate software) to both administer and author new material.

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[1]"Ten Good Reasons: The learning benefits of Interactive Technologies", R.L, Miller, Monitor, 2/90, p15.

[2]"Effectiveness and Cost of Interactive Videodisc Instruction in Defense Education and Learning", J. Dexter Fletcher, Monitor, 3/91, p18

3. The authoring language should be easy to learn, requiring no more than one week of training to produce a program.

4. Lessons should be programmable locally, at centers and at other locations (especially universities) where NWS can contract for production.

5. The transfer of material to videodisc should be done centrally.

6. The quality of image representation should be clear enough to enable an inexperienced meteorologist to observe the phenomena under discussion. Poor quality imagery is generally detrimental to the learning process. The image clarity issue has been discussed and investigated by the NWS and the COMET. The results of the efforts show that graphics resolution requirements can be met if the transfer of material to videodisc is done carefully.

C. CBL Module Instruction

Normal instruction development follows a logical flow of information, trial and testing. The flow of material allows the student to;

- learn the required material,
- be evaluated on comprehension (tested)
- and be lead from the responses to other information, a more careful explanation of the material or, if available, the instructor.

The student may begin with a laboratory exercise that illustrates the situation before proceeding into testing. When the student falters, some lecture material can be presented if the programmer/instructor determines by a certain sequence of actions that a point has been missed or a misconception has been identified. The development of the material to be presented must also include satisfactory answers to the majority of the questions the student is likely to have.

Development of the basic course material is approximately the same for conventional instruction and CBL classes. The major difference is in the method of presentation of the material.

COMET Training & Professional Development Plan

1. Introduction

COMET is a cooperative endeavor with the NWS as primary sponsor; DoD is a contributing partner, and NESDIS and ERL are contributing co-sponsors. COMET's mandate is to facilitate the development and administration of training/education courses and materials, to facilitate the organization and exchange of data to be used for applied research, and to serve as a general catalyst to bring the operational and research components of the atmospheric sciences closer together.

COMET is administratively housed within the University Corporation for Atmospheric Research (UCAR) at Boulder, Colorado, and is governed by individual Memoranda of Understanding between NOAA and UCAR. Additionally, the NWS participation in COMET is governed by a Cooperative Agreement between UCAR and NWS.

A NWS/COMET Program Manager, an employee of NWS' Office of Meteorology (OM), is located at Boulder to carry out the NWS functions required by the Cooperative Agreement to support COMET, and to provide coordination with other sponsors who use the NOAA/UCAR agreements indirectly as their administrative link to COMET.

1.1 T & PD Objectives

COMET is a cooperative effort of three groups; the operational NWS, the academic community and the research community. It provides a unique opportunity for the NWS to gain the benefits of academic advances and the scientific advances of research efforts. At the same time, the academic and research participants learn the operational aspects of their science. All involved have the opportunity to make significant gains.

COMET has three major programs designed to enhance PD. They are; 1) the COMET Resident Program, 2) the COMET Distance Learning Program, and 3) the COMET Outreach Program. Each of these programs provides unique learning opportunities. Each program will be utilized by NWS forecasters in varying combinations.

In general, technical training and systems-related training will not be offered directly to the student by COMET in either short course or CBL form; however, COMET will provide assistance to other centers or groups in teaching CBL production techniques, or by serving as a broker to arrange human resources to assist with such instruction.

2. COMET Resident Program

The COMET Resident Program was designed primarily for the NWS. The program provides a university style atmosphere, centered in a research center, with classroom and laboratory facilities. One advantage of the COMET Resident Program is that, because it has no fixed faculty, experts for each element can be drawn from the entire field of cooperating universities, research labs or operations.

Resident courses currently planned by COMET will be held at Boulder. However, COMET short courses developed in the future will be taught at other locations in the U.S. as appropriate.

2.1 COMAP Course

The COMAP course is an in-depth, 8-week residence course designed to teach hydrometeorological theory, diagnostic and prognostic techniques, and applied research techniques utilizing the latest scientific and technological methods. The course will have a strong focus on mesoscale phenomena and will be taught in a simulated WFO environment at the college post-graduate level.

2.1.1 Course Development

The COMET Curriculum Working Group, consisting of representatives from the NWS, COMET, universities and NOAA research laboratories, have designed and coordinated the curriculum with the NWS Regional and National Headquarters. The course will consist of a combination of background lectures, case studies supplemented with discussions by subject matter experts and displaced real-time case studies. In displaced real-time cases, data is provided in a chronological replicate of the actual case.

The COMAP course is designed primarily for SOOs but is also applicable to certain SSD and National Center personnel. DOHs will attend only the first week (the lecture overview portion). Each class will accommodate approximately 20 students.

2.1.2 Course Instructors

Instructor teams, consisting of a university professor or research subject matter expert, and an operational NWS forecaster, will combine to instruct the integrated lecture/labs. Arrangements will be made prior to each class for the selected operational forecaster to be relieved of normal duties in order to prepare and present the course. It is assumed that the operational and academic instructors will share responsibility for conducting the course. A list of instructors for COMAP Courses follows:

Course	University Instructor	Operational Instructor
COMAP #1	Prof. Howard Bluestein, University of Oklahoma	Brad Colman, WSFO SEA
COMAP #2	Prof. Gregory Forbes Penn. State University	Prof. Kenneth Crawford, Okla. State Univ.
COMAP #3	Prof. Kenneth Crawford Oklahoma State University	TBD
COMAP #4	Prof. Carlyle Wash Naval Postgrad. School	Experienced SOO
COMAP #5	Prof. Fred Carr University of Oklahoma	Experienced SOO

2.1.3 Course Schedule

The schedule of courses is determined by the rate of SOO and DOH hiring. COMAP I was held September 23 through November 15, 1991. COMAP II will be held early in 1993. Two courses per year are planned thereafter.

2.2 Hydrometeorology Course

COMET, working with OH, will develop a 3-week graduate-level course containing material primarily for the DOH, hydrologic forecasters, hydrometeorological analysis and support (HAS) forecasters and service hydrologists.

This course will cover advanced mesoscale theory, but will focus on meteorological and hydrometeorological considerations of importance in hydrological forecasting. Emphasis will be placed on recognizing attributes of various storm systems from the signatures that are presented by the new technologies.

2.2.1 Course Development

The COMET Curriculum Working Group and residence program staff, will develop and coordinate the course content. In addition, the NWS has planned to hire a full-time hydrometeorologist, assigned to OH/HRL and located in Boulder to assist in the course development.

2.2.2 Course Instructors

The NWS hydrometeorologist at Boulder will be expected to assist in the teaching, but the rest of the instructor staff has yet to be determined.

3. COMET Distance Learning Program

COMET will develop and distribute CBL materials to NWS field offices to facilitate local T & PD. On average, each CBL module will take about 3-8 hours to complete and will be focussed on a single subject. All modules will consist of multiple lessons of 20-40 minutes duration each. Maximum use of branching and interactive techniques will be employed. Written material will also be used where appropriate. The modules are aimed at the baccalaureate level.

COMET T & PD, administered via CBL modules at local offices, is designed for all NWS forecast personnel including meteorologists, hydrometeorologists, hydrologists and oceanographers. CBL modules will be administered in self-teaching mode. The SOO or DOH will serve as instructor assistant when needed. The overall target audience is approximately 2000.

3.1 CBL Development

The COMET development effort will ensure compatibility across all COMET sponsor agencies so that training/education materials can be cross-utilized. COMET CBL modules will be developed by similar working groups drawn from all participating agencies in COMET. CBL design experts will be drawn from the University of Colorado at Denver, the University of Georgia and other universities on contract. Production of actual modules on videodisc will be accomplished at the United States Air Force Academy in Colorado Springs, Colorado and other production facilities in the U.S. including DoD facilities and the private sector. The NWS, through an agreement with the U.S. Air Force Academy (USAFA), has placed a NWS instructor at the USAFA to instruct and assist with CBL production.

COMET CBL modules will be evaluated by an appointed team of operational forecasters as an integral part of the production process. Suggestions for revisions will be reviewed by SSDs and other personnel.

3.2 CBL Schedule

The first two COMET CBL modules are complete and were distributed in December 1991 and January 1992. Design phase of the third module has begun and will be completed during the summer of 1992. Each module will require about a year from conception to validation stage. The goal is to reduce this time frame to an average of 9 months by year three through experience and streamlined production processes.

The following is a list of planned CBL modules by anticipated calendar of completion.

1991	Doppler Radar Interpretation
	Convection Initiation
1992	Heavy Precipitation and Flash Flood Forecasting
	The Forecasting Process
1993	Numerical Weather Prediction
	Extratropical Cyclones
	Marine Meteorology I
1994	Thunderstorm Structure
	Detection and Forecasting of Severe Convection
	Convective Hazards to Aviation
	Marine Meteorology II
1995	Forecasting Fog and Stratus
&	Tropical Meteorology I
BEYOND	Observing and Forecasting Winter Storms
	Tropical Meteorology II

3.3 Third CBL Team

Consideration is currently being given towards establishing a third CBL team to be funded solely by the NWS to provide NWS-unique CBLs required for the Modernization. Personnel on this third team would produce CBLs for the Special Service areas, such as Agricultural Meteorology, Fire Weather, Marine Weather and Hydrometeorology modules. See Appendix D for details on the Special Services T & PD plan.

4. COMET Outreach Program

The objective of the COMET Outreach Program is to "increase opportunities for mesoscale and synoptic-scale education and research, and improve local forecasts by fostering professional interactions between NWS forecasters and university faculty and students." Cooperative activities covered (for example) include:

a. activities to improve the use of new observing systems or the understanding of local mesoscale forecasting problems;
b. activities to assist operational forecasters in enhancing their educational backgrounds and staying abreast of research developments;
c. activities to assist the university research community in staying abreast of operational problems and needs;
d. activities to create case studies or new data analysis techniques with application to teaching, research, or operational forecasting.

Two types of programs are in place;

Partners Program: A cooperative effort between an individual NWS forecaster and a researcher focused on the study of a particular forecast problem. This type of program will generally be of limited duration, use locally available data, and lead to the preparation of a joint paper and/or adoption of a new forecast technique.

Cooperative Program: A broad cooperative activity between a university department and a NWS office. Activities may include forecast applications research, involvement of university faculty and graduate students in NWS PD activities, and use of NWS data and personnel in university educational activities. Programs of this type may be related to specific short term objectives; however they are more likely to involve the establishment or expansion of long-term relationships between a university department and a NWS office.

4.1 Outreach Program Development

COMET will serve as a clearinghouse for all NWS SSDs, and local SOOs and DOHs to facilitate applied research, data exchange and local or regional collaborative efforts with the research community. PD activities associated with enhancement of applied research, local initiatives with other COMET cooperators and general knowledge-enhancing efforts are designed for all NWS employees, professional and technical. The overall target audience is approximately 3000.

Support for applied research and local cooperative initiatives with universities will be coordinated by the COMET staff with SSDs, NWS headquarters personnel and the NWS Program Manager.

Local applied research initiatives will be submitted as joint proposals from the NWS and universities/research laboratories to COMET. Written final reports of the findings of these efforts will be documented by the cooperators and broadly disseminated by COMET.

University, ERL, NESDIS, DoD and NWS personnel will serve as subject matter experts, collaborators and mentors to assist in applied research activities and other cooperative programs at the local level. Special data sets on CD-ROM or other media will be produced and distributed by COMET to facilitate local applied research.

Applied research and local cooperative programs will be validated by the NWS local managers, SOOs, DOHs, regional SSDs and the COMET Program Manager. Adjustments in emphasis, techniques, resources, etc., will be made in accordance with these reviews.

4.2 Outreach Schedule

The first COMET outreach programs involving applied research and cooperative initiatives with local universities have begun. Outreach projects will be supported indefinitely in accordance with available resources.

APPENDIX C

NWSTC Training Plan

1. National Weather Service Training Center Training Plan

The NWSTC provides a number of carefully designed, job-centered training programs for employees of the NWS, and on occasion for those from other Federal agencies and foreign governments who cooperate with the United States in international atmospheric programs.

Subjects taught range from electronics technology, meteorology, and hydrology to supervision and management. These topics are offered both as residence courses and in the form of correspondence study. The latter employs a multimedia approach (computer assisted instruction, videotape and printed materials).

Course development and revision are continuous activities and are performed by the staff, with advice and assistance from regional, national and private sector experts. The training curriculum is periodically reviewed by national program leaders, and appropriate regional focal points and SSD Chiefs.

1.1 Engineering Division

The Engineering Division offers over 25 residence and correspondence courses on as many subjects, and provides virtually all the equipment training NWS electronics technicians require. This training includes instruction on new equipment as well as current operational models.

The Division is deeply involved in maintenance courses for the WSR-88D. The six-week residence course is designed to teach maintenance and repair down to the locally-replaceable-unit level. Each WSR-88D technician is scheduled to receive training prior to the installation of their respective WSR-88D.

1.2. Hydrometeorology and Management Division

The Hydrometeorology and Management Division currently provides NWS employees with eight residence courses and 15 remote training modules. Specific modules are required of most courses and must be successfully completed prior to residence training.

Present courses include the Flash Flood Forecasting Course, the Forecasters' Development Course (FDC), the Weather Service Operations Course, a Management and Supervision Course, two radar courses and a Writing and Broadcast Seminar. Specifications, including objectives and target audience for all these courses, are listed in the Center's current catalogue.

2. Future Courses

The vital role that the NWSTC will play in future NWS training is outlined throughout the IT & PDP. This role continues the important work of the FDC in shaping Meteorological Interns for their role in the modernized NWS. The current NWS Operations, and Station Management and Supervision courses will evolve into a course for HMTs and MAR managers, respectively. The Flash Flood Forecasting Course will refocus its objectives and concentrate more on hydrology for meteorologists than on flash floods alone. The contractor-led AWIPS Systems Training will be conducted at the NWSTC as will a course on the NWR CRS. A new Basic Operational Hydrology course is under development. A WCM course will be sponsored by the NWSTC and will be a required course for all new WCMs. As the WSR-88D is deployed, the two radar meteorology courses will be discontinued in response to decreases in conventional radar usage.

Engineering maintenance courses will continue on a strong path with a major focus on WSR-88D and ASOS maintenance training. As other new equipment is accepted for operational use, courses will be developed to provide NWS field maintenance personnel with the skills needed to keep data flowing and communications open.

The Remote Training Module program will continue to provide background and prerequisite material for NWSTC courses. These modules will assist in keeping the overall course costs to a minimum as well as provide a source of reference material for future use.

The NWSTC will continue to be a strong and significant player in the MAR training, complementing associated efforts by COMET and OSF.

OML 5-91

Sequence of Forecaster Development Program (FDP) Training

This directive specifies those training requirements which are generally applicable for meteorologist interns in the National Weather Service (NWS) field offices. All modules in all three sections of this program are generally mandatory for meteorologist interns, recognizing that the regions still require flexibility to authorize exceptions, e.g., when a particular meteorologist intern's operational duties do not require all components of the program. Completion of this training will be documented in each meteorologist intern's performance plan. The regions and the National Meteorological Center (NMC) will determine which portions of this sequence of training are required for their personnel in these categories: (1) hydrologist interns, (2) meteorological technicians crossing over to meteorologist status, (3) meteorologist interns at the national centers, and (4) newly hired meteorologists who are entering the NWS in a position other than meteorologist intern.

The sequence of training begins with an introduction to the NWS's basic data collection and public service responsibilities (section 1). In general, it covers the minimum knowledge and certifications that are necessary in order to be able to work shifts in an NWS office. Section 2 continues with an introduction to the forecast methodology and general philosophy of NWS operations. Section 3 is primarily concerned with advanced forecasting problems. All training in sections 1 and 2 must be completed within 2 years, except that attendance at the Forecaster Development Course (FDC) may be delayed due to course availability.

As new modules are added in the future, they will be assigned to the section which best fits their purpose. New training programs are being developed for the new systems [Next Generation Weather Radar (NEXRAD), Advanced Weather Interactive Processing System (AWIPS), Profiler, etc.)]; these will not be required for all NWS personnel at the same time, thus regional discretion will be used as to when meteorologist interns will participate in these training programs.

At the moment, there are no NWS-wide requirements for sections 2 and 3 in the category of "national requirements which are administered by the region or at the local level." For those requirements in section 1, the regions and NMC will be responsible for keeping records of the completion of these requirements for their own meteorologist interns. An individual region or NMC may specify a requirement for its entire area or for a particular office (as in the case of AWIPS, NEXRAD, and Profiler training). Individual regions will alert other regions and the Office of

Meteorology of any such requirements so that consideration can be given to adding them as a national requirement. Thus, the FDP training will remain flexible so new training requirements can be incorporated into the appropriate section.

This document lists the modular content of each section of training. Modules are units of training with their own objectives, study material, and evaluation. They may have prerequisite modules and/or be prerequisites to other modules. In some instances, blocks of modules are prerequisites to residency training.

Definitions

NWS Training Center (NWSTC)-administered modules are modules on which the NWSTC maintains individual records of student completion of the modules. In general, the meteorologist intern must request the module (or block of modules) from the NWSTC; the local training coordinator administers the examinations which are received from the NWSTC.

Remote Training Modules (RTM) are individual, self-study courses which the employees complete at their duty location. Some RTMs serve as prerequisites for residence training courses. Others are stand-alone training that address a specialized topic and may consist of a review of a publication or videotape, completion of a workbook, etc. Stand-alone RTMs are not associated with a residence course requirement.

Module specifics

1. Meteorologist interns must order the RTMs in sections 1 and 2 by block but may order RTMs in section 3 one or more at a time. Once an RTM has been completed, it need not be repeated even if it is part of a block which is a pre-requisite for an NWSTC course.

2. The times specified in sections 1 and 2 designate the normal maximum allotment of time. Individuals who can progress at a faster pace may do so.

Section 1

In general, all training in section 1 is done on-station. This should be performed during the meteorologist intern's first 12 months. However, employees who complete this section sooner should continue immediately into section 2. Regions are encouraged to closely assess the "national requirements which are administered by the region or at the local level" and determine which of the "certificate if needed" requirements are essential for individual meteorologist interns.

National requirements which are administered by the region or at the local level are as follows:

Aviation Observations	Certificate if needed
Synoptic Observations	Certificate if needed
Radar Certification	Certificate if needed
Upper Air Observations	Certificate if needed
Pilot Weather Briefing	
NOAA Weather Radio	
Warning - Call to Action	
Standard Hydrometeorological Exchange Format	
Hydrologic Services Course	

NWSTC-Administered RTMs are as follows:

BASIC BLOCK
(The requirements of the BASIC BLOCK are specified in an appendix to this attachment.)

NWSTC Residence Courses:

Regions should use their discretion here, except that the meteorologist intern will not normally attend the FDC during this section. Anyone scheduled for a radar course will be required to complete the RADAR BLOCK (which is also a block of NWSTC-administered RTMs; the requirements of the RADAR BLOCK are specified in the appendix to this attachment).

Section 2

The training in section 2 is a combination of on-station study and NWSTC residency. It should be taken immediately after section 1 and completed within 1 year. Of course, employees who complete this section sooner should continue immediately into section 3.

NWSTC-Administered RTMs

Forecasting Handbook #6, Satellite Meteorology
(Regional discretion required as to placement of this course in section 2 or section 3.)
FDC BLOCK*
(The requirements of the FDC BLOCK are specified in the appendix.)

* Meteorologist interns attending the NWSTC Radar Meteorology Course before completing section 2 shall substitute the RADAR BLOCK for RTM MMFDC240. In addition, meteorologist interns may substitute the RADAR BLOCK for MMFDC240.

NWSTC Residence Courses

FDC
(Prerequisites: RTMs--BASIC BLOCK and FDC BLOCK)
Other courses at discretion of region.

Section 3

In general, a meteorologist intern will be expected to complete section 3 less than 1 year after completion of the requirements of section 2.

NWSTC-Administered RTMs

MMFDC252	Aircraft Icing
MMFDC270	Hurricanes

NWSTC Residence Courses

Courses at discretion of the regions.

The completion of section 3 ends the FDP training for meteorologist interns. Beyond section 3, the training requirements for meteorologist interns are the same as for journeyman meteorologists.

APPENDIX

The BASIC BLOCK includes the following RTMs:

MMFDC210	Introduction to the NWS
MMFDC211	NWS Directives
MMFDC260	Training Guide for AFOS Operations I

The FDC BLOCK includes the following RTMs:

MMFDC230	The Skew T, Log P Diagram
MMFDC240	Radar Basics for FDC
MMFDC250	Aviation Terminal Forecast
MMFDC251	Transcribed Weather Broadcast
MMRAD450	Beginning Doppler Principles for NEXRAD

The RADAR BLOCK includes the following RTMs:

MMFDC230	The Skew T, Log P Diagram
MMFDC270	Hurricanes
MMRAD410	Radar Principles
MMRAD412	Fundamentals of Radar Wave Propagation
MMRAD414	Radar Reflectivity
MMRAD420	Fundamentals of Weather Radar Systems
MMRAD450	Beginning Doppler Principles for NEXRAD

Special Service Program
Training & Professional Development Plans

1. Introduction

The special weather service programs will require two levels of service or product preparation. The first is a routine level of warning and forecast service provided by each forecaster in each office with the service responsibility. T & PD for this level will be accomplished on-site with the assistance of the SOO or DOH (or the program focal point) via CBLs, seminars and workshops.

The second level of service involves special services, user contacts, other non-routine forecasts and maintaining program currency. These services will be performed by specially trained staff members appointed as focal points. In these cases, multi-level T & PD will be required. The special training or education generally will take place via residence courses at a location where subject matter experts are available. Such courses could be offered to more than one agency, as in the case of the Fire Weather Course at Boise, Idaho.

Program focal points from appropriate offices will attend the course. It is desirable that SOOs also attend, but this will not be practical initially. When they return to their office, focal points serve as the local expert and, as such, will assist with on-site T & PD. The long range goal is to capture as much of this information on CBLs as possible so that the knowledge level of the entire staff can be enhanced.

2. Agricultural Weather T & PD Plan

The NWS Agricultural Weather Program consists of agricultural weather forecasts and observations tailored to current agricultural activities, communication of updated weather information to the farm community and special interpretive statements or advisories issued jointly by the NWS and U.S. Department of Agricultural and/or Extension Services.

This program has been scheduled for termination by the Administration but, up to now, has been restored annually through Congressional budget appropriation. As long as Congress mandates continuation of the program, these activities will be conducted.

2.1 T & PD Objectives

- Improve knowledge of the sensitivity of agricultural operations to weather events,

- Improve the forecasting of meteorological variables critical to agricultural management practices (extreme temperatures and duration, minimum relative humidity, sunshine duration, micro-scale processes, etc.).

2.2 Forecaster T & PD

Forecasters at offices with agricultural forecast responsibility will receive on-site T & PD in basic agricultural meteorology and climatology via CBLs, assisted by the focal point and/or SOO.

2.2.1 CBL Development

Meteorologists at the current Agricultural Weather Service Centers (AWSCs) and at WSO Riverside, California will serve as subject matter experts for a CBL produced by COMET. The CBL will cover basic agricultural meteorology. Syllabus development by AWSC personnel will take 10 months, while the CBL development by COMET will require 9 months. It should be available before MAR Stage 2 is complete.

2.3 Focal Point T & PD

Selected agricultural weather focal points will attend university courses to receive PD on the basic plant-animal responses to weather. Universities will provide appropriate experts from the agro-meteorological community as instructors.

2.3.1 Course Implementation

The NWS, in cooperation with universities, will develop a 3- to 5-week short course covering the appropriate subjects. The first class should be available before MAR Stage 2 is complete, with regional focal points and selected SOOs attending every three years.

Regional focal points will use input from forecasters, SOOs and all users of Ag products to assess the effectiveness of T & PD. The centralized classroom course should be rotated among land-grant universities in major agricultural areas of the country every 3 years.

Course	Presented	Revised	Students
Basic Ag/weather	CBL	Every 6 yrs	Forecasters
University Course	Every 3 yrs	As Required	Focal Points

3. Aviation Weather T & PD Plan

3.1 General T & PD

The current NWS Aviation Program consists of providing specified terminal, route and area forecasting services on a regular basis, and pilot weather briefings upon request. In-Flight Advisories for domestic and specified international airspace are issued as required. Local airport advisories are also prepared at a limited number of airports.

During MAR Stage 2, it is proposed that these activities be expanded to increase the temporal and spatial resolution of terminal forecasts (25 - 40 mile radius and below 10,000 feet) for selected hub airports.

3.1.1 T & PD Objectives

- Improved accuracy of terminal, route, and area forecasts.
- Improved forecast accuracy of aviation weather hazards within the terminal environment.
- Enhancement of the meteorologist's understanding of the effects of weather on aircraft operations.
- Ability to apply state-of-science knowledge to all aviation weather support products and services.
- Capability to provide community outreach and aviation weather education functions.
- Capability to effectively write and interpret terminal forecasts in the new, enhanced format.

3.1.2 Implementation

T & PD for all meteorologists who prepare aviation-related products (e.g., meteorologists at WFOs, National Centers, CWSUs and the Central Flow Weather Support Unit {CFWSU}), will be on-site using a combination of self-study, CBLs and workshops. CBLs will cover state-of-science aviation meteorology (e.g., low-level windshear forecasting techniques). Aviation weather workshops, held biennially, will feature sessions devoted to: the detection and warning of wind shear, icing, and other hazards; the short-term forecasting and "nowcasting" of potentially hazardous weather conditions; and the effects of weather and weather forecasts on aircraft operations.

SOOs and NWS meteorologists performing the Weather Service Evaluations Office (WSEO) functions will serve as the on-site

instructors. The effectiveness of the effort will be assessed from input provided by forecasters, MICs, SOOs and users.

3.1.3 Course Development

The Pilot Weather Briefing (PWB) Course is currently available and will continue as long as the pilot briefing requirement continues. NWS will cooperate with COMET to develop CBLs. NWS staff at the FAA Academy will be used as a source of subject matter experts.

3.2 Specialized T & PD

The CWSUs and CFWSU provide dedicated meteorological support to the National Airspace System. The CWSUs are located outside the WFOs but within a WFO area of responsibility. The MIC, SOO and aviation focal point will include the CWSU in the WFO T & PD plans utilizing CBLs, workshops, seminars, etc.

3.2.1 T & PD Objectives

- Provide information on the FAA and air traffic operations.
- Provide instruction to aid meteorologists in conducting weather familiarization training at their assigned facilities.
- Enhance the meteorologist's ability to forecast aviation weather hazards.

3.2.2 Implementation

Newly assigned CWSU meteorologists and AVSMs will attend the CWSU course offered at the FAA Academy in Oklahoma City. The course is offered in a classroom/laboratory setting and is conducted by NWS instructors assigned to the FAA Academy.

3.2.3 Course Development

The course is currently available and will be revised in concert with the NWS modernization and restructuring. CWSU and CWSFU meteorologists will provide input on the effectiveness of the course, which will be revised/updated by NWS staff at the FAA Academy, as necessary. The requirement to continue this course will continue into the foreseeable future. The frequency of the course may increase if the decision to proceed with full-time operations at the CWSUs is made.

3.3 Aviation Services Evaluation

The aviation services evaluation requirement will continue into the foreseeable future whether the function resides in the WFO or in regional headquarters as an AVSM position.

3.3.1 T & PD Objectives

- Consistent evaluation of FAA pilot weather briefers using PWB techniques developed at the FAA Academy.

- The knowledge to provide T & PD to FAA PWB personnel and to evaluate Flight Service Station, and CWSU individuals or quality assurance programs.

3.3.2 Implementation

Meteorologists at selected WFOs that are assigned quality control/program evaluation duties will attend a course conducted by NWS instructors at the FAA Academy. It is anticipated that revisions to the course may be required as the NWS modernization and restructuring effort progresses.

4. Fire Weather T & PD Plan

The NWS Fire Weather Program consists of routine fire weather forecasts and warning functions, Air Transportable Mobile Unit (ATMU) support at wildfires and other incidents, and liaison and user T & PD efforts provided by NWS staff.

4.1 T & PD Objectives

The objectives are for every forecaster at a WFO with fire weather forecast responsibility to:

- develop the capability to provide accurate fire weather, smoke transport and stability forecasting;
- improve understanding of fire weather needs of user agency decision makers.

An additional objective is that selected staff members understand the requirements of, and be able to operate, the ATMU.

4.2 Forecaster T & PD

Forecasters at WFOs with fire weather responsibility will receive T & PD in basic fire weather meteorology and user needs. T & PD will be on-site using correspondence (state-of-the-art self-study) courses or CBLs in basic fire behavior, assisted by the focal point and/or the SOO.

Once on-site T & PD is completed, videotapes, which include highlights of residence courses, and teleconferencing will be used to address changing user needs and technology in the fire weather program.

4.2.1 Course Development

Currently a self-study course, S390 Intermediate Fire Behavior from the USDA, Forest Service, is available by correspondence from NWSTC. Other applicable self-study courses are being developed at the Boise Interagency Fire Center (BIFC). These courses, along with material being videotaped at the Fire Weather Forecaster Course (FWFC), will be combined to develop a CBL.

Much of the material is already organized as part of the current FWFC, held every other year. Below is a partial list of topics that will be included in the T & PD material:

- Synoptic/meso/micro/Mountain Meteorology
- User agency National Fire Danger Rating System (NFDRS)
- User agency computer systems and fire weather information software (AFFIRMS, IAMS, FW CLIMAT, FIRE FAMILY)
- Forest and rangeland fuel model characteristics

- Wild/prescribed/natural fires
- Boundary layer meteorology (turbulent diffusion in the lower atmosphere)
- Air Transportable Mobile Unit (ATMU) operation
- User management structures and on-site briefing requirements
- User agency weather observation platforms

The NWS will be coordinating with the BIFC, COMET and user groups to develop CBLs. Material from BIFC residence courses, supplemented by subject matter experts, will form the basis of the CBL contents. It should be possible to accomplish this by the beginning of MAR Stage 2.

If a CBL is not produced, the NWS must develop a course that is a subset of the existing FWFC. This course would be taught centrally or regionally prior to the transfer of routine fire weather forecast programs to WFOs.

The teleconferencing seminars will be organized by meteorologists from WFOs providing out-of-office services. The videotapes would be viewed on-site by WFO personnel. Then, a conference call could link students and meteorologists who had attended the FWFC (these may include the SOO, focal point, or ATMU meteorologists). This would allow for detailed review, and questions and answers regarding the material.

4.2.2 Implementation

The plan is to continue centralized FWFC at present level of support if a CBL is developed. Otherwise, greater participation and more frequent courses must be planned to get core meteorologists educated prior to Stage 2. All forecasters should be encouraged to complete the USDA, Forest Service S-390 course or equivalent.

Videotapes with teleconferencing will not be necessary until after the CBL is in place.

4.3 ATMU T&PD

Selected SOOs and designated focal points that have responsibility for ATMU will receive basic operation information and techniques to accompany hands-on operation of the ATMU. In addition to the basic fire weather training, the ATMU program training will teach fire-site forecasting support techniques, including logistics, incident management interface, and data acquisition and forecasting applied to small scale hazards.

4.3.1 Implementation

The NWS will contract with the BIFC training center to develop ATMU CBLs and videotapes in cooperation with experienced fire weather meteorologists. Since the ATMU is relatively new, configuration changes are likely in the future, particularly as we adapt to new NWS and land management agency technology and communications. Current videotape and personal instruction by experienced meteorologists will continue to be the training mode until the final configuration of the ATMU has been established.

A centralized FWFC at BIFC every other year for all meteorologists providing out-of-office services will be continued. The course will be scaled down to include advanced topics in fire weather meteorology once the CBL is in place, reflecting new requirements, and will include SOOs where practical. A 3-day course developed by BIFC Staff Meteorologists and BIFC personnel, with technical support from COMET, will be planned.

4.4 Focal Point T & PD

In most cases, the fire weather focal point will be a forecaster that has also been designated as an out-of-office/ATMU support forecaster and would, therefore, have received all of the above T & PD. In addition, the focal point (and, desirably, the SOO) would attend residence courses, seminars, and workshops provided by BIFC and other user groups. The focal point, in conjunction with the SOO, would then provide the WFO forecast staff with appropriate on-site T & PD.

4.5 Implementation

Course	Presented	Revised	Students
Basic Fire/weather	CBL	Every 6 yrs	Forecasters
ATMU	Videotape	Every 6 yrs	Focal Points/ Selected Mets
FWFC Course	Every 2 yrs 26/ea	Each	Focal Points/ SOOs
Central Course #	10/year 26/ea	Every 2 yrs	Forecasters
ATMU Course #	Every 18 mo 44/ea	As required	Focal Points/ Selected Mets
Videotape/telcon	Variable	As required	Forecasters

Required if CBLs not available

5. Marine Weather T & PD Plan

The NWS Marine Weather Program consists of warning and forecast services for coastal, high seas, and Great Lakes areas, and liaison and user education efforts provided by NWS staff.

5.1 T & PD Objectives

The marine weather T & PD objectives are:

- Improved understanding of marine meteorology and air-sea interaction.
- Improved understanding of coastal processes related to land-sea transition.
- Improved understanding of sea state and forecasting of waves, swell, storm surge, seiche, and coastal flooding.
- Understanding of tides, water levels, and major ocean currents.
- Improved understanding of weather needs of marine users; recreational boating, marine transportation, commercial fishing, offshore energy, coastal communities and facilities.

5.2 Forecaster T & PD

Meteorologists at 42 coastal WFOs, and the high seas units at NMC and NHC will utilize on-site self-study materials and CBLs, supplemented by workshops to acquire the necessary forecast skills. The self-study Marine Reference Manual and Forecasting Guide will provide basic knowledge and references, stressing operational concepts in lieu of rigorous theoretical treatments. The Guide will contain open book, discussion type questions monitored by the marine focal point (high seas unit leader at NMC/NHC) or the SOO.

5.2.1 Course Development

The Southern Region marine focal point, coordinating with the Marine and Applied Services Branch at NWS Headquarters, is leading an effort to develop the Marine Reference and Forecasting Guide. Self-study materials will be prepared by a team of experts from NWS, other NOAA units and Texas A&M University, and will be evaluated before printing in 1992.

Prior to Stage 2, a CBL will be developed, adapted from the Marine Reference Manual/Guide and supplemented by advanced techniques resulting from regional workshops. This self-study material will be converted to CBL by COMET after it is

ascertained that the reference manual/guide is complete with regard to necessary basic course material and has been demonstrated as being effective. The CBL is planned for completion by approximately 1994.

5.2.2 Implementation

1. Outline and format - completed.
2. Complete first draft.
3. Complete technical expert and editorial review of draft.
4. Revise and print draft.
5 Complete test/evaluation of draft manual with selected WSFO marine focal points, SSDs and SOOs
6. Conduct SSD, SOO, marine focal point workshop on Manual.
7. Revise and print manual.
8. Begin self-study program.
9. Convert self-study portion to CBL.

5.3 Focal Point T & PD

In addition to the on-site PD, coastal WFO MICs, SOOs, WCMs, Port Meteorological Officers (PMOs) and marine focal points require supplemented PD. This is provided by periodic regional workshops focusing on meteorological problems unique to the region (e.g., East Coast, Gulf of Mexico and Puerto Rico, West Coast and Alaska, Hawaii and Micronesia, and the Great Lakes). These advanced regional workshops highlight operational marine weather problems unique to the region.

5.3.1 Implementation

Workshops are developed by NWS Regions in coordination with other NOAA line offices, the U.S. Navy and private sector experts, as required, through a contract with a convener who makes all arrangements (curriculum, instructors, case studies, training facility, etc.).

Regional workshops will be planned and organized after each coastal office in the marine region has had at least one person trained via self-study. Completion of the self-study course is a prerequisite for workshop attendance. Current plans are for the first workshop to be held in 1993 with two per year thereafter.

5.4 Validation/Revision

Regional SSDs will evaluate the effectiveness of the Marine T & PD effort with the assistance of the students, SOOs, and program managers from NWS Headquarters.

The reference manual self-study program will be evaluated prior to implementation and revised only as required prior to CBL conversion. The self-study CBL will be revised at 4-5 year

intervals (or sooner) as required by new technology, forecast guidance, mesoscale techniques, etc. Recommendations for revision will be from SOOs, national and regional marine program managers (services, data, guidance), and other NOAA agencies (e.g., NOS re: tides/water levels).

Course	Presented	Revised	Students
Ref Manual/Fcst Guide	Self-study	As Required	Forecasters
Marine Weather	CBL	4 years	Forecasters
Local Workshops	As Required	Each	Forecasters
Region Workshops	2 per year	As Required	Focal Points

6. Satellite Program T & PD Plan

The NWS Satellite Program provides basic satellite data, products, and research to support the NWS Public, Aviation, Marine, Agriculture, Fire Weather and Hydrologic Programs. These operational NWS programs provide a variety of forecast services including the Watch and Warning programs, liaison, and user education efforts provided by NWS staff.

6.1 T & PD Objectives

- A thorough understanding of basic satellite analysis and interpretation techniques, necessary for expert use of satellite observations in all analysis and forecasting applications, and in related hydrometeorological activities.

- A thorough understanding of advanced satellite techniques using both geostationary and polar orbiting satellite data and derived products, necessary to conduct research for improved applications of satellites. New developments will be underway with the deployment of advanced satellite systems (GOES-I/M and NOAA-K/M) and a state-of-the-art display system (AWIPS) that will exploit the new capabilities for integrating data sets.

6.2 Forecaster T & PD

Each meteorologist and hydrometeorologist who produces forecasts and warnings at a WFO, RFC, CWSU or National Center will receive on-site T & PD via CBL, videotape, self-study and expert visitation, developed to provide updated material to the operational meteorologist. Instructors will be SOOs, focal points or meteorologists with expert satellite interpretation knowledge and experience from WFOs, National Centers, Regional Offices or the NESDIS Satellite Applications Lab.

6.2.1 Course Development

Much of this material is already organized as part of the current self-study Satellite Imagery Interpretation course. Satellite Application Interpretation Notes (SAINs) have proved to be a valuable, efficient and low cost training technique.

OM will coordinate with COMET, the NWSTC, NESDIS and the Air Weather Service to transfer existing concepts and techniques to CBL. The presentation will be expanded using computer graphics available in CBL to address new technology from GOES-I/M and NOAA-K/M through AWIPS and WSR-88D integrated displays.

Additionally, Regional (Local) Satellite Workshops will be designed by personnel that attend classroom instruction, with support from NESDIS, and the SSDs and OM.

SOOs will evaluate T & PD effectiveness at the field level under the overall guidance of the SSDs and will develop local workshops as needed. Recommendations for program revision will be based on information from the SOOs, national satellite program managers, NESDIS, students and SSDs.

6.3 Focal Point T & PD

T & PD should result in a cadre of experts able to lead regional and local workshops. Specialized T & PD for selected meteorologists (focal points) from within NWS Regional Offices, WFOs, National Centers and River Forecast Centers will consist of centralized courses given by universities, NWSTC or contract facilities, coordinated through NWSTC and COMET.

Regional T & PD for SOOs and focal points that addresses changing technology will be developed.

6.3.1 Course Development

OM will work with COMET, the NWSTC, NESDIS and/or private contractors to develop and implement an advanced satellite workshop for selected SOOs, DOHs and focal points. Expanded T & PD will address the latest developments in satellite related activities, such as new studies dealing with GOES-I/M, NOAA-K/M, DMSP (SSM-I) and ERS-1/2. This might include classroom instruction that emphasizes latest technology and techniques of satellite meteorology and develops enhanced analysis and operational satellite research skills.

Instructor staff could consist of meteorologists with expert satellite interpretation knowledge and experience for WFOs, National Centers, Regional Offices, and the NESDIS Satellite Applications Lab.

Classroom instruction will be developed after the CBL for basic satellite training is in place. The CBL should be available during Stage 2 and will be revised at approximately 4-year intervals, depending upon changing satellite technology. In addition, Regional (Local) Workshops will be developed as needed.

6.4 Implementation

Course	Presented	Revised	Students
Basic Satellite/wx	CBL	Every 5 yrs	Forecasters
Residence Workshop	Every year	As Required	15-20 SOOs or FPs
Local Workshops	Periodically	Continuously	All Mets

7. Warning Coordination and Awareness Program T & PD Plan

The Warning Coordination and Awareness Program will consist of procedures designed to effectively provide information on hazardous weather (i.e. watches, warnings, advisories, etc.) to the media, local governments and the general population for the purpose of reducing the loss of life and property. The "awareness" aspect of the program is accomplished via education with the goal of ensuring that, once a warning is received, the user will know what to do to protect life and property.

The program involves the entire staff at a WFO. For most of the staff, program awareness and user sensitivity will be developed on-site. Due to the critical nature of the NWS warning mission, a dedicated position has been developed, namely, the WCM.

The WCM position will be much more comprehensive and managerial-intensive in nature than the Warning Preparedness Meteorologist (WPM) position has been. In addition to incorporating all the old WPM duties, the WCM will need to be acutely attuned both to the new technology and T & PD needs of their staff, and to the needs and responsibilities of emergency management personnel. In addition to management training, the WCM will be expected to visit his/her regional office within six months of being hired to learn about the region's focus in the hazard awareness program.

7.1 T & PD Objectives

Due to the importance of the WCM position to the NWS modernization effort, standardized and comprehensive T & PD for WCMs is necessary. Required topics must include the following:

1. The hazardous weather and hydrology data acquisition and dissemination process.
2. The weather and hydrologic information needs of state, county and local emergency management personnel.
3. Establishing and maintaining spotter networks and spotter training.
4. Interacting with and using the mass media.
5. Techniques of public and persuasive speaking.
6. Damage survey methodology, including basic wind engineering and related aspects of structural failure, and aspects of flood damage.
7. Preparing and conducting hazardous weather and flash flood drills, both on-station and in the community.
8. Collecting and preparing storm data.
9. Public relations.
10. Basics of personnel management, including scheduling and arbitration.

7.2 WFO Staff T & PD

The Warning Coordination and Awareness activities affect the primary function of every WFO and impact all forecast programs. The importance of understanding the operations of the program and the continued reinforcement of awareness of the program is a major function of T & PD in this area.

T & PD for forecasters and HMTs will be achieved on-site, primarily by the WCM, using a WCM manual, workshops and OJT. The on-site program for the WFO staff will be developed by the WCM in cooperation with the SOO. On-site courses will be presented before an office becomes a WFO and on an as-needed basis thereafter.

A detailed WCM manual, containing two sections, will be prepared for each WFO. Section 1 will be generic and cover the first nine objectives listed above. Section 2 will contain local information such as emergency management and law enforcement contacts, mailing lists, awareness activities, etc.

National and regional WCM newsletters will be distributed routinely and will provide educational/training sections.

7.3 WCM T & PD

In addition to the above, the WCM will receive T & PD through a series of residence courses and conference/workshops.

A one-week residence course at the NWSTC for WCMs will cover all objectives except management, which should be covered in other management-oriented courses. The course will consist primarily of lecture/workshop sessions. The WCM manual will provide reference and background material, whereas the course will concentrate on subjects not readily learned from written material.

Course instructors are expected to consist of a mix of NWS and outside experts. Topics unique to the NWS such as spotter training, and storm data and hazardous weather drill preparation, will be taught by in-house subject matter experts. For topics such as emergency management needs and dealing with the media, outside subject matter experts will be used under contract.

Every two years, all WCMs will attend a national WCM conference/workshop. The conference will introduce new ideas/advances, and will provide a forum for an exchange of experiences among WCMs.

7.3.1 Course Development

The WCM Manual is being developed by the Southern Region Headquarters in conjunction with NWS Headquarters and the other Regional Offices. The manual will be available in 1992 for MARD offices.

The Southern Region, in coordination with NWS Headquarters, has already hosted a workshop for the Amarillo, Tulsa and Norman WCMs. In addition, NWS Headquarters (W/OM11), in coordination with the regions, provided a one-week workshop for the MARD WCMs at the NWSTC. These two workshops are expected to serve as a prototype for the WCM course. Details on the transition from the prototype to the formal course need to be worked out. Workshop material will be developed on an ad hoc basis for each workshop.

7.3.2 Implementation/Completion

Section 1 of the manual will be completed in 1992. Section 2 of the manual should be completed within 6 months of arrival of WCMs at NWSFOs and NWSOs.

New WCMs should be scheduled for the one-week residence course as soon as possible after selection and, at the latest, within the first year of their assignment. Since selection of the WCM is tied to the delivery of the WFO's WSR-88D, course requirements can be projected through the transition to Initial Stage 2. Assuming an average class size of 15 WCMs, 2-3 courses should be offered per year through 1996.

Requirements for the WCM course will continue beyond the initial restructuring of the NWS. Based on a projected turnover in the WCM position of 7% per year, there will be a requirement for one class per year for 1997 and beyond.

On-site courses will be presented before an office becomes a WFO and on an as-needed basis thereafter.

7.4 Validation/Revision

Validation - On-site T & PD evaluation will be conducted by the SOO with assistance from the regional WCMs and input from DOHs. The one-week residence course is expected to be validated through the prototype workshop for the MARD WCMs.

Revision - WFO WCMs will be responsible for WFO manual updates and for any adjustments to on-site T & PD for the rest of the staff. NWS Headquarters will work with the regions to provide any generic updates. Input for revisions will be obtained at WCM national conferences. The one-week residence course will be reviewed annually with revisions made as necessary.

Course	Presented	Revised	Students
WPM Manual	On-site	As Required	WFO Staff 1955
Conf/Workshop	every 2 yrs	As Required	WCMs - 130 ea
One-week Course	every year	As Re-quired	WCMs

8. Public Service Training Plan

Since public service tasks are unique to each WFO, on-site training will be provided by the operational staff under the guidance of the SOO. Each office will have public service duties clearly outlined in the Station Duty Manual and each new meteorologist, service hydrologist, hydrometeorologist and HMT will be required to show proficiency in providing public services before being certified to stand operational shifts. Additionally, each WFO will have sufficient climatological and environmental data information available in an easy to use manual for use in the public service program.

NEW TECHNOLOGIES TRAINING PLANS

1. Automated Surface Observation System (ASOS)

The overall ASOS T & PD Plan consists of the following four main elements:

- The ASOS User's Manual;
- ASOS Operator Training;
- ASOS Network Management Training; and
- ASOS Maintenance Training.

The impact of ASOS training on NWS operations will be minimal for User and Operator training (both conducted on-site). Maintenance training will require travel by NWS employees to the training facility and absence from the job for periods of up to three weeks.

1.1 The ASOS User's Manual

This manual will be prepared by the ASOS Program Office. It is intended to acquaint users of ASOS data (e.g., meteorologists and air traffic controllers) with the operating components, characteristics, capabilities and limitations of ASOS. This manual will be reviewed periodically and revised as necessary by the ASOS Program Office during the ASOS Operational Implementation Phase (1991-1994).

1.2 ASOS Operator Training

ASOS training (and all necessary training material) will be provided by the ASOS contractor, AAI Corporation (AAI) of Hunt Valley, PA. This training is intended for NWS and FAA personnel who will communicate with ASOS to either input data (such as edited or augmented observations) or extract data and information on system performance through an OID. There are two levels of operator training planned:

Level I training is for NWS HMTs, and for FAA and contract observers who will use the OID for editing or to input augmentation (additional) data for inclusion in the ASOS observation. This training is intended to provide observers with hands-on proficiency in operating the OID. The training will be conducted on-site for a core group of local observing staff (up to a maximum of six persons per OID-equipped location). Proficiency training shall be about two hours per student. Level I training, which includes a videotape, will be developed as an integral part of AAI's Phase II proposal.

Under the Phase I contract, AAI will prepare a "storyboard" of the videotape for review and approval by the Government prior to preparation of the videotape in Phase II. The videotape is the

initial equipment familiarization tool and, as such, shall describe ASOS configurations, operator controls and indications, and the function menus that allow the operator to interface with the system. A videotape will be provided to each OID location at least four weeks prior to the start of equipment installation, and will remain on site for refresher training and training of newly hired employees. All training provided by AAI will occur during the familiarization portion of the site component activation process (1991-1995).

Site follow-on operator familiarization/proficiency training (i.e., on-site training using materials developed by AAI) must be complete, and trainees must be fully able to operate the assigned ASOS duties before ASOS commissioning at that site. This includes augmentation and backup duties.

1.3 ASOS Network Manager Training

Level II training will be provided for 60 Government managers of the ASOS network. It will provide an in-depth understanding of ASOS hardware and software and will not exceed 5 working days in length. AAI is to train a maximum of 12 Government personnel per Level II class. The training course will include information contained in Level I training, plus:

- in-depth sensor and algorithm explanations;
- how to initialize system with constants, special criteria, etc.; and,
- remote dial-in procedures.

The Level II training course will be presented a minimum of five times. The first two classes will be conducted prior to (or during) initial Lot 1 deliveries. The final three classes will be conducted not more than six months prior to delivery of Lots 3a, 5a, and 5b, respectively. AAI will submit a proposed training schedule and training material outline for Government review and approval.

1.4 ASOS Maintenance Training

Total maintenance service (i.e., ILS) has been cost competed with industry. Maintenance training was an element of the ILS. The NWS ILS proposal was determined to be the most cost effective and was selected.

Fully trained ETs will provide field maintenance services for NWS maintained ASOS systems. These services will be provided as systems are delivered in accordance with the ASOS production schedule. Site maintenance personnel will receive their training prior to system acceptance. NWS field, Regional and National Headquarters personnel (including maintenance instructors, depot, and supply support) will receive training prior to system

acceptance in their sphere of responsibility. Trained personnel will be provided in sufficient numbers to meet the installation schedule and normal attrition.

1.4.1 Assumptions

The ASOS systems, as delivered, will meet the procurement contract specified performance requirements (e.g., Mean Time to Repair - MTTR, Mean Time Between Failure - MTBF, fault isolation, training documentation sufficient to meet tactical needs of the technical training program, system documentation sufficient to meet maintenance, training, depot and supply support user needs).

1.4.2 Planning

The OSO Engineering Division has been active in ASOS planning since its inception. Detailed planning for ASOS training has been included in ASOS procurement documents. Much of the work remaining is dependent upon reasonable products being delivered under the contract. For example, should the government be forced to accept less than adequate training documentation, the time to prepare for instruction of employees will be lengthened.

1.4.3 Training Objectives

The ASOS technical training program objective is that each person receiving training be able to perform at the full performance level within a reasonable time after training is completed. A 1-year learning curve is anticipated before personnel are operating at the "100 per cent" level. At this level, the maintainer can meet the MTTR criteria, assuming parts are available.

1.4.4 Course Development

Training material is a deliverable under the prime contract. The presumption is that this documentation, when accepted by the government, will be able to be utilized without material changes. NWS is cooperating with AAI to assure the development of the best training materials. This is required in order to begin training at the earliest possible date, and to match the training of personnel with the delivery and support schedule.

Level I (field maintenance) training will be primarily for a core group of field ETs who will be maintaining ASOS units delivered during the limited production phase. Level II (expert level maintenance) training will be primarily for AESs who will be responsible for ASOS maintenance oversight in the field. Depot and software maintenance training will be primarily for depot repair technicians at the NRC. Headquarters (NWS and Navy), NWS regional program personnel, and NWSTC instructors will also be trained as appropriate.

Government-designated instructors will attend and critique the initial presentation for Level I and II maintenance training. Course content and materials will be revised by AAI as directed by the Government based on these critiques. Depot Maintenance Course outline, development and materials will be reviewed and approved by the Government prior to formal course presentation.

A software maintenance training course is to be developed by AAI. The purpose of this course is to familiarize those NWS personnel responsible for maintenance of the ASOS software with the existing source documents that will be used for diagnosis and maintenance. AAI will train six NWS people; the duration and location of the course has yet to be determined.

1.4.5 Training Schedule

Training will be conducted in phases. Limited training of government personnel is anticipated to begin in accordance with the production schedule. Training will continue through production and fielding of the approximately 868 operational systems comprising the operational network. Allowances for attrition have been built into the training schedule.

AAI will provide initial training for maintenance support of the ASOS network to NWSTC instructors at the factory. Follow-on training will be provided by the NWSTC. The initial training will prepare a core group of ETs, maintenance oversight personnel, depot technicians, and headquarters and regional program personnel to support ASOS until NWSTC training courses are established. Initial training courses include Level I and Level II equipment maintenance; depot maintenance and system software maintenance. Initial training requirements are described below.

Course	Location	# Students	Duration	# Classes
Level I	AAI	19	5 Days	3
Level II	AAI	27	3 Weeks	4
Depot	NRC	5	TBD	1
Software	TBD	6	TBD	1

TBD = To Be Determined

1.4.6 Validation/Revision

This is a continuing process. The NWSTC has, for decades, sent follow-up forms to the supervisors of personnel who have received training for an evaluation of the employee's performance. This technique, modified slightly, will continue to be utilized. Students will also queried at the end of each course. The information obtained from students, supervisors, and headquarters engineering managers (who conduct periodic reviews) will be utilized to improve the product delivered by the NWSTC. As engineering changes are made to operational equipment, information will be provided to the NWSTC and revisions, as appropriate, will be made to the courseware.

1.5 ASOS Software Training

ASOS training (and all necessary training material) will be provided by AAI. This training is intended for NWS or support personnel from AAI who will be maintaining the ASOS operational software. The training will be conducted either on-site or at AAI's site for six NWS-designated trainees.

The ASOS software training course will include information on the following topics:

- Hardware overview
- Software overview and hierarchy
- Familiarization with available documentation
- Familiarization with the use of software development system
- Error identification, fault isolation and resolution
- Generation of a new system release
- Maintenance and update of the software baseline and supporting documentation
- Conversion of a software release into firmware

2. Advanced Weather Interactive Processing System (AWIPS)

NOTE: The current plan for the acquisition of AWIPS-90 calls for a total service contractual arrangement under which the AWIPS-90 contractor would be responsible for systems maintenance and user training. The total service acquisition strategy is now being re-examined. More detailed information concerning AWIPS-90 training requirements and dates will be available upon AWIPS-90 contract award.

2.1 Operator Training

Operator training will be provided in three distinct segments; 1) Initial User Training, 2) Routine User Training, and 3) System Training. All three segments will be developed by the AWIPS contractor. The contractor will also be responsible for conducting initial user and system training. Routine user training will be a CBL package that will always be available through the AWIPS system. The NWS is responsible for developing and conducting scientific training.

"Initial User Training" for the entire operational staff (meteorologists, hydrometeorologists, hydrologists and HMTs) will be conducted on-site by the contractor immediately following AWIPS installation and equipment acceptance. The contractor will be expected to provide instruction to each user on "day-to day" operational usage of the system. This instruction will either be individual or in small groups, and will include "hands-on" use of the AWIPS system. It is expected that each person will receive several hours of instruction.

Training will be tailored to each site's particular system configuration and will enable users to operate in all operational and maintenance modes. Identification of basic system malfunctions and how to take simple corrective actions will also be included.

"Routine User Training" will be an automated-interactive form of training that will always be available at each site to allow the NWS to train new users and to provide refresher training. Initial user training will be a subset of the routine user training package. It is an AWIPS requirement that the AWIPS system be able to support training while in an operational mode.

For "System Training," the contractor will provide the necessary equipment and manuals, and will present a 3-week course at the NWSTC. The course, designed for the AWIPS Focal Point, SOOs and DOHs, and the ESA from each AWIPS office, will cover AWIPS computer operations, system and applications software, support software, algorithms, AWIPS data base(s), programming

conventions, performance verification procedures, error correction procedures, special maintenance requirements and documentation. NWSTC will assume this training responsibility after the Deployment Phase is complete.

"Scientific Training" (i.e., data interpretation, manipulation, presentation and application) will be developed and conducted by the NWS through COMET and on-site professional development. This form of training will include the play-back of "pre-recorded" scenarios to allow NWS forecast personnel to either practice or demonstrate various forecast techniques. Each AWIPS system will be capable of combining and archiving operator-selected sets of observational data, forecast products, radar data and satellite imagery for the most recent 36 to 96 hours to be used as recorded scenarios.

The AWIPS-90 Program Office is currently working with the Program for Regional Observing and Forecasting Services (PROFS), COMET and the SSDs to start preliminary work in developing scientific training. PROFS is developing product descriptions of profiler, satellite, simulated WSR-88D, meso-net data, etc., that may be used as reference material for future scientific training. PROFS is also initially developing case study scenarios that address winter storm forecasting and mesoscale convective activity. The table below summarizes AWIPS operations training.

Who	Course	Location	By	Duration	When
SOO, DOH ESA, FP	System	NWSTC	Contract	3 Weeks	TBD
All Staff	User (initial)	On-site	Contract	Variable	At Install
All Staff	User (Routine)	On-site	Self	As Needed	As Needed
SOO, DOH	Science	Boulder	COMAP	8 Weeks	TBD
All Fcstr (Other)	Science	On-site	CBL SOO, DOH	As Required	As Needed

Fcstr - Forecasters include meteorologists, hydrologists, and hydrometeorologists.
FP - Focal Point

2.2 AWIPS Maintenance Training

Under a total service contract, the only training required is system level training at NWSTC for the ESA. See "System Training" above.

3. Next Generation Weather Radar (WSR-88D)

The current WSR-88D training plans are contained within the Tri-agency (Department of Commerce {DOC}, DoD, and FAA) contract with UNISYS Corporation (the WSR-88D contractor).[1] Through the Interim Tri-agency training period, during which classes will be shared with DoD and FAA personnel, these courses will be managed by the Systems Program Office (SPO).[2] When the three agencies agree to conduct their own training, NWS will begin to conduct and manage NWS-exclusive training.

3.1 WSR-88D Operations and Technology Training

Initial WSR-88D operations training will be accomplished primarily via the 4-week Operations Course at Norman, OK. Staffing plans during the transition provide for the addition of two meteorologists and a SOO for each NWSFO, and a MIC, SOO, WCM, five core meteorologists and a service hydrologist to each NWSO. These additional staff members will be assigned in time for the WSR-88D training required prior to WSR-88D activation. This restructuring of office staff provides the opportunity, not ordinarily available because of limited staffing, to send staff to centralized training.

The Operations Course will consist of two phases; the Interim Tri-agency training phase and the NWS agency exclusive training phase. Current plans are for the phase change to be primarily in the management area and should be transparent to the student. All WSR-88D training for each office will be completed before commissioning of the WSR-88D system at that office.

A shorter version of the Operations Course, called the WSR-88D Managers' Course, will be offered to Regional and National Center Headquarters Personnel who require basic knowledge regarding WSR-88D but will not be using the radar operationally. This overview training for managers will be conducted on-site.

3.1.1 Training Objectives

After completing the WSR-88D Operations Course, operators will be able to operate all applicable WSR-88D equipment, and to interpret and operationally use radar-generated products in making forecast and warning decisions.

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[1] Limited Production Phase Weather Surveillance Radar-88D (WSR-88D), Contract 50-DWNW-8-00032, Personnel Requirements, Training and Training Equipment Plan, CDRL #218, dated 15 Nov 90.

[2] Refer to the document entitled Administrative policy for the WSR-88D Interim Tri-agency Training Courses, JSPO, dated June 1990.

The goals for the WSR-88D Managers' Course are: (1) to enable students to describe the basic operation of the WSR-88D system (communications and interfaces, data distribution, capabilities and limitations), (2) to provide basic information on algorithms and product generation, and some of the capabilities and limitations, (3) to describe the importance of site adaptation of algorithms and the need for climatic input, (4) to describe the decision-making process, (5) to describe the impact and importance of the UCP and, (6) to emphasize the value of training in general.

3.1.2 Target Audience

All the operational staff at NWSFOs, NWSOs, RFCs, CWSUs, National Centers, and certain meteorologists and hydrologists from National and Regional Headquarters and the NWSTC will be trained prior to WSR-88D implementation at their office. Focal point duties will be assigned as additional responsibilities; however, no additional training is currently planned.

Approximate number to be trained
- 3000 - some level of on-site training
- 2250 - forecaster training at Norman
- 250 - managers, etc.

3.1.3 Location of Training

Precursor training material continues to be developed and distributed to NWS offices for on-site study prior to attending the Operations Course. The residence portion of the WSR-88D training will be conducted at Norman to take advantage of the proximity to the National Severe Storms Laboratory (NSSL) and the OSF. A post-course checklist to be developed by OSF will be administered by the SOO or DOH on-site to ensure that students successfully completed the course.

3.1.4 Type of Presentation

On-site training consists of precursor training materials and on-site "remote modules" under the tutelage of the SOO or DOH (focal point until a SOO or DOH is assigned). These modules consist of videotapes, workbooks, and printed material and cover topics ranging from "Doppler Radar Theory and Interpretation," to applications such as "Precipitation Estimation Techniques." In addition, the NWSTC has distributed three modules on conventional radar theory which may serve as useful refresher material. These and additional materials (e.g., Fornear WSR-88D algorithm modules) have been packaged into local training packages for on-site training prior to attending the Norman course.

The Operations Courses features a combination of lectures and laboratories using PUPs and UCPs.

All Operations Course attendees will be given OJT checklists to complete at their home office to evaluate their understanding of and ability to use the WSR-88D system.

HMTs will receive on-site job-oriented training using CBLs and OJT, under the guidance of the SOO, DOH or other staff member. Adjustments to this training will be made as the WSR-88D duties of the HMT are more clearly defined.

The PD Program (COMET and on-site) will focus on the development of additional skills in the integration of WSR-88D data into the concept of total analysis and forecast preparation. The on-site approach will be employed as new applications, algorithms, etc., are developed.

3.1.5 Instructor Staff

The SOO & WSR-88D focal point at each office will provide assistance to individuals (forecasters and HMTs) in completing the precursor modules, CBLs and the post-Norman checklist.

A 5-week course for instructors and the Operations Course have been conducted as a SPO Tri-agency course taught by UNISYS at the OSF. Government (NWS and DoD) instructors have now assumed the instruction responsibilities. When agency-exclusive training begins, only NWS instructors will remain at Norman.

The WSR-88D Managers' Course will be conducted by OSF instructors at various Regional and National Headquarters sites.

3.1.6 Course Development

Precursor material was developed by the NWSTC, NSSL and OH. Several precursor modules continue to be developed.

In order to initiate the process of developing the Operations Course, the NWS provided UNISYS with the meteorological and hydrological portions of the training material. UNISYS then integrated the material into the Operations Course. The SPO and OM closely monitored the production of the training material by UNISYS to ensure adequacy for the needs of the NWS. The instructors have modified the course as a result of the evaluation of the first Operations Course, which was held in the fall of 1990. The Operations Courses resumed in September 1991 and further course modifications and improvements will continue to be made.

The NWS instructors at OSF will develop on-site modules as new WSR-88D algorithms, capabilities and applications are developed.

3.1.7 Training Schedule

NWS operational personnel will receive their training during the period immediately before WSR-88D activation ("Activation," also known as government acceptance, will occur several months after installation at each site).

The projected class schedules for the NWS Operations Course have been developed with the guidelines presented below:

- maximum of 24 students per class,
- maximum of two classes at a time initially (i.e., a maximum of 48 students at one time), with the possibility of an increase to three classes sometime during 1993 (i.e., up to 72 students at one time),
- field personnel will generally be trained immediately before their office receives a PUP,
- meteorologists and hydrologists will generally be trained in groups of two or three from each NWSFO, RFC or NWSO,
- personnel in Alaska, Hawaii, and Puerto Rico will generally be trained during 1994 and 1995,
- the schedule will have some flexibility to accommodate attrition. Slots will be designated on the schedule as "Attrition" and are primarily intended to be used for attrition purposes; i.e., if an office has already completed its WSR-88D training, and a new person transfers to that office, this person will be assigned to WSR-88D training by filling one of the "Attrition" slots.

The actual class assignments are frequently being updated through coordination with the NWS regions, and are not contained in this plan.

The following table summarizes WSR-88D operations training.

Who	Course	Location	By	Duration	When
All Staff	Precursor	On-site	Self	Variable	Bfr Ops Course
Fcstrs.	WSR-88D Ops	Norman	NWS	4-Weeks	Before Activtn.
HMTs	UCP	On-site	CBL SOO/FP	Variable	Bfr Comm
Fcstrs.	Updates	On-site	CBL/SOO	Variable	As Avail.
Managers	Overview	On-site	NWSH	1 Week	As Avail.

3.1.8 Training Validation

A policy on how to follow-up with students who do not successfully complete the Operations Course has been established. The two categories of students to be considered with regard to this "failure" policy are discussed below.

a) Employees who pass the course will be given an OJT checklist designed to assess their proficiency in using WSR-88D data. Failure to demonstrate proficiency, as assessed by the MIC or HIC, will necessitate additional OJT at the office. Failure to demonstrate proficiency this second time indicates that a fully successful rating cannot be achieved for critical element(s) associated with the utilization of WSR-88D. At this point, a Performance Improvement Plan (PIP) under the GWPAS or PMRS systems is instituted.

b) Employees who fail the course will receive remedial on-site training in particular areas of weakness, to be completed during duty time. Upon completion of this additional training, employees will be expected to demonstrate proficiency in the OJT checklist activities. No further action will be necessary for those successfully demonstrating this proficiency. Those who, after remedial training, are still unable to demonstrate proficiency in the checklist activities must be placed on a GWPAS/PMRS PIP.

   As part of the PIP, the student may, in the judgment of the MIC/HIC, regional director and/or WSR-88D Operations Training Unit Chief, be required to attend the Operations Course a second time. (NWSH attrition slots will be used to accommodate such students.) Employees failing the course a second time cannot be considered to have successfully completed the additional training, and the MIC/HIC must take an appropriate performance-based personnel action.

3.1.9 Training Revision

The MICs and SOOs will ultimately validate the effectiveness and appropriateness of the training. Their feedback through the SSDs and program managers will impact the training program.

OSF will manage validation and revision until the NWS assumes management of the NWS WSR-88D operator training. Generally, course evaluation forms will be used at the end of each course and after 90-120 days.

3.2 WSR-88D Maintenance Training

The Assistant Administrator for Weather Services has determined that field maintenance services for WSR-88D will be performed by the NWS. The NWSTC has assumed the responsibility for this

training. The NWS also has ILS responsibilities (e.g., OSF, depot repair operations, central supply depot) to the other joint procuring agencies.

3.2.1 Objective

Fully trained ETs will provide field maintenance services for doppler radar systems owned and operated by the NWS (including those units at National Centers). These services will be provided as systems are delivered in accordance with the latest WSR-88D full-production schedule. Site maintenance personnel will receive their training prior to system acceptance. Field, regional and national headquarters (including maintenance instructors, OSF, depot, and supply support) personnel will receive training prior to system acceptance in their sphere of responsibility. Trained personnel will be provided in sufficient numbers to meet the installation schedule and normal attrition.

Maintenance training will consist of either the full 6-week maintenance course or a 2-week PUP only maintenance course; and, as required, a 2-week course covering maintenance of associated MLOS equipment at selected sites; or a 2-week Maintenance Managers course.

3.2.2 Assumptions

The WSR-88D systems, as delivered, will meet the procurement contract specified performance requirements (MTTR, MTBF, fault isolation, training documentation sufficient to meet tactical needs of the technical training program, system documentation sufficient to meet maintenance, training, depot, supply support user needs, etc.).

The cost comparison process resulted in the government obtaining the contract to perform field maintenance services for NWS WSR-88D operational systems.

3.2.3 Planning

The OSO Engineering Division has been an active member of the WSR-88D Training Advisory Committee since its inception in 1980. Status of current activities follows:

ACTIVITY	WSR-88D STATUS
Plan/schedule	NWSTC is in the process of revising the maintenance training plan/schedule. The revised plan will include all four maintenance training courses-- 6-week maintenance, 2-week PUP only, 2-week MLOS, and 2-week Maintenance Managers.
Costing	The cost estimates are procurement sensitive. Training of maintenance personnel is within scope of the WSR-88D cost comparison field maintenance services project. Training cost estimates during the installation phase of the WSR-88D program were provided to W/OSO31 in January 1990. They cover the time period FY 91-FY 97, inclusive. The decision affecting who performs WSR-88D field maintenance services will not be made until the conclusion of the cost comparison project.
Training Documentation	This is a deliverable under the contract. The presumption is that the documentation will be suitable, with very minor revision, to be utilized immediately upon receipt. The scheduled delivery of training documentation is to be determined.
Contract	Contract items, schedule, etc., are pending resolution. Many things are yet to be resolved between the contractor and the government. When a schedule is agreed to by the government, it will be provided as an exhibit.

3.2.4 Dependencies

Much of the work remaining is dependent upon reasonable products being delivered under the contract. For example, if the government is forced to accept less than adequate training documentation, the time to prepare for instruction of employees will be lengthened in a non-linear (i.e., not 1:1) fashion. The privatization decision will determine who performs maintenance training and field maintenance.

3.2.5 Training Objectives

The WSR-88D technical training program objective is that each person who receives training (i.e., 6-week; 2-week PUP only; 2-week MLOS; 2-week maintenance manager; and depot level training levels I, II, and III) will be able to perform at the full performance level within two years after receiving training. Full performance level is defined to mean the maintainer can meet the MTTR criteria, presuming required resources (e.g., parts, documentation) are on site.

3.2.6 Target Audience(s)

The target audiences are as follows:

- field site ETs
- field site ESAs
- field maintenance managers,
- Regional Headquarters maintenance managers, and
- NWS Headquarters technical personnel and managers.

3.2.7 Location of Training

Training for cadre personnel (NWSTC instructors), limited production system personnel and full production WSR-88D systems will take place at the NWSTC. The site for special training for MLOS (cadre) is yet to be determined; for government trained personnel, it will be at the NWSTC. Depot training for levels II and III are special: level II will be located at major subcontractor locations (e.g., Westinghouse transmitter -- Baltimore, MD). Specific locations are not firm yet. Level III will be located at the NRC.

Precursor training will occur at the ET's site via NWSTC-provided videotapes.

3.2.8 Type of Presentation

Presentation modes will be mixed: classroom, some CBL, video and self-study.

3.2.9 Instructor Staff

For the cadre training, the instruction staff will be provided by the prime contractor. For government-provided training, staff from the NWSTC will be utilized. For special courses (i.e., depot levels II, III), major subcontractors are expected to be utilized.

3.2.10 Course Development

Courseware is a deliverable under the prime contract. The presumption is that this documentation, when accepted by the SPO and provided to the government, will be able to be utilized without material changes. This is required in order to begin training at the earliest possible date, and to match the training of personnel with the delivery and support schedule.

The NWSTC completed and released two precursor videotapes for maintenance training in FY 89. Employees are required to complete these two units prior to attending formal WSR-88D instruction.

The NWSTC will be responsible for maintaining training documentation.

3.2.11 Training Schedule

Several events must occur prior to implementation. Among these are: completion of cadre training; acceptance of training courseware (documentation); delivery/acceptance of the training equipment (e.g., system, support equipment, spares); completion of training facilities; supply/depot support in-place; and production of Limited Production Prototype, and production systems and facilities.

Training will be conducted in phases. First, the cadre must be trained. Next, an infrastructure of Headquarters personnel (e.g., depot, OSF, Regional) must be trained. Then, field personnel will be trained. Phasing is important,but may be blurred due to the integration of the overall effort.

Training will continue through production and fielding of the approximately 113 operational systems comprising the NWS operational network. Allowances for attrition have been built into the training schedule. The number of personnel that will be trained is procurement sensitive.

3.2.12 Validation/Revision

Validation and revision the training approach is a continuing process. The NWSTC will utilize the technique of sending follow-up forms to the supervisors of personnel who have received training for an evaluation of the employees' performance. Also, students will be queried at the end of each course. The information obtained from students, supervisors, and headquarters engineering managers (who conduct periodic reviews) will be utilized to improve the product delivered by the NWSTC. As engineering changes are made to operational equipment, this information will be provided to the NWSTC and revisions, as appropriate, will be made to the courseware.

4. GOES-I Training Plan

See Appendix D for scientific satellite training. No hardware operations training is involved.

5. NOAA Weather Radio Console Replacement System (CRS)

The planned upgrade to the NWR system is primarily a replacement of the office consoles. The new equipment will incorporate digital-to-voice technology and will have the capability to interface directly to the AWIPS equipment in the WFOs. Requirements are currently being prepared for a procurement action. The preliminary training requirements are given below.

As part of the contract, the contractor shall develop a training plan. Preliminary plans are for the prospective contractor to develop and administer an in-depth course for selected instructors and Headquarters focal points at the NWSTC. The contractor shall provide the necessary equipment, outlines, instructor and student guides, lecture guides and slides for the course. This contractor training shall cover three subjects; operational use and data base management, hardware maintenance, and software maintenance on the CRS units. This training shall compliment but not duplicate writing and broadcast techniques covered in other NWSTC training courses. The training should be completed well before deployment of field site CRS units. The contractor shall provide any updated training to NWSTC that may be required due to system changes.

5.1 Operator Training

The Contractor will develop and administer an in-depth course for NWSTC instructors and regional and national headquarters focal points at the NWSTC. This training will consist of three subjects; operational use, system software maintenance, and hardware maintenance of CRS units. This training will be completed in the 90 day period before deployment of the CRS units and there will be up to 15 students in each of the three subject areas. The attendees will form a core of in-house CRS expertise for the NWS.

As part of the CRS acceptance procedures at each office, the Contractor will provide on-site training in the operational use of the CRS to up to 15 persons per office. The Contractor will also provide on-site training in CRS database and system management to up to two persons per office, who will serve as CRS focal points for the office.

The contractor shall submit training material for NWS evaluation to use on-site as review or for training new employees. The contractor shall also propose an appropriate format for this training material; e.g., computer based, written or videotape.

The following supporting information will supplied at a later time:

- Training schedules that are tied to the deployment of the CRS units.

- Requirements for training content and length for the NWSTC and field sites.

- Schedules for CRS delivery to the NWSTC (including the number of units required) in anticipation of instructor training.

5.2 Maintenance Training

The plan for maintenance training will be developed based on the Maintenance Support Plan and the training plan submitted by the contractor.

6. Profiler Training Plan

6.1 Operator Training

The Wind Profiler Program, while still a developmental program, has developed training material for use with Profiler sites in a 30-site demonstration network in the Central U.S. Training materials consist of four videotapes and accompanying workbooks. Selected personnel (focal points) at some WSFOs have been trained for the Profiler assessment program. The same strategy will be applied to WFOs established in the MARD area that will have access to profiler data.

The four manuals and 30-minute videotapes are on the following subjects:

1. Principles of Wind Profiler Operation,
2. Quality Control of Wind Profiler Data,
3. Subjective Uses of Wind Profiler Data in Warm-Season Analysis and Forecasting,
4. Subjective Uses of Wind Profiler Data in Cool-Season Analysis and Forecasting.

6.2 Maintenance Training

When the Profiler becomes an operational system, a maintenance policy, including appropriate training, will be developed.

ROLE OF REGIONAL SCIENTIFIC SERVICES DIVISIONS

1. Introduction

As the NWS enters the MAR, field personnel will have an increased need for scientific information. This will be reflected in a changing role for the Regional SSDs, which are charged with ensuring the scientific integrity of the NWS field programs and the technical competence of its employees. This Appendix will examine the functions of the SSDs in the modernized NWS.

2. Historical Background

SSDs originated with the Weather Bureau reorganization of 1964, which shifted "complete responsibility for technical and administrative activities in the field to the Regional Offices."[1] Six Regional Offices were established. The SSD, under the management of the Regional Meteorologist, was one of the divisions in each Region. In discussing the duties of the Regional Meteorologist, it was noted that the SSD "evaluates the effectiveness of existing techniques for the preparation of forecasts and warnings, and develops and tests improved methods for performing these services."[2] Each SSD had on staff an Assistant Regional Meteorologist for Techniques Improvement. The role of this individual was "to develop and recommend uniform technical procedures for making the best use of guidance material." The other key SSD position was the Regional Radar Meteorologist, who was "responsible for initiating and monitoring local studies on the use of radar..., for organizing and supervising special radar research data-collection programs..., and for recommending improvements in Bureau-wide methods of radar utilization."[3]

SSD programs have evolved over the last quarter century. Major program areas now include verification, training, techniques development, hydrometeorological computer applications, technology transfer, scientific assessment of new technology and mesoscale analysis and forecasting methods.

In the two non-mainland regions, the SSD programs are coordinated by single individuals and the workload is divided among the Regional Headquarters staff. In the Alaska Region this is done by the Chief Regional Scientist, who is part of the Environmental Services Branch of the Operations Division; while in the Pacific Region the Staff Meteorologist operates directly under the Regional Director.

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[1]Topics, Volume 23, Number 4, April 1964, page 67.

[2]Topics, Volume 23, Number 8, September 1964, page 134.

[3]Topics, Volume 24, Number 2, March-April 1965, page 55.

3. Scientific Services Division Emphasis Areas

3.1 WFO/RFC Scientific Programs

The new sensing technologies and data processing capabilities associated with the MAR give the NWS the potential to refine the temporal and spatial scales of scientific weather forecasts and warnings. However, the ultimate success of the NWS modernization efforts will not be measured by the deployment of new technologies, but rather by how they are used to improve weather services. Thus, an intensive scientific development and training effort will be needed before the nation will reap the full fruits of the modernization. The SSDs, in conjunction with the various offices of NWS Headquarters, will be responsible for the direction, coordination and quality assessment of this effort.

After the MAR there will be 115 WFOs and 13 RFCs. Each will be staffed with either a SOO or a DOH who will be responsible for local scientific and training projects. It will be incumbent upon the NWS to assess, facilitate, coordinate and manage these 128 individual field scientific programs. These efforts will be a primary mission of the Regional SSDs.

The SSD staffs' experience in performing applied research and techniques development will allow them to guide SOOs, DOHs, and other field meteorologists and hydrologists through the pitfalls of developmental work. Their scientific expertise will enable them to counsel field meteorologists, hydrologists and hydrometeorologists on what has previously been done and what has appeared in the literature.

The SSD staff will be actively involved with the individual SOOs and DOHs in formulating, initiating, carrying out, and documenting research and development efforts that are scientifically strong and operationally relevant. Further, the SSDs will continually review the programs within their region to ensure reasonable progress and to minimize redundant efforts. The SSDs will review, publish, and distribute reports on completed projects.

The SSDs will provide editorial assistance, graphical design and creation, data retrieval, literature searches, library materials, computer programming and "camera ready manuscript" preparation to support individuals at WFOs and RFCs with publication and conference presentations. All these items are essential for an active research and development program, but are beyond the resources of any individual office.

3.2 T & PD Activities

SSDs, with the assistance of SOOs and DOHs, will monitor the T & PD needs of field personnel. While SOOs and DOHs will provide much of the necessary T & PD on station, there will continue to be a need for national and regional programs for both forecasters and technicians. Scheduling, tracking and assessing the operational value of this T & PD will be an SSD function.

With the assistance of the SOO and DOH, the individual WFO and RFC T & PD programs, respectively, will be periodically assessed for currency, completeness, accuracy and consistency among offices. When deficiencies are identified, the SSDs will give refresher information to the staff and provide current materials and intensive one-on-one T & PD to the SOO or DOH. Such efforts may be held at the Regional Headquarters, COMET or at the office of a subject matter expert.

During daily operations at any NWS office, scientific and technical questions arise. The SSD will be the principal regional resource for answering such questions. SSD personnel will possess a relatively in-depth knowledge of the theory behind the various measuring systems and a working knowledge of the equipment itself. They will be familiar with the nuances and mechanics of the NWS guidance system so they can answer questions from the field about specific guidance products. Also, SSD staff will provide information not only on how various forecast techniques and algorithms work, but also on the specific sets of meteorological and hydrological conditions for which various techniques were designed.

Along with assistance on a request basis, the expertise of the SSD staffs will be shared with the WFOs and RFCs through a program of regular office visits that will include one-on-one T & PD, seminars, and workshops. These personal contacts will not only help employees maintain their scientific credentials, but will also help SSDs identify the strengths and weaknesses of various offices. Also, the SSDs will work with SOOs and DOHs to arrange and conduct on-site workshops presented by national experts, regional personnel or even forecasters (or SOOs and DOHs) from other offices.

3.3 Liaison Activities

NWS field staff generate many technical and scientific ideas, suggestions and/or comments. While the quality of these vary on a case-by-case basis, they are all important to the initiator and require a response. The SSDs are the regional contact point for such matters. Field inquiries are evaluated, and are either responded to directly or forwarded along with further documentation to the appropriate parties (i.e., NWS Headquarters, NMC, TDL, HRL or the various ERL laboratories). This liaison function

of the SSDs streamlines scientific communication within the NWS by reducing redundancy and clarifying requests. The doubling in the number of primary field offices will necessitate the expansion of the SSD's role as the interface between NWS Headquarters (and the National Centers) and field offices.

With the increased emphasis on scientific activities by the NWS, interactions with universities, other government agencies and the private sector should increase. The SSDs will ensure that field meteorologists and hydrologists participate in various research projects ranging from the COMET Outreach program and government--helping-government projects, to national efforts such as the STORM project. SSDs will provide leadership in organizing, facilitating, coordinating and documenting these efforts. It is incumbent upon the NWS, through the SSDs, to maintain the scientific credibility and integrity of these efforts.

The SSDs will actively initiate and cultivate working relationships with the academic and research communities. They will also encourage and support those SOOs and DOHs who are collocated with (or near) academic centers and research facilities to cultivate a working relationship between these facilities and the local WFO staff. Possible research interactions with the NWS through COMET and the DoC Small Business Innovation Research program will be explored, and cooperative efforts whereby NWS personnel present seminars at a university in exchange for in-office seminars by the university faculty will be developed. The SSDs will work with universities to develop courses in applied meteorology and hydrology, and will actively participate to recruit scientifically competent hydrologists and meteorologists into the NWS. Furthermore, the SSDs should actively promote the new hydrometeorologist classification with both Civil Engineering and Atmospheric Science departments.

3.4 Technology Transfer and Technique Development

An operational assessment is necessary before new observing, forecasting, and/or communications systems can be procured in large numbers and deployed throughout the NWS. Presently, SSDs are involved in the operational demonstration of ASOS, Lightning Detection Systems and wind profilers. As the full capabilities of thermodynamic profiling, GOES-I, WSR-88D, etc., are explored, the need for the SSDs to systematically assess the operational value of new data and systems will increase.

The SSDs, assisted by the SOOs and DOHs at the local level, will continue in their historical role of performing verification and forecast skill assessment. It is only through these efforts that a measure of the value of the weather services provided by the NWS can be established.

4. SSD Resources

Since the SSDs will serve as a scientific and technical resource to the field offices, they must be staffed with hydrometeorologists who not only have operational experience, but are also experienced in applied research and technique development in meteorology and hydrology. Relatively frequent interchanges of working level personnel between the SSDs and the various field offices is desirable in order to keep an operational flavor to SSD activities.

In addition to personnel, the SSDs must have access to appropriate equipment. A WSR-88D PUP is needed so the SSDs can pursue their mission by performing regional/local technique development and applied research. Also, as the AFOS experience has shown, regions must have a remote troubleshooting capability so that they can simulate and solve problems that arise during routine operations at the field offices.

A WSR-88D PUP is also essential for the SSD T & PD effort. Even though forecasters will attend the WSR-88D Operations Course by the time their radar is commissioned, a WSR-88D UCP training program for HMTs will have to be developed by the SSDs for administration by SOOs. Also, there will be a requirement for the SSDs to develop refresher training and modules containing new operational concepts for experienced WSR-88D "operators" and training modules delving into local or regional problems.

Each regional SSD must also receive an early AWIPS system. Not only do arguments similar to those just given for the WSR-88D PUP hold, but it is also apparent that many local and regional applications programs presently exist on AFOS that will not be in the AWIPS Initial Operating Capability. The conversion of these routines to AWIPS is a high priority item that will be pursued as part of the technique development activities of the SSDs. For this to be done, direct access to AWIPS is essential.

A PDW in each SSD will allow the staff to assist with the testing of COMET-produced CBL modules. The SSD staff will be responsible for answering questions from the field concerning the CBL content.

Hydrometeorological Technician (HMT) Training Plan

1. Current Meteorological Technicians

Current meteorological technicians who fill HMT positions will receive the following training:

1.1 WSR-88D Training

Training for all field HMTs will concentrate on the operations of the UCP. On-site UCP training will be conducted by SOOs, DOHs and radar focal points, using CBL modules and materials developed by the OSF staff for each HMT. (An outline of UCP training for HMTs is included as Attachment G1.) Also, portions of WSR-88D precursor modules (developed by NSSL and NWSTC) will be used to provide an overview on doppler and standard radar operation. The SOO or DOH will do their best to ensure that this training is completed prior to WSR-88D commissioning.

1.2 AWIPS Training

Each HMT will receive on-site equipment operations training and AWIPS data monitoring training.

1.2.1 AWIPS Operations Training

Systems operator training will initially be provided to each user at the office by the AWIPS contractor at the time AWIPS is installed. Additionally, an interactive computer-based training module will be available on AWIPS for refresher training and for new employees at any time. The SOO/DOH/AWIPS focal points will provide on-site training as new capabilities are developed.

1.2.2 AWIPS Data Monitoring Training

Training in data base management will be conducted by the AWIPS focal point, SOO or DOH. The course content is to be determined after contract award, probably based strongly on the material the SOO, DOH, AWIPS focal point, and ESA will receive at the 3-week AWIPS System training course at NWSTC.

1.3 ASOS Training

At NWS offices responsible for an ASOS system, training will consist of operator training, and ASOS data interpretation (use) and monitoring. At offices that do not have an ASOS system, data interpretation will still be an important responsibility.

1.3.1 Operator Training

1.3.1 Operator Training

Any HMTs required to communicate with the OID will be trained on-site by videotape and personnel from AAI when the equipment is installed. Training for augmentation and backup policies will be self-paced using ASOS-provided workbooks and training papers.

1.3.2 ASOS Data Interpretation

The ASOS User's Manual will acquaint ASOS data users with components, characteristics, capabilities and limitations of ASOS.

The DAPM will provide OJT on how to observe those parameters required for augmentation. Employees assigned after initial training will be trained by OJT using materials developed by AAI.

1.4 NWR CRS

The NWR focal point at each NWR equipped office will train all site personnel on the operations of the NWR CRS. NWR focal points will be trained on-site by CRS contractor. Detailed training plans will be developed as the CRS contract proceeds.

1.5 Wind Profiler

Each HMT will utilize the Profiler videotapes and manuals for on-site training on profiler data.

1.6 Local Data Quality Control

Data quality control will be a very important function within the WFO. The specific procedures will be determined by the capabilities of the various systems. These capabilities are not completely defined; therefore specific training is still to be developed. Each new system (ASOS, AWIPS, etc.) will require data management training. Additional OJT will be provided by the DAPM.

1.7 Basic Hydrology and Hydrologic Data Handling

Additional hydrology and hydrologic data collection training will be developed by the NWSTC. Training will be on-site conducted by the DAPM, service hydrologist and SOO.

1.8 CPM Training

The CPM program for MAR is being developed. Training is expected to be conducted at the NWSTC as part of the HMT course.

1.9 Hydrometeorological Training

The availability of on-site CBL modules developed by COMET and others for use under guidance of the SOO or DOH will provide enhanced understanding of meteorology and hydrometeorology.

Some current meteorological technicians (e.g., at WSMOs) have not attended the Weather Service Operations (WSO) course at the NWSTC because their present duties are limited. These technicians would be trained as newly hired HMTs.

2. Newly Hired HMTs

Newly hired HMTs will attend a three-week (depending on hydrology and CPM training decisions) residence course at the NWSTC. The course structure will be similar to the Weather Service Operations Course. The new course contains updated non-forecast portions of the current course (e.g., Weather Communications - written & oral) but incorporates such new features as data management on ASOS and other systems and CRS training (when available).

Additionally, newly hired HMTs will receive the following:

- Training for current meteorological technicians (above) not covered in the residence course.
- Training for local, office-unique factors (e.g., local procedures, local orographic effects, etc.) provided on-site by the SOO/DOH/DAPM.
- PWB Course (if responsible for pilot briefings).
- Other Remote Training Modules prepared at the NWSTC.

A complete HMT Workload Assessment will be distributed by OM in 1992.

Outline of Hydrometeorological Technician UCP Training

(to be administered by SOO)

I. Training Approach

Focus training on the most frequent UCP tasks:
- commercial/backup power
- system status monitoring (i.e. loadshedding, comm etc.)
- Archive II and III requirements
- VCP changes/PRF changes
- environment wind entry and update
- product generation and distribution
- Free Text Message (FTM) transmission
- change authorized adaptable parameters

II. Base Knowledge

	TITLE	TRAINING MEDIA	HOURS	PREPARATION SOURCE	MILESTONE FOR AVAILABILITY
A.	Introduction to NEXRAD -provides high level overview of NEXRAD system	Video/Workbook Computer Based	1 1	NWSTC OSF/OPS	Complete Complete
B.	Principles of Weather Radar (Module 1)	Workbook	8	OSF/TRNG	Complete
C.	NEXRAD Algorithm Overview -provides information on what parameters the UCP operator is dealing with	Computer Based	8	OSF/OPS	Complete
D.	Mission Requirements -provides information on unique tri-agency missions/ requirements (supplement with local URC requirements)	Workbook/Local supplements	4	OSF/TRNG	TBD

III. Skill Knowledge

	TITLE	TRAINING MEDIA	HOURS	SOURCE	MILESTONES
A.	UCP Menu Simulator -provides for simulated UCP menu manipulation and familarization with UCP menu hiearchy -- explain the purpose of all menus -- describe the functionality and practice the mechanics of editing individual fields	Computer Based/ Workbook	6	OSF/OPS	TBD
B.	-If computer based simulator is not available for OUN training, use UCP attached to V&V at OSF1 or OSF2	Live System	4	OSF/Trng	IF Required

IV. Practical Application Knowledge

	TITLE	TRAINING MEDIA	HOURS	SOURCE	MILESTONES
A.	Job Sheets -provides hands-on diagnostic problem solving experience	Live System/OJT	5	OSF/Trng	TBD
B.	Problem Scenarios -provides for evaluation of trainee's proficiency	Live System/ Demonstration	1	OSF/Trng	TBD

Appendix H

Master Training Plan for Hydrometeorological Service Operations for the 1990's

TABLE OF CONTENTS (Cont)

Executive Summary

As the National Weather Service (NWS) proceeds toward a modernized service, major new technologies (Next Generation Weather Radar (NEXRAD), Advanced Weather Interactive Processing System (AWIPS), Automated Surface Observing System (ASOS), et al.) and scientific advances in hydrology and meteorology with state-of-the-art application software techniques and analysis and prediction algorithms will be introduced to NWS field forecasters. The new technologies will provide forecasters with large volumes of data in new forms and higher frequencies. Advanced data processing application software will be available to assist the forecaster in assimilating these data; however, the benefits to our Nation from the new technologies can only be realized if the forecasters are adequately trained in both the new technologies and the scientific advances that have been and are continuing to be developed and applied in the forecasting process.

The training which is currently available in the hydrology/hydrometeorology program is severely inadequate to meet the needs of the modernized NWS. Since the 1970's, improvements and developments in technological application software for hydrological/hydrometeorological forecasting have been advancing at an increasing rate. The rate of training and the transfer of the application software to field operations is also increasing but not sufficiently to keep pace with the increases in the development of the application software. Hydrological training currently conducted by the NWS for meteorologists is limited to the Hydrologic Services Correspondence Course and training courses in Flash Flood Forecasting and Radar Meteorology offered by the NWS Training Center (NWSTC). Service Hydrologists have one additional course available which focuses on the Hydrological and Climatological Networks; this course includes some very limited training on basic hydrology. River Forecast Center (RFC) forecasters may also attend the above courses and may, on occasion, have the opportunity to attend one or more advanced hydrological workshops presented by senior staff members of the Hydrologic Research Laboratory (HRL) in the Office of Hydrology (OH). These workshops have not been offered on a regular basis but have been provided at RFCs upon request.

Hydrological/hydrometeorological training requirements are based on the knowledge, skills, and abilities of the present and future work force, the advancements in forecasting and modeling systems, and the new technologies that are being installed. These changes will bring new and more complex duties, and the future work force will require special knowledge and skills to handle these duties. In some cases, new positions will be created to perform the new duties. Career opportunities will result from the new positions and the hydrologist-in-charge (HIC) will provide the leadership to help the hydrologists and hydrometeorologists develop their careers.

The master training plan for "Hydrometeorological Service Operations for the 1990's," conceptually shown in fig. H-1, defines the training and professional development activities that will be utilized to meet the training requirements that will enhance the hydrological/hydrometeorological knowledge and skills of the NWS work force at the RFCs and Weather Forecast Offices (WFO) to provide improved services in the 1990's.

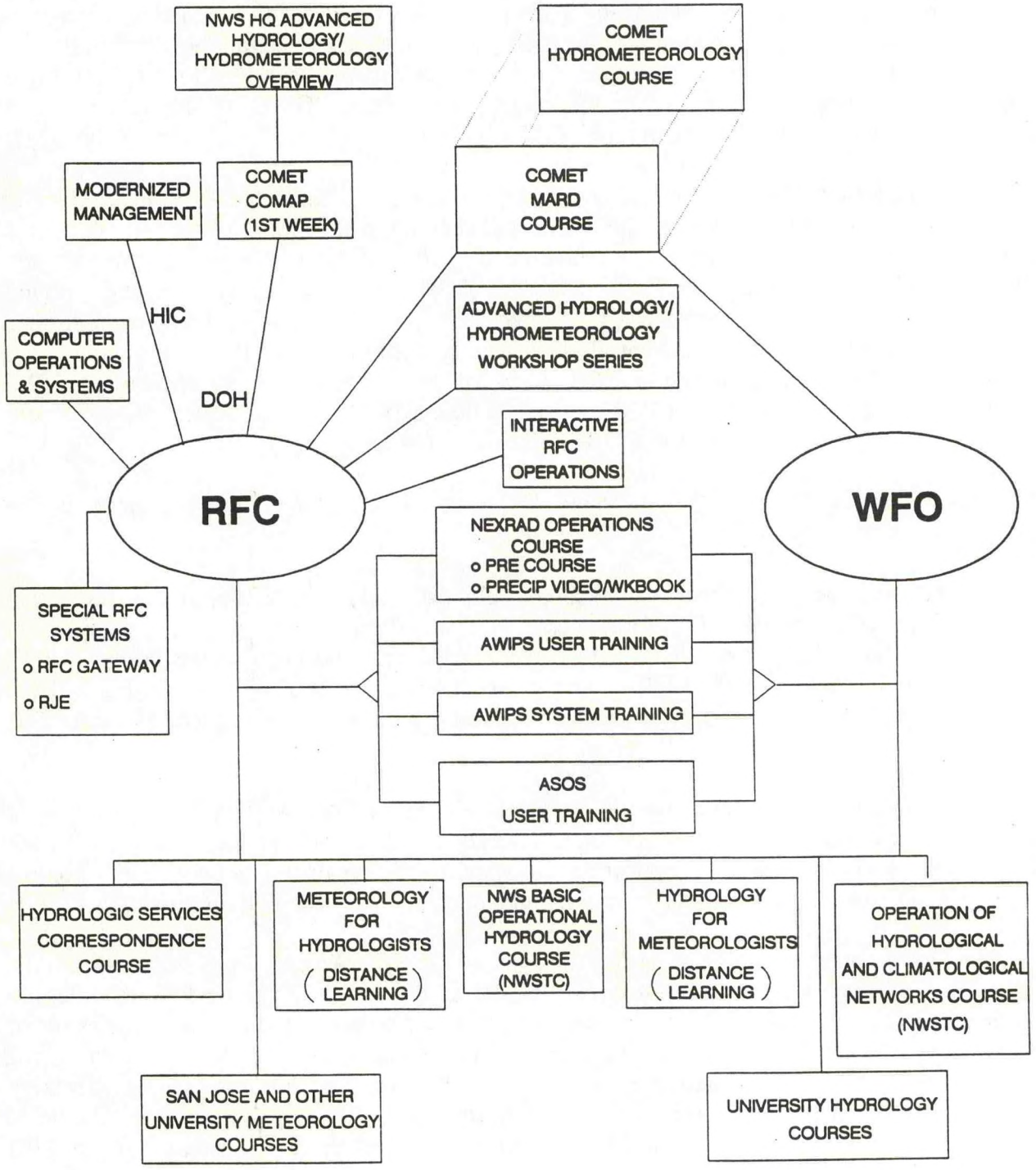


Figure H-1. *Hydrology/Hydrometeorology Training for the 1990's*

A 3-week hydrometeorology course shown, at the upper center of fig. H-1, will be provided for all hydrometeorological analysis and support (HAS) forecasters, development and operations hydrologists (DOH), and service hydrologists by the Cooperative Program for Operational Meteorology, Education and Training (COMET). The fundamental components include multisensor precipitation estimation and analysis, quantitative precipitation forecasting, and other hydrometeorological aspects of hydrological forecasting. As some time will be required to fully develop the course, the 2-week COMET Modernization and Associated Restructuring Demonstration (MARD) course will initially fill part of this need.

Since it will be the DOH's responsibility to guide, oversee and assist the RFC forecasters in the implementation of techniques, the DOH will attend the first week of an 8-week course at COMET on mesoscale analysis and prediction. This COMET Mesoscale Analysis and Prediction (COMAP) course will introduce the DOH to mesoscale systems and provide firsthand knowledge of the meteorological forecasting process. The DOH will need further training in all of the various advanced hydrological/hydrometeorological techniques and models which will be provided in the form of an intense 3-week session at NWS Headquarters with senior staff of HRL as well as others from the Techniques Development Laboratory (TDL) and the National Meteorological Center (NMC).

Also shown in fig. H-1, HICs will attend a course on managing field resources in the modernized era at the NWSTC.

Figure H-1 also shows a series of workshops held nationally, regionally, and at individual RFCs which will provide RFC forecasters with the detailed theory and principles of advanced hydrological/hydrometeorological techniques and models. The workshops will be presented by the senior staff of HRL, who will be in close contact with the DOHs and the regional and RFC management to ensure the workshops will be designed to meet their needs.

RFC forecasters will receive on-site training in the interactive application software techniques developed for modernized RFC operations. Training will be conducted by the HRL staff who developed the application software consisting of interactive quality control of NEXRAD-based precipitation estimates and interactive forecasting of rivers.

Training for the new technologies is also depicted in fig. H-1. Among these is the NEXRAD Operations course along with its precursor modules; the latter, including four modules on hydrometeorological precipitation processing, are to be completed by all forecasters prior to attending the 4-week residence course in Norman, Oklahoma. The AWIPS training will be provided by the AWIPS contractor and will consist of user and systems training. Training for the ASOS will be in the form of user manuals. Two RFC-unique systems, shown in fig. H-1 consist of the Remote Job Entry (RJE) system and the replacement for the RFC Gateway system. OH personnel who developed the systems will provide user manuals and hands-on training.

The training in basic hydrology and basic meteorology that is needed to provide the professional hydrologist with a foundation in the hydrometeorological sciences is also shown in fig. H-1. A 2-week course in NWS Basic Operational Hydrology will be provided at NWSTC. One form of meteorological training for hydrologists will be Computer Based Learning (CBL) modules. Training at universities will provide further support in both the hydrological and meteorological sciences. Two additional courses which add to this foundation are the Hydrologic Services Correspondence Course and the NWSTC Operations of the Hydrological and Climatological Networks Course.

In conclusion, the Master Training Plan for Hydrometeorological Service Operations for the 1990's attempts to provide a road map of required education and training for various NWS positions and career paths. This includes an identification of training requirements followed by a formulation of various methods to provide training. The Master Training Plan will undergo some evolution with time as new applications software is developed and as training experiences are evaluated.

1.0 Introduction

The NWS work force will require significant training and education as the NWS proceeds with Modernization and Associated Restructuring (MAR). Advanced modeling systems will be available, and forecasters will need to expand their knowledge in the hydrometeorological sciences in order to understand and use these new and improved modeling systems. NEXRAD and ASOS technologies will provide large volumes of new and improved data sets that forecasters will need to learn how to use. The AWIPS technology will integrate the new data sets with advanced scientific models, thereby providing a means for forecasters to interactively quality control the data sets and prepare forecasts. The approaching changes to field operations will provide exciting opportunities for professional growth and result in significantly improved services to the Nation.

There are also some more fundamental, but complex, reasons for placing significant emphasis on training at this time. These reasons have to do with the level of training that was being provided during the 1960's and early 1970's, the important advancements that have been made to the science of hydrology/hydrometeorology since that time, and the lack of a significant increase in the training that was provided during the same period. It can be argued that the NWS was doing a better job training our hydrologists in the 1960's and early 1970's than is being done today. This is because at that time the science of flood forecasting had reached a reasonable level of sophistication with the NWS in the lead from a national perspective. The contributions that were made by the NWS were recognized throughout the world and a training course was developed to teach procedures for flood forecasting to foreign nationals in order to transfer this technology to their countries. This course was also designed to teach new NWS hydrologic forecasters the state-of-the-art skills in flood forecasting.

In the early 1970's, HRL made a major commitment to begin development of conceptual and physical-based hydrologic modeling systems in order to provide a much higher level of hydrologic forecast services to the Nation. The central thrust of this effort has been, and continues to be, focused on providing more timely and accurate flood forecasts. Planning efforts have resulted in a complete forecast system that is known as the National Weather Service River Forecast System (NWSRFS). This system is broad in scope and covers multiple components such as a conceptual soil moisture accounting rainfall/runoff model, river mechanics models, multisensor precipitation estimates, and long-range forecasting capabilities. As these components have been put into practice, the improvements in the forecasting services have been significant.

Hydrologic forecasters require a sound base of knowledge in the hydrological/hydrometeorological sciences in order to apply the new forecasting procedures. While some training has been provided on the new forecast procedures, the development of the hydrologic forecasting science has increased more rapidly than appropriate corresponding training. A major effort is now required to increase the available training in order to cover all areas where scientific and technological advancements have been and are continuing to be made.

1.1 Historical Perspective and Present Training

In past years, the total number of new hydrologists hired by each RFC has been relatively low compared to the total NWS work force. This is because the complement of hydrologists in the NWS comprises a small portion of the total work force. Previously, the knowledge and skills needed by new hydrologists were such that most training was generally best handled at the RFC. Most operational forecast systems (OFS) and procedural development activities were unique to each RFC, which did not lend themselves to a "national" focus on training for RFC hydrologists. Certain aspects of "national" training, however, have emerged over a period of time as the NWSRFS was developed and implemented. Training on NWSRFS and some advanced river mechanics models such as the Dam Break (DAMBRK) and Operational Dynamic Wave (DWOPER) models have been provided by the HRL for staff members of many RFCs.

Training has most recently been focused on a 3-week course on Operational Hydrological and Climatological Networks at NWSTC for new Service Hydrologists. This residence course has been provided once per year. While this course has been centered on the various data networks, the hydrologists receive some limited instruction on applying the data for operational hydrologic forecasting; this has not always been the case. The original course was very much oriented toward the duties of the cooperative program manager (CPM). However, even in the old CPM course, attendance always included hydrologists since the data networks served by the CPMs were of primary interest to the hydrology program, especially from the standpoint of the data requirement for real-time forecast operations.

Training courses do evolve over a period of time -- as they should in order to meet ever changing needs. The original course was focused on the duties of the CPM, and a considerable amount of time was, and continues to be, focused on areas such as calibration of the weighing precipitation gages used in the networks. Since this subject matter strictly pertained to duties of the CPM, this portion of the 3-week course had little utility for the hydrologists. Before long, a variation in the course was developed that enabled the CPMs to continue to learn the technical aspects of calibration of the gages while, at the same time, the hydrologists received some restricted basic hydrologic training.

Hydrologic training conducted by the NWS for meteorologists is presently limited. The primary centralized training is the Hydrologic Services (Correspondence) Course, which is an NWS-developed correspondence course currently under major revision. This course is taken on-station by NWS personnel and is part of the Forecaster Development Program. Therefore, all meteorologist interns either have in the past or will in the future be taking it early in their careers. Planned revisions to the course as well as new topics to be covered by the revised course will provide forecasters with a better basis for carrying out their responsibilities; however, this course in itself does not provide the depth of training necessary for meteorologists to acquire the level of hydrologic expertise necessary for future NWS operations.

There is a strong need for meteorologists to have a fundamental understanding of the science of hydrology. This will be especially true in the MAR NWS since the responsibility of the lead meteorological forecasters will increase for issuing flood and flash flood watches and warnings to the public.

The NWSTC provides a course in Radar Meteorology, a Radar Users Course, and a Flash Flood Forecasting Course. These courses include content focused toward interpretation of rainfall data and operational analysis techniques for the detection of flash floods. While these courses are indeed good, they are not sufficient and are not completely integrated into a total training program to meet the needs of the meteorologist's hydrologic responsibilities in the MAR NWS.

From this brief glance at the most recent training available within the hydrology program, it is obvious that a major effort is required to significantly enhance hydrological/ hydrometeorological training for the future. The challenge facing the NWS is very real. A significant amount of new hydrometeorological analysis techniques and advanced hydrologic modeling systems will be implemented to take advantage of the new technologies (NEXRAD, AWIPS, ASOS, et al.) in the MAR NWS. Training in these techniques and technologies is necessary for forecasters to be able to provide the hydrologic services required for our Nation.

2.0 Hydrologic Training Requirements

Hydrologic training requirements for the modernized NWS operations are based on the knowledge, skills, and abilities of the present and future work force, the scientific and technical advancements in forecasting and modeling systems as well as data processing procedures that have been developed and are about to be implemented, and the new technologies (NEXRAD, ASOS, AWIPS, et al.) that are being installed. Meeting these requirements range from university education, or its equivalent prior to entering the work force, to learning to perform the duties that are required in the modernized NWS after joining the work force. Not all individuals will need to have satisfied all requirements, but some requirements are considered prerequisites for certain positions. Most of the National Oceanic and Atmospheric Administration (NOAA)/NWS operationally unique training requirements will be satisfied by training that will be provided or sponsored by NWS. Training requirements shall be completed over a period of time rather than grandfathered because an individual occupies a certain position.

2.1 List of Hydrologic Training Requirements - Defined

This section identifies 21 separate training requirements. They are summarized in table H-1 and are defined within this section. Training requirements numbered 1 through 5 are needed for an appropriate scientific educational level. Training requirements numbered 6 through 21 are necessary for modernized operations; they deal with unique technological/scientific advancements and desirable cross-training between the meteorological and hydrological work force.

2.1.1 Training requirement number 1 is the basic education necessary in an appropriate area of Physical Sciences (or Engineering) to enable qualification as a hydrologist or a B.S. or equivalent in Meteorological Science to enable qualification as a meteorologist or an appropriate combination of the two disciplines to enable qualification as a hydrometeorologist. This requirement not only enables an individual to become qualified so that he or she can be hired into the NWS at the lowest intern level but, depending upon the type, quantity, and quality of additional course work and/or work experience, the individual may enter at a higher grade level.

2.1.2 Training requirement number 2 is to successfully complete the 18 semester hours of hydrology and hydrometeorology course work to satisfy the Type B hydrometeorologist qualification standards (in addition to the 6 semester hours of meteorology course work). These courses, or their equivalent in appropriate experience include the following: an introductory level Hydrology course (sometimes called Engineering Hydrology); a course in Remote Sensing of the Atmosphere, Radar Meteorology (Hydrology), or Satellite Meteorology (Hydrology); and at least 12 semester hours from any of the following courses (including at least 3 semester hours from the following courses: Fluid Mechanics or Fluid Dynamics, Hydraulics, Open Channel Flow, Hydrodynamics, or River Mechanics), Physical Hydrology or Hydrometeorology, Advanced Hydrology, Snow Hydrology, Fluid Mechanics

Table H-1. *Hydrologic Training Requirements*

1. Successfully complete BS or equivalent in an appropriate area of Physical Sciences (or Engineering) to enable classification as a Hydrologist, or a BS or equivalent in Meteorological Science to enable classification as a Meteorologist.
2. Successfully complete the hydrology and remote sensing course work to satisfy the Type B hydrometeorologist qualification standards.
3. Successfully complete the meteorological course work to satisfy the Type B hydrometeorologist qualification standards.
4. Successfully complete the meteorological and remote sensing course work to satisfy the Type A hydrometeorologist qualification standards.
5. Successfully complete the hydrological course work to satisfy the Type A hydrometeorologist qualification standards.
6. Learn the additional complexities and responsibilities of managing an RFC in the modernized NWS.
7. Learn the advancements that have been made in the science of mesoscale meteorology as they apply to operational hydrologic forecasting, and gain an in-depth overall view of advances and improvements in hydrological and hydrometeorological modeling.
8. Learn to operationally apply improved hydrometeorological analysis and forecasting techniques including Stage I, II, and III precipitation estimation, quantitative precipitation and temperature forecasting, and hydrologic forecasting.
9. Learn background and theory of hydrometeorologic analysis techniques, hydrologic modeling systems and model calibration; and learn to use them operationally.
10. Learn to use interactive NWSRFS and interactive Stage III precipitation analysis, quality control mosaicking techniques.
11. Learn to use NEXRAD based products operationally.
12. Learn to use AWIPS operationally.
13. Learn Systems, Software, and Data Base features of AWIPS.
14. Learn to use ASOS data.
15. Learn to use computers in hydrologic forecasting
16. Learn to use RFC-unique systems.
17. Learn and understand the Hydrologic Service Program of NWS.
18. Hydrologists learn the basic principles of meteorology.
19. RFC hydrologists and hydrometeorologists and WFO service hydrologists and hydrologic interns learn NWS basic operational hydrology. (Typically applies to new personnel in these positions.)
20. Meteorologists learn the basic principles of hydrology.
21. Learn the operations of the hydrological and climatological networks.

or Fluid Dynamics, Hydraulics, Open Channel Flow, Hydrodynamics, River Mechanics, Hydrological Forecasting and Watershed Modeling. Desirable electives, if needed to complete the 18 hours of course work, would be: Hydrologic Instruments, Soil Physics, Statistical Hydrology, Water Resource Engineering, Hydro-geology, Water Resources Management, Data Analysis, and Probability and Statistics.

2.1.3 Training requirement number 3 is to successfully complete the 6 semester hours of meteorological course work to satisfy the Type B hydrometeorologist qualification

standards (in addition to the 18 semester hours of Hydrology and Remote Sensing course work). These courses, or their equivalent in appropriate experience, include the following: General Meteorology, Weather Analysis and Forecasting (sometimes called Synoptic Meteorology), or calculus-based Dynamic Meteorology. Desirable electives would be Physical Meteorology, Mesoscale Meteorology, Climatology, and Physical Climatology.

2.1.4 Training requirement number 4 is to successfully complete the 18 semester hours of Meteorology/Hydrometeorology course work to satisfy the Type A hydrometeorologist qualification standards (in addition to the 6 semester hours of Hydrology course work). These courses, or their equivalent in appropriate experience include the following: 3 semester hours of General Meteorology (sometimes called Physical Meteorology); 6 semester hours of Weather Analysis and Forecasting (Synoptic Meteorology); 6 semester hours of calculus-based Dynamic Meteorology; a course in Remote Sensing of the Atmosphere, Radar Meteorology (Hydrology) or Satellite Meteorology (Hydrology). Desirable electives, if needed to complete the 18 semester hours of course work, would be: Cloud Physics, Mesoscale Meteorology, Climatology, Physical Climatology, Data Analysis, and Probability and Statistics.

2.1.5 Training requirement number 5 is to successfully complete the 6 semester hours of hydrological course work to satisfy the Type A hydrometeorologist qualification standards (in addition to the 18 semester hours of meteorology and remote sensing course work). These courses, or their equivalent in appropriate experience, include the following: a 3 semester hour introductory level Hydrology course (often called Engineering Hydrology); 3 additional semester hours in hydrology chosen from the following: Physical Hydrology or Hydrometeorology, Advanced Hydrology, Hydrological Forecasting, Snow Hydrology, River Mechanics, Hydraulics, Watershed Modeling, Open Channel Flow, Fluid Mechanics or Fluid Dynamics, and Hydrodynamics. Desirable electives, if needed to complete the 6 semester hours of course work, include: Hydrologic Instruments, Soil Physics, Statistical Hydrology, Water Resource Engineering, Hydro-geology, Water Resource Management, Data Analysis, and Probability and Statistics.

2.1.6 Training requirement number 6 is to learn the additional complexities and responsibilities of managing an NWS RFC in the modernized era. This requirement includes providing oversight for all RFC activities requiring interfaces both within the NWS with associated WFOs, regions, and national headquarters and outside the NWS with cooperative water and emergency management agencies.

2.1.7 Training requirement number 7 is to learn the advancements that have been made in the science of mesoscale meteorology as they apply to operational hydrologic forecasting. This includes an in-depth overview of the advances and improvements in the modeling and analysis techniques in the hydrologic and hydrometeorological sciences.

2.1.8 Training requirement number 8 is to learn the principles and theory of advanced techniques in the hydrometeorological sciences and how to operationally apply these

techniques in hydrologic forecasting. Particular attention will be focused on learning multisensor Stage I, II, and III precipitation estimation and quality control procedures, techniques for the assimilation of quantitative precipitation and temperature forecast products, and hydrologic forecasting.

2.1.9 Training requirement number 9 is to learn the background, theory, and operational use of hydrometeorological analysis techniques, hydrologic modeling systems, and model calibration techniques that have been developed by the HRL and others.

2.1.10 Training requirement number 10 is to learn to operationally use the interactive NWSRFS OFS and the interactive Stage III precipitation analysis, quality control, and mosaicking techniques that have been implemented on the Prototype RFC Operational Test, Evaluation, and User Simulation (PROTEUS) workstation and will be implemented on the AWIPS workstation.

2.1.11 Training requirement number 11 is to learn to use NEXRAD products in the hydrologic forecasting environment; this is required for all hydrologists and hydrometeorologists.

2.1.12 Training requirement number 12 is to learn the use of the AWIPS workstations; almost all RFC forecast operations (including those which require interaction with the central computer facility) will be carried out on these workstations. RFC operations executed on AWIPS range from data processing and quality control to forecast preparation and issuance; therefore, this training is required for all hydrologists and hydrometeorologists.

2.1.13 Training requirement number 13 is to provide in-depth training of the AWIPS system for at least two hydrologists from each RFC. This training will focus on application program conventions, applications program languages, programming of support software, and the features, capabilities, limitations, and interface procedures of the AWIPS database.

2.1.14 Training requirement number 14 is to understand the ASOS system and receive user training on ASOS data; this is required of all hydrologists and hydrometeorologists, especially the service hydrologists and the HAS forecasters.

2.1.15 Training requirement number 15 is to learn how to optimally use computers in hydrologic forecasting. This requirement is for all RFC staff, and it includes learning applications, program languages, operating systems and system commands, support software features, software design techniques for optimum system performance, telecommunications (including networks), and Job Control Languages (JCL) for use on mainframe computers.

2.1.16 Training requirement number 16 is to learn the operation and use of special RFC-unique systems which include the replacement for the RFC Gateway system and the RJE system. One or two individuals from each RFC will require in-depth training while the remainder of the staff will require user training.

2.1.17 Training requirement number 17 is for all field personnel to learn and understand the Hydrologic Service Program of the NWS.

2.1.18 Training requirement number 18 is for all hydrologists to learn basic principles of meteorology.

2.1.19 Training requirement number 19 is for all service hydrologists and RFC hydrologists to have a foundation in NWS Basic Operational Hydrology.

2.1.20 Training requirement number 20 is for all meteorologists to learn basic principles of hydrology.

2.1.21 Training requirement number 21 is for all Service Hydrologists to learn the Operations of the Hydrological and Climatological Networks. This course will also be available for DAPM and hydrometeorological technicians.

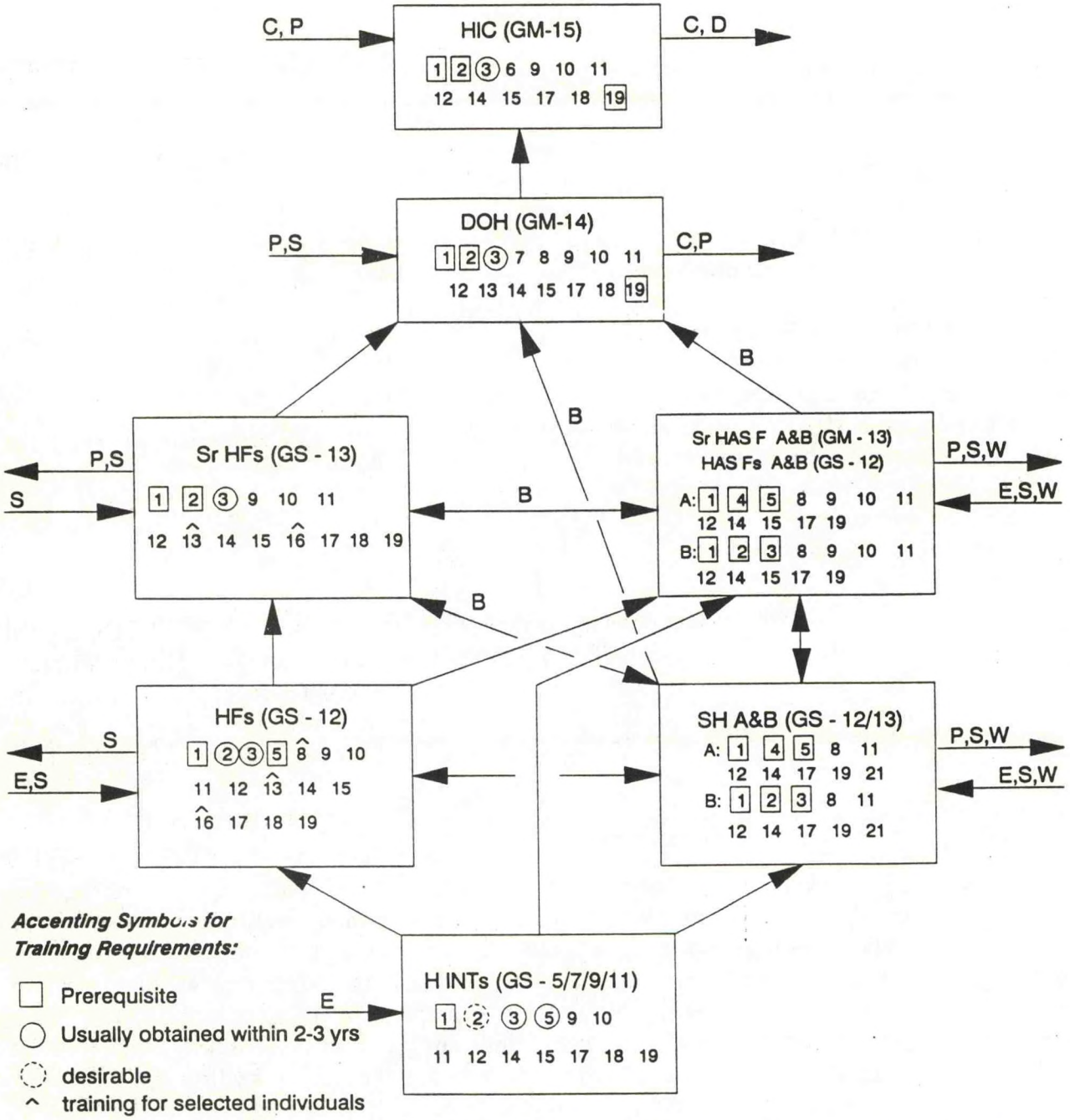
2.2.0 Training Requirements for Hydrologist Positions

Figure H-2 is a schematic diagram showing hydrologist positions in the MAR NWS, typical career paths that individuals could take, and the training and professional development requirements that are required for each position. Each large box represents a position. For example, at the top of fig. H-2 is a box representing the HIC along with the grade for this position (GM-15). All of the position titles, acronyms, and grades are shown in table H-2.

The rows of numbers below the position title of each box shown in fig. H-2 correspond to numbered training requirements for each position. These numbers and associated training requirements are defined in table H-1. Some of the numbers are further defined with accenting symbols around or above them. These symbols are defined in table H-3.

Since both service hydrologists and HAS forecasters will require hydrometeorological backgrounds of either the Type A or Type B qualification, each set of training requirement numbers in these boxes is preceded by "A:" for the Type A and "B:" for the Type B. The interconnecting lines between the boxes indicate the normal career paths that individuals could follow. It should be recognized that the paths (arrows) allow for lateral moves as well as promotions. Some of these paths are labeled with the letter B; this indicates that satisfying the Type B hydrometeorologist qualification standards is required prior to making the move.

The letters on the short lines with arrows entering or exiting the boxes indicate positions outside the RFC from which or to which an individual could transfer. These are defined below in table H-4.



NOTE: Training Requirements Nos. 1-5 represent university course work or equivalent (see table H-1).
Training Requirements Nos. 6-21 represent NWS training and professional development (see table H-1).
See Table H-2 for complete definition of abbreviated position descriptions.
Training requirement numbers without accenting symbols should normally be completed within a year after entering the position (see table H-3).
Letters (C,D,E,P,S,W) entering & exiting the boxes represent other positions (see table H-4). HYDRTRN3.DRW

Figure H-2. *Career paths for field hydrologists/hydrometeorologists.*

Table H-2. *Position Titles, acronyms and grades shown in Figure H-1.*

POSITION TITLE	CODE	GRADE
Hydrologist In Charge	HIC	GM-15
Development and Operations Hydrologist	DOH	GM-14
Senior Hydrologic Forecasters	Sr HFs	GS-13
Hydrologic Forecasters	HFs	GS-12
Senior Hydrometeorological Analysis and Support (HAS) Forecaster *	Sr HAS F	GM-13
Hydrometeorological Analysis and Support (HAS) Forecasters *	HAS Fs	GS-12
Service Hydrologist *	SH	GS-12/13
Hydrologist Interns	H INTs	GS-5/7/9/11

NOTES: * Positions which require Type A or Type B hydrometeorologist qualification standards are indicated by the letters A and B in the box.

2.3.0 Career Paths and Training Requirements

Figure H-2 can be used conveniently to follow possible career paths and determine the training that is required along the way. The additional training requirements needed to advance to another position along a particular career path can be determined easily by noting the differences in the training requirements between the boxes representing any two positions along an arrowed, career pathway. For example, the hydrologic forecaster has a training requirement number 2 which is circled (indicating it shall be obtained usually within 2 to 3 years after assuming the position); however, for the senior hydrologic forecaster position, training requirement number 2 is boxed (indicating it is a prerequisite). Thus, in this example, the hydrologic forecaster must complete training requirement number 2 before the individual becomes a senior hydrologic forecaster.

Another example which illustrates the use of fig. H-2 for determining the training required for a given position is the following. A hydrologist intern has training requirement number 11 (NEXRAD). If a hydrologist intern advances to the position of service hydrologist, which also has training requirement number 11, then the hydrologist intern would have satisfied training requirement number 11 and would not be required to take the same training after advancing to the service hydrologist position.

Table H-3. *Definitions of accent symbols used in figure H-2.*

Accenting symbols that further define training requirements (n indicates the training requirement number)	
n =	This training should normally be completed within a year after entering the position.
$\boxed{n}$ =	This training is a prerequisite for the position.
$\textcircled{n}$ =	This training should be completed usually within two to three years after the position is taken.
$\textcircled{\scriptstyle n}$ =	This training is highly desirable but not required at this time; it will be required for higher level positions.
$\hat{n}$ =	Only selected individuals at a given RFC will require this training.

From fig. H-2, it is evident that there are numerous career paths. Two example career path scenarios illustrating the training requirements associated with each path are presented in 2.3.1 and 2.3.2.

2.3.1 Example Career Path Scenario Number 1 and Associated Training Requirements (Hydrologic Intern - Hydrologic Forecaster - Senior Hydrologic Forecaster - DOH - HIC)

In this first scenario, the new employee enters the service from a college/university with a B.S. or equivalent in Physical Science (or Engineering). This satisfies training requirement number 1.

The intern will take a position in a colocated RFC/WFO as a hydrologic intern. Normally the intern will enter at the GS-5 level; however, an individual may enter at higher grade levels, depending upon grades, extent of education, or a combination of education and experience. The intern will normally take two or more assignments of which at least one will be in the RFC and another in the WFO. The HIC/meteorologist-in-charge (MIC) will be responsible for establishing a personal development training plan for each assignment of the hydrologist intern. Most of the training requirements in this plan will depend upon the assignment (either at an RFC or a WFO) and previous training. Upon graduation from the

Table H-4. *Codes used in fig. H-1 for career moves outside the RFC*

Code	Career Move Outside the RFC
E	Entry from universities or other organizations outside NWS.
W	Weather Forecast Office (WFO) Forecasters
S	National and Regional Headquarters Staff Meteorologists and Hydrologists
P	National and Regional Headquarters Program Management and Supervisory positions
C	National and Regional Headquarters Senior Program Management and Supervisory positions
D	Regional Directors, Deputy Regional Directors, OH Senior Managers

Hydrologist Intern Program, the individual will have completed (or in some instances partially completed) the following training requirement numbers shown within parentheses:

(2) Several, if not most, of the 18 semester hours (at least 6) of hydrology/hydrometeorology course work to meet the requirements of the Type B hydrometeorologist qualification standards.

(3) All of the 6 semester hours of meteorology course work to meet the requirements of the Type B hydrometeorologist qualification standards.

(5) All of the 6 semester hours of hydrology/hydrometeorology course work to meet the requirements of the Type A hydrometeorologist qualification standards.

(9) Training in the theoretical background of hydrometeorological analysis techniques, hydrologic modeling systems; and training in model calibration and operational use of the models.

(10) Training on interactive NWSRFS and/or interactive Stage III precipitation analysis, quality control, and mosaicking techniques.

(11) Training in NEXRAD-based products.

(12) Training in the operational use of AWIPS.

(14) Training in the operational use of ASOS data.

(15) Some training in the use of computers for hydrologic forecasting.

(17) Training in the Hydrologic Service Program.

(18) Training in basic principles of meteorology for hydrologists through distance learning modules.

(19) Training in NWS Basic Operational Hydrology.

In this scenario, the graduate Hydrologist Intern, having satisfactorily completed training and having served the necessary time in grade, is selected by competition for the position of an RFC hydrologic forecaster. Training for the hydrologic forecaster will be concentrated on increasing the scientific hydrological/hydrometeorological knowledge that is necessary for performing the duties associated with the position. This will include further training on the operational use of advanced hydrologic models and their calibration. Typically, a person entering a hydrologic forecaster position will have already completed the educational requirements for the Type B hydrometeorological qualification standards. However, as illustrated in fig. H-2, meeting some of these requirements can be be accomplished over a period of time after entry into the position. In this scenario, appropriate university course work or equivalent would have to be completed within 3 years.

After the meteorological courses or equivalent requirements for the Type B qualifications standards have been completed, training will be needed in the principles and theory and operational analysis techniques associated with hydrometeorology to enable the hydrologic forecaster to assist the HAS forecaster during prolonged and/or widespread rainfall events.

In summary, in addition to the training requirements completed as a hydrologic intern, the hydrologic forecaster in this example scenario shall complete all of the following training requirements within 1 year (except as indicated):

(2) Usually within 2 to 3 years, all of the hydrology and remote sensing course work or equivalent experience to meet requirements of the Type B hydrometeorologist qualification standards.

(3) Usually within 2 to 3 years, all of the meteorological course work or equivalent experience to meet the requirements for a Type B hydrometeorologist qualification standards.

(8) Hydrologic forecasters shall receive special hydrometeorological training after having completed training requirement number 3.

(9) Training will be received on some additional hydrologic and hydrometeorological models; training will be received in both the principles and theory as well as operational use of the models.

(13) If selected as the AWIPS focal point, the hydrologic forecaster will need to complete systems training on AWIPS.

(15) Additional training, as required, shall be provided in the computer skills necessary for hydrologic forecasting.

(16) If selected, the hydrologic forecaster will receive the appropriate training to become the focal point on RFC-unique systems.

In this scenario, the individual is next selected for one of the senior hydrologic forecaster positions. The additional training requirements consist of the following:

(9) Continue to receive training on additional hydrological and hydrometeorological analysis techniques, hydrologic modeling systems, and model calibration.

(15) Continue as necessary to receive training in the use of computers in hydrologic forecasting.

In this scenario, the individual is selected by competition for the DOH position. While as a hydrological forecaster or before, training requirements numbers 3 and 8 were completed, and therefore, there were occasions to work HAS forecaster shifts. The DOH will require additional training in advanced hydrometeorological analysis techniques and hydrologic models for implementation in the RFC operations. The additional training requirements for the DOH are:

(7) Learn the advances in mesoscale meteorology as applied to hydrology and an overall view of all advances and improvements in the modeling and analysis techniques in the hydrological and hydrometeorological sciences.

(9) Continue to receive detailed training in the background and theory of hydrometeorological analysis techniques, specific hydrologic models - their calibration and operational use.

(13) If training has not been received on the systems, application programming, and database capabilities of AWIPS, training will need to be taken in this area.

(15) Continue training, as needed, on the use of computers in hydrologic forecasting.

The DOH is one of the most logical incumbents for HIC. In this scenario, the DOH is next selected to the position of HIC. The DOH's background and training are well suited to the HIC position and essentially no additional scientific and/or technical educational requirements will need to be met. The only new training requirement is the following:

(6) Learn the additional complexities and responsibilities of managing an RFC in the modernized era.

2.3.2 Example Career Path Scenario Number 2 and Associated Training Requirements (Service Hydrologist - HAS Forecaster - Senior Hydrologic Forecaster - DOH - OH Branch Chief)

In this second scenario, an individual enters the NWS from another Federal agency, having previously completed the requirements for a Type B hydrometeorologist qualification standards. The individual has also met the time-in-grade requirements and qualifies for the service hydrologist position. This individual has many training requirements that will need to be completed within the first year, if possible. They are:

(8) Training on operationally applying improved hydrometeorological analysis and forecasting techniques including Stage I, II and III precipitation estimation, quantitative precipitation and temperature forecasting, and hydrologic forecasting.
(11) Training in NEXRAD-based products.
(12) Training in the operational use of AWIPS.
(14) Training in the operational use of ASOS data.
(17) Training in the Hydrologic Services Program.
(19) Training in NWS Basic Operational Hydrology.
(21) Training in the operations of the Hydrological and Climatological Networks.

In this scenario, the individual is selected next for a senior HAS forecaster position in an RFC. In this case, since the individual has already met the requirements of the Type B hydrometeorologist qualification standards, there are only three additional training requirements to be met. They are:

(9) Training in the background and theory of hydrometeorological analysis techniques, specific hydrologic models - their calibration and operational use.
(10) Training in interactive Stage III precipitation analysis, quality control, and mosaicking techniques.
(15) Training in the use of computers in hydrologic forecasting, as appropriate.

The senior HAS forecaster, in this scenario, laterals to the position of a senior hydrologic forecaster. However, the following additional training will be needed:

(9) Continue to receive training in the background and theory of additional hydrometeorological analysis techniques, hydrologic models - their calibration and operational use.
(10) Additional training in the use of interactive NWSRFS; the training for interactive Stage III precipitation analysis, quality control, and mosaicking techniques was taken previously while in the HAS forecaster position.
(13) If selected as the RFC computer systems specialist, the senior hydrologic forecaster will receive in-depth training on AWIPS systems, software, and databases.
(15) Additional training will be provided in the computer skills necessary for hydrologic forecasting.
(16) The senior hydrologic forecaster will be trained in RFC-unique systems if selected to be a focal point.

Next, in this scenario, the senior hydrologic forecaster is selected to the DOH position. The following additional training will be needed:

(7) Training in the advances that have been made in the science of mesoscale meteorology as applied to hydrologic forecasting and an in-depth overall

view of advancements in hydrometeorological analysis techniques and hydrological modeling.

(9) Continue to receive detailed training in the background and the theory of hydrometeorological analysis techniques, hydrologic models - their calibration and operational use.

(15) Additional training in the use of computers in hydrologic forecasting.

In this scenario, the DOH is selected for the position of a Branch Chief in OH. No new training requirements are identified for this position since this plan only addresses field training requirements. However, some additional management and supervisory training would clearly be in order.

3.0 Training That Will Be Provided To Meet Training Requirements

Table H-5 lists the training that will be provided to meet the training requirements identified by number as described in section 2. Also, this is shown schematically in fig. H-3. The numbers in the lower, right-hand corner of each box in fig. H-3 correspond to the numbers associated with the training listed in table H-5. Table H-6 lists the type of training for each of the hydrologist/hydrometeorologist positions that is needed to meet the training requirements defined in section 2 that are identified by number. The Xs in table H-6 (and where necessary A's for type A hydrometeorologists and B's for type B hydrometeorologists) indicate which training is required for each of the hydrometeorologist position(s). The accenting symbols used with the Xs further define the training; these symbols are the same used in fig. H-2. Table H-7 summarizes when this training is required by the various hydrologist/hydrometeorologist positions. The modernization stages shown in table H-7 are those time periods associated with modernization of NWS offices. The only accenting symbol used in table H-7 is the one which indicates that only some individuals will require the indicated training. All training that is a prerequisite for a position is excluded from table H-7 since it is assumed to have been completed by individuals prior to entering the position. Training that usually will be obtained over a period of time (within 2 to 3 years) is shown for more than one modernization stage. Also, some of the training, such as that which will be provided through the Advanced Hydrology/Hydrometeorology Workshop Series, is shown in each of the modernization stages since this training is of a continuing nature. This section further describes some of the details of the training that will be provided to meet the requirements identified in section 2.

3.1 College/University Education - B.S. or Equivalent

A college/university education with a Bachelor of Science degree in the Physical Sciences, Engineering or Meteorology, (or equivalent) satisfies training requirement number 1. This education is a prerequisite for obtaining a full time permanent field hydrologist position. Persons having satisfied this requirement will normally enter the Hydrologic Intern Program where they will begin to receive the training that will be provided by the NWS. Today the college graduate most often will not have received education in the complementary (meteorological for Type B and hydrological for Type A) science but it would be desirable to change this in the future so that this knowledge could be obtained prior to entering the NWS. In the modernized NWS, this will be highly desirable. Section 4.6 provides additional information about the progress that is being made with universities to develop curricula so that students can complete their education with a minor in the complementary science.

3.2 Course Work in Hydrology and Hydrometeorology to Satisfy the Type B Hydrometeorologist Qualification Standards

In addition to 6 semester hours of meteorology, hydrologists and hydrometeorologists will need to successfully complete 18 semester hours of course work in the hydrological/hydrometeorological sciences. This course work includes: (a) a 3 semester hour introductory level Hydrology course (often called Engineering Hydrology); (b) a 2 or 3 semester hour course

Table H-5. *Training provided to meet training requirements*

Training Requirement Number	Training Provided to Meet Requirement
1.	B.S. or equivalent College Degree in the Physical Sciences (Engineering) or Meteorology
2.	Eighteen semester hours of Hydrology/ Hydrometeorology University or equivalent course work
3.	Six semester hours of Meteorology University or equivalent course work
4.	Eighteen semester hours of Meteorology/ Hydrometeorology University or equivalent course work
5.	Six semester hours of Hydrology University or equivalent course work
6.	Three-week MARD Managers Course at the NWSTC
7.	COMET COMAP Course (1-week) and Advanced Hydrology/Hydrometeorology Overview Course
8.	COMET Hydrometeorology Course (3-week) (Substitute the COMET 2-week MARD Course until the Hydrometeorology Course is ready)
9.	Advanced Hydrology/Hydrometeorology Workshop Series
10.	RFC Operations Training on Interactive Processing and Forecasting Systems
11.	NEXRAD Operations Course
12.	AWIPS User Training
13.	AWIPS Systems Training
14.	ASOS Data User Training
15.	Computer Operations and Systems Training
16.	RFC Gateway and RJE User Training
17.	Hydrologic Services Correspondence Course
18.	Distance Learning Modules in the Principles of Meteorology (for Hydrologists)
19.	NWS Basic Operational Hydrology Course (2-weeks) at the NWSTC
20.	Distance Learning Modules in the Principles of Hydrology (for Meteorologists)
21.	Operations of the Hydrological and Climatological Network Course

in Remote Sensing of the Atmosphere, Radar Meteorology (Hydrology) and/or Satellite Meteorology (Hydrology); and (c) at least 12 semester hours from any of the following courses (including at least 3 three semester hours from the following courses: Fluid Mechanics or Fluid Dynamics, Hydraulics, Open Channel Flow, Hydrodynamics, or River

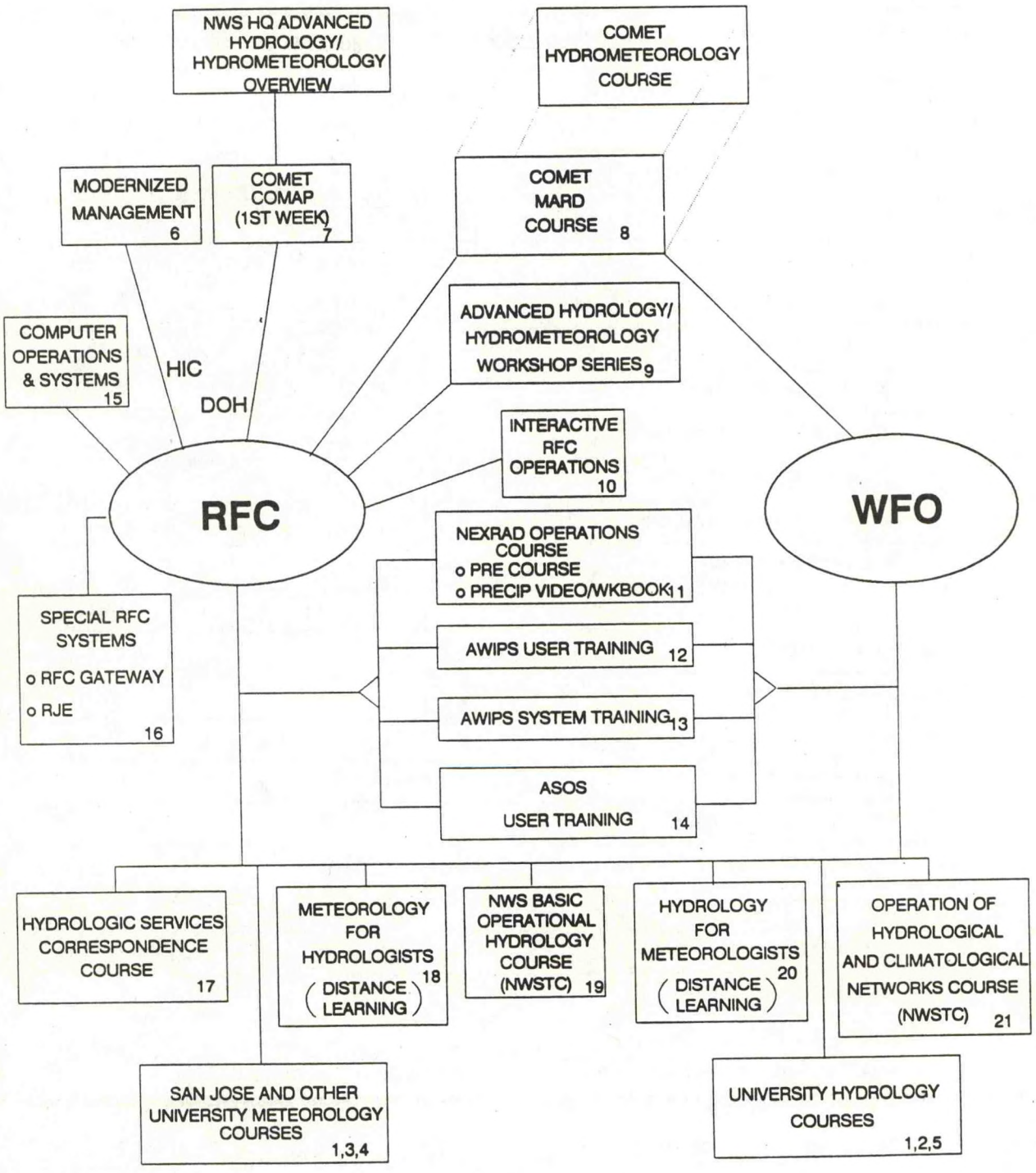


Figure H-3. *Training provided to meet hydrology/hydrometeorology requirements.*

Table H-6. *Training required by various hydrologist/hydrometeorologist positions*

REQUIRED TRAINING	HYDROLOGISTS / HYDROMETEOROLOGIST POSITIONS								
	HIC	DOH	Sr HF	HF	Sr HAS	HAS	H INT	SH GS-13	SH GS-12
1. UNIVERSITY EDUCATION	[X]	[X]	[X]	[X]	[X]	[X]	[X]	[X]	[X]
2. 18 HRS HYDRO / HYDROMET	[X]	[X]	[X]	(X)	[B]	[B]	(X)	[B]	[B]
3. 6 HRS METEOROLOGY	(X)	(X)	(X)	(X)	[B]	[B]	(X)	[B]	[B]
4. 18 HRS MET / HYDROMET					[A]	[A]		[A]	[A]
5. 6 HRS HYDROLOGY				[X]	[A]	[A]	(X)	[A]	[A]
6. MARD MGRS COURSE	X								
7. COMAP & HYDRO OVRVIEW		X							
8. COMET MARD/HYDROMET		X		X	X	X		X	X
9. ADV HYD / HYDMET WKSHPS	X	X	X	X	X	X	X		
10. RFC INTERACTIVE OPS	X	X	X	X	X	X	X		
11. NEXRAD OPS	X	X	X	X	X	X	X	X	X
12. AWIPS USER	X	X	X	X	X	X	X	X	X
13. AWIPS SYSTEMS		X	$\hat{X}$	$\hat{X}$					
14. ASOS DATA	X	X	X	X	X	X	X	X	X
15. COMPUTER OPS/SYS	X	X	X	X	X	X	X		
16. RFC - UNIQUE SYSTEMS			$\hat{X}$	$\hat{X}$					
17. HYD SERVICE COURSE	X	X	X	X	X	X	X	X	X
18. MET FOR HYDROS	X	X	X	X			X		
19. NWS BASIC OPER HYDRO	[X]	[X]	X	X	X	X	X	X	X
20. HYDRO FOR METS									
21. HYDRO CLIMATE NETWKS								X	X

X - INDICATES THAT THE TRAINING IS APPLICABLE TO EACH OF THE HYDROLOGISTS/ HYDROMETEOROLOGISTS POSITIONS. [A] FOR TYPE A, [B] FOR TYPE B HYDROMET.

SEE TABLE H-3 FOR THE DEFINITION OF ACCENT SYMBOLS ([X] , (X) , (X) , $\hat{X}$).

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Table H-7. *Time period when training to be completed by hydrologist/hydrometeorologist positions.*

Hydrologist/ Hydro-meteorologist Positions	Modernization Stages			
	Pre-MAR Stage 1	MAR Stage 1	MAR Initial Stage 2 (IOC)	MAR Stage 2
HIC	3, 9, 11, 14, 18	3, 6, 9, 10, 12, 18	9, 18	9, 18
DOH	3, 9, 11, 14, 15, 18	3, 7, 8, 9, 10, 12, 13, 15, 18	9, 15, 18	9, 15, 18
Sr HF	3, 9, 11, 14, 16, 18, 19	3, 9, 10, 12, 13, 15, 18	9, 15, 18	9, 15, 18
HAS A	9, 11, 14, 15, 17, 19	8, 9, 10, 12, 15	9, 15	9, 15
HAS B	9, 11, 14, 15, 17, 19	8, 9, 10, 12, 15	9, 15	9, 15
HF	2, 3, 9, 11, 14, 15, 16, 18, 19	2, 3, 8, 9, 10, 12, 13, 15, 18	9, 15, 18	9, 15, 18
SH A	11, 14, 17, 19, 21	8, 12		
SH B	11, 14, 17, 19, 21	8, 12		
H INT	2, 3, 5, 9, 11, 14, 15, 17, 18, 19	2, 3, 5, 9, 10, 12 15, 18	9, 15, 18	9, 15, 18

MODERNIZATION STAGE DEFINITIONS

Pre-MAR Stage 1 is from the present time to when the NEXRAD PUP is delivered.

MAR Stage 1 begins with the delivery of the NEXRAD PUP and ends with the delivery of AWIPS.

MAR Initial Stage 2 (IOC) begins with the delivery of AWIPS and ends after at least one major upgrade.

MAR Stage 2 is the period of time after the completion of MAR Initial Stage 2 (IOC).

Mechanics): Physical Hydrology or Hydrometeorology, Advanced Hydrology, Snow Hydrology, Fluid Mechanics or Fluid Dynamics, Hydraulics, Open Channel Flow, Hydrodynamics, River Mechanics, Hydrological Forecasting, and Watershed Modeling. Desirable electives, if needed to complete the semester 18 hours of course work, would be: Hydrologic Instruments, Soil Physics, Statistical Hydrology, Water Resource Engineering, Hydro-geology, Water Resource Management, Data Analysis, and Probability and Statistics. This training/course work will normally be acquired either from an accredited college or university or through correspondence study from an accredited institute of higher learning, or a combination of course work and appropriate experience. When formal university course work is necessary, the incumbent should initiate action with his or her immediate supervisor in the same manner as for all training requests. The formal course work should be received by attending local colleges and universities, where possible.

3.3 Course Work in Meteorology to Satisfy the Type B Hydrometeorologist Qualification Standards

Hydrologists and all hydrometeorologists will need to successfully complete 6 semester hours of university or equivalent course work in the meteorological sciences. This course work includes General Meteorology, Weather Analysis and Forecasting (sometimes called Synoptic Meteorology), or calculus-based Dynamic Meteorology. This training/course work will normally be acquired either from an accredited college or university or through correspondence study from an accredited institute of higher learning, or a combination of course work and appropriate experience. When formal university level course work is necessary, the incumbent should initiate action with his or her immediate supervisor in the same manner as for all training requests. The formal course work should be received by attending local colleges and universities, where possible.

3.4 Course Work in Meteorology and Hydrometeorology to Satisfy the Type A Hydrometeorologist Qualification Standards

In addition to the 6 hours of hydrology, hydrometeorologists desiring to meet the Type A hydrometeorologist qualification standards will need to successfully complete 18 semester hours of course work in the meteorological/hydrometeorological sciences. This course work includes: (a) 3 semester hours of General Meteorology (sometimes called Physical Meteorology); (b) 6 semester hours of Weather Analysis and Forecasting (Synoptic Meteorology); (c) 6 semester hours of calculus-based Dynamic Meteorology; and (d) a 2 or 3 semester hour course in Remote Sensing of the Atmosphere, Radar Meteorology (Hydrology), or Satellite Meteorology (Hydrology). Desirable electives, if necessary to complete the 18 semester hours, include: Cloud Physics, Climatology, Mesoscale Meteorology, Data Analysis, Probability and Statistics, and Physical Climatology. This training/course work will normally be acquired either from an accredited college or university or through correspondence study from an accredited institute of higher learning, or a combination of course work and appropriate experience. When formal university-level course work is necessary, the incumbent should initiate action with his or her immediate

supervisor in the same manner as for all training requests. Most of the formal course work should be received by attending local colleges and universities, where possible.

3.5 Course Work in Hydrology to Satisfy the Type A Hydrometeorologist Qualification Standards

Hydrometeorologists and those meteorologists desiring to meet the Type A hydrometeorologist qualification standards will need to successfully complete 6 semester hours of university or equivalent course work in the hydrological sciences. This course work includes: (a) 3 semester hours of Introductory Level Hydrology (sometimes called Engineering Hydrology) and (b) 3 additional semester hours in hydrology from one of the following: Physical Hydrology or Hydrometeorology, Advanced Hydrology, Hydrological Forecasting, Snow Hydrology, Hydraulics, River Mechanics, Watershed Modeling, Open Channel Flow, Fluid Mechanics or Fluid Dynamics and Hydrodynamics. This training/course work will normally be acquired either from an accredited college or university or through correspondence study from an accredited institute of higher learning, or a combination of course work and appropriate experience. When formal university course work is necessary, the incumbent should initiate action with his or her immediate supervisor in the same manner as for all training requests. The formal course work should be received by attending local colleges and universities, where possible.

3.6 Modernized Management Course

The NWSTC has traditionally provided training for new field office managers, and they will continue to provide that type of training. Certain aspects of the course will require modification based on the different responsibilities of current NWS field managers and those of the MAR NWS. All MICs and HICs will attend this course prior to their offices becoming modernized.

3.7 COMET COMAP Course (First Week) and Advanced Hydrology/Hydrometeorology Overview Course

The primary duty of the DOH is to provide direction for integrated implementation and operational support for the high levels of technology and advanced scientific application techniques employed in the RFC. To adequately perform these duties, the DOH will receive training in the advancements that have been made in the science of mesoscale meteorology. The DOH will also need an overall view of the advances and improvements in the modeling and analysis techniques in the hydrological and hydrometeorological sciences.

3.7.1 COMAP Course

During the first week of the COMET COMAP course, lecturers will present a significant amount of fundamental and advanced elements of mesoscale meteorology to establish a

good foundation for the sciene and operations officer (SOO) in the science of mesoscale meteorology. The presence of the DOH at the first week introductory portion of this course will enable him/her to be introduced to the details of the new science and technology with the SOO. The Stage I NEXRAD-based precipitation processing estimation will have already been presented at the 4-week NEXRAD course. It will be presented a second time, but as a refresher subject area, during an overview session on new observing systems at the COMAP course.

During the first week of the COMET COMAP course, lecturing will prevail; however, opportunities will exist to use the COMET workstations during evening periods when the lab is planned to be open. A PC-based version of the Denver AWIPS-90 Risk Reduction and Requirements Evaluation Phase 2 (DAR^{3}E-II) software will be delivered to COMET for use in the course. The following subject areas will be covered during the first week:

1. Course overview and course objectives;

2. Training on how to use the instructional laboratory;
3. Overview of new observing systems;
   a. Ground-based profiling of winds, temperature, and moisture;
   b. New ASOS;
   c. Geostationary Operational Environmental Satellite (GOES)-NEXT observing capabilities;
   d. Doppler radar signals from weather targets; and
   e. Information content and interpretation of integrated data sets.

4. Overview of mesoscale systems including synoptic/mesoscale interactions;

5. Forecasting process;

6. Overview of quasi-geotropic theory;

7. Overview of Numerical Weather Prediction (NWP) products for the mesoscale; and

8. Introduction to research collaborators.

3.7.2 Advanced Hydrology/Hydrometeorology Overview Course

It is critical that the DOH receive training in the advanced hydrological/hydrometeorological analyses and forecasting techniques that will be available in AWIPS at the RFCs. This type of training will be provided in a 3-week residence course offered by OH at NWS Headquarters. The classroom contents of this 3-week course for the DOH are outlined below:

- Introduction and Overview (1/2 day);

- Flash Flood Guidance in the Modernized NWS (1/2 day);
  Significant enhancements are underway to provide uniform procedures for use by all RFCs in preparation of Flash Flood Guidance. How the guidance values will be utilized by the WFOs and the interaction between the RFC and the WFO will be covered in broad terms.

- Precipitation Processing (1 day);
  The theory and techniques for NEXRAD Stage I, II, and III precipitation processing will be presented. Interactive sessions on computer workstations will be used to learn the techniques available for performing interactive quality control and analysis of precipitation estimates.

- NWSRFS (2 days);
  This 2-day session will give the DOH an understanding of the current status of the NWSRFS and the direction it is moving for future operations. Since one of the primary responsibilities of the DOH is to plan for implementation of the new technologies at his or her RFC, implementation considerations will be stressed.

- Water Resources Forecasting System (WARFS)/Extended Streamflow Prediction (ESP) (1 day);
  One of the major thrusts of the modernized NWS is the implementation of WARFS technology. Many of the RFCs currently provide some type of long-range forecasting services; however, many of the methods in use today are limited and do not have the capabilities included in the state-of-the-art models now available from HRL. Significant advancements in the science of ESP have occurred and the DOH will be introduced to these so that plans can be developed to implement such at his or her RFC. Implementation of these advanced procedures, which have been extremely slow in the past, must be greatly accelerated in the future.

- River Mechanics (1 day);
  Forecasting services can be improved in many of the major rivers throughout the Nation with the application of improvements that have been made in river mechanics. This 1-day session will give the DOH the necessary understanding so that plans can be made to implement these techniques within his or her RFC area of responsibility.

- Model Calibration (1 1/2 day);
  A 1 1/2-day session is far from sufficient to train the DOH to perform model calibration, especially with the advanced models that will be available in the modernized NWS and all of the options they will have. This 1 1/2-day session will, however, provide the DOH with an opportunity to become familiar with

techniques to calibrate models at the RFC as well as with resources available from HRL to assist the RFC hydrologic forecasters in calibrations.

- Reservoir Operations (1/2 day);
  Reservoir Operations can be very critical in the Operational Forecast System and, therefore, require some special attention within the forecasting process. Learning of the resources available to support the RFC in this area will enable the DOH to optimize the use of resources available at his or her RFC.

- Quantitative Precipitation Forecasting (QPF) (1 day);
  This 1-day session will primarily be spent with personnel from both the NMC and the TDL of the Office of Systems Development (OSD). Attention will be focused in two areas: first, the capabilities and limitations of present QPF; and second, what improvements are being made in the science of QPF and how these improvements will impact the RFCs. Since there is a degree of uncertainty associated with quantitative precipitation forecasting, some time will be reserved at the end of the sessions to consider cautions in the use of QPF in river forecasting.

- Interactive Forecasting (1 day); and
  Significant advancements will be available for the operational forecasting system on AWIPS which will be able to process very large volumes of data very rapidly. The application of the interactive forecasting procedures will be presented to the DOH. Since these techniques have only recently been developed, a significant amount of hands-on training will be provided. An appropriate amount of time will be devoted to provide background information to the DOH so that he or she can begin to implement this new technology at his or her RFC, and the DOH can provide assistance in directing the use of the operational interactive forecast system.

- Special Problem and Computer Laboratory Assignments (5 days).
  Interdispersed among the various periods of classroom instruction will be opportunities for the students to gain hands-on experience through special problem- solving assignments and computer laboratory activities.

The above outlined 3-week course for the DOH will be conducted approximately once per year. It is planned that only two or three DOHs at a time attend this course in order that discussions on RFC-unique interests can be held between each of the Project Area Leaders of HRL who will be presenting the material to the DOHs. Each course will be scheduled so that the DOHs will receive their training approximately 2 to 6 months prior to the installation of AWIPS at their respective RFC.

3.8 COMET MARD/COMET Hydrometeorology Course

COMET will play a central role in the training plan for hydrology. OH has been a strong

advocate of hydrometeorology as the linking discipline in the modernized field operations. It is very important that the training of the entire NWS professional field work force be linked together. Hydrologists need some education and training in meteorology and meteorologists need some education and training in hydrology. In order to provide the hydrological- and hydrometeorological-specific training material from COMET to all of the NWS meteorologists, hydrometeorologists, and hydrologists, it will be necessary to add a hydrometeorologist to the COMET staff. While this person will be an NWS employee, he or she will provide support to the Director of COMET and will be responsible for ensuring that all of the hydrological and hydrometeorological training material is developed and assembled for presentation to the forecasters. This includes both classroom/laboratory material and distance learning material. Guidance on the course curriculum will come from the Hydrometeorological Training Council (see section 4.1),augmented with a representative from COMET.

Coordination will take place between the COMET hydrometeorologist and the NWSTC hydrologist/hydrometeorologist to ensure that development of distance learning material is in agreement with the goals set by the Hydrometeorological Training Council. Most of the distance learning material developed by COMET will be on hydrometeorologic subject matter.

3.8.1 COMET MARD Course

The 2-week MARD course will be offered as a focused training effort to prepare all NWS meteorological and HAS forecasters, DOHs, and service hydrologists involved in the MAR demonstration. The emphasis will be on mesoscale meteorology and hydrometeorology; it will be applications oriented. Functional elements planned for the AWIPS Initial Operating Capability (IOC) will be presented, using case studies to ensure that forecasters are fully capable to handle the forecast situation in a modernized operational environment.

The tentative COMET MARD course outline is presented below. During the course, all students will have the opportunity to spend a significant amount of their time at COMET workstations, since many of the course topics will be presented as part of major case studies. Sections 1-5 will be covered mainly by lectures during the first week of the course but will be revisited during case studies and forecasting simulations. Many of the topics under section 6 will be integrated into the major case study on "severe convection" and again during the "major flash flood" case study.

TENTATIVE COMET MARD COURSE OUTLINE

1. Introduction;

2. Overview;
   A. NWP Models (emphasis on nested grid model (NGM) and Eta models);

B. Overview of New Observing Systems; and
C. Overview of Q-G Diagnosis and Q Vectors.

3. Forecasting Methodology;
   A. Control by Larger Scales;
   B. Role of Diagnosis in Forecasting;
   C. Estimating the Trend of the Dependent Variables;
   D. Inferring Weather from Future Fields of the Dependent Variables; and
   E. Nowcasting (Approaches and Constraints).

4. Forecasting Winter Storms;
   A. Cyclone Development;
   B. Cyclogenesis and Cyclone Tracks Affecting the MARD Area; and
   C. Winter Weather Attending Cyclones.

5. Mesoscale Processes;
   A. Overview of Mesoscale Meteorology.

6. Forecasting Severe Convection; and
   A. Overview of Severe Local Storm Forecasting;
   B. Diagnose the Evolution of the General Circulation - Planetary Waves;
   C. Diagnose the Synoptic Scale Environment;
   D. Diagnose Mesoscale Environment and Features;
   E. Convective Initiation;
   F. Thunderstorm Type and Structure;
   G. Organization of Convection and Development of Mesoscale Convection Systems (MCS);
   H. Storm Motion;
   I. Detecting and Nowcasting Thunderstorm Weather; and
   J. Thunderstorm Hazards to Aviation.

7. Forecasting Flash Floods.
   A. Definition and Types of Flash Floods;
   B. Synoptic Scale Environment Associated with Excessive Rains;
   C. Mesoscale Aspects of Flash Floods;
   D. Doppler Radar and Satellite Patterns Associated with Flash Floods;
   E. A Method for Short-Term Forecasting of Excessive Floods; and
   F. Hydrology of Flash Floods.

NOTE: Section 7.F. (Hydrology of Flash Floods) is further subdivided as follows:

(1) Areal Flash Flood Guidance;
(2) ADVIS (Flash Flood Forecasting Model);

(a) Antecedent Basin Conditions;
(b) Rainfall - Runoff Relationships;
(c) Hydrographs and Unitgraphs.

(3) Hydrologic Aspects of DAR^{3}E II Workstation; and

(4) Dam Break Catalog.

All of the functional elements presented at the 2-week course for meteorological and HAS forecasters, DOHs, and service hydrologists in the MARD area are intended to ultimately be developed into a series of distance learning modules. These mesoscale meteorology, hydrology, and hydrometeorology topics will be developed as CBL modules. The NWS hydrometeorologist assigned to COMET (see section 3.8) will contribute to their development. These modules (supported appropriately by the SOO and the DOH) will provide training for on-site learning beyond MARD.

In the restructured NWS, there will be an increased requirement for meteorological forecasters to be able to assess the hydrologic situation and to prepare and disseminate hydrologic forecasts, watches, warnings and other products. Distance learning material, in addition to that already available, will be developed for field office personnel to assist them in learning these duties. These materials will supplement some of the more formal training methods that will be available; they will become an additional avenue to assist those hydrologists and meteorologists who need to become qualified as hydrometeorologists.

3.8.2 COMET Hydrometeorology Course

The training needs of the SOO, the DOH, and the HAS forecasters are somewhat different. The DOH requires more training in RFC operations than does a HAS forecaster. Examples of the additional training required by the DOH include DAMBRK, ESP, and calibration of NWSRFS. The training needs of the SOO, on the other hand, will be focused in areas such as severe weather, thunderstorm development, winter storms, etc. The training needs of HAS forecasters are of major importance to the modernized NWS. The 2-week MARD course, described previously, will be beneficial; however, an additional COMET course on Hydrometeorology is ultimately necessary. Two in-depth courses will therefore be required of COMET; one on mesoscale meteorology (the COMAP Course) to be focused on the needs of the SOO and the second on hydrometeorology to be attended primarily by HAS forecasters and other hydrometeorologists. Both of these courses are in addition to the MARD course.

The Hydrometeorology course presented primarily to the HAS forecasters and service hydrologists by COMET will cover advanced mesoscale theory but will focus on mesoscale meteorological and hydrometeorological considerations of importance in hydrological forecasting. Considerable emphasis will be placed on recognizing attributes of various storm systems from the signatures that are presented by the new technologies. During operations, the HAS forecaster will spend a significant amount of time integrating and quality controlling NEXRAD-based precipitation estimates; therefore, it is necessary that the theory and

principles in this area be thoroughly covered. Since the HAS forecaster will be responsible for integrating large volumes of other data (such as gridded QPF products), learning the techniques necessary to integrate these data sources (e.g., surface, upper air, satellite, NEXRAD, Profiler) is critical to successful operations. Also, understanding the fundamentals of cloud physics and dynamics as they relate to quantitative precipitation and temperature forecasting is important to the HAS forecaster as is a basic understanding of how to assimilate QPF and QTF products from several sources into gridpoint estimates for input to hydrologic models.

Attendance at this 3-week Hydrometeorology Course will not be limited to HAS forecasters. The DOH will need to attend this course to obtain a solid foundation in hydrometeorological processes and the service hydrologists will need to attend the course for the same reason. This will also prepare the service hydrologist to effectively couple the hydrological and meteorological functions at the WFO. Attendance by the SOO will provide a broader base of knowledge in the applied hydrological and hydrometeorological sciences so that he/she will be able to assist in the training of other WFO staff members.

Those individuals meeting the Type A hydrometeorologist qualification standards will have a predominant background in meteorology; they should receive training in basic operational and some advanced hydrology prior to the 3-week COMET Hydrometeorology Course. Their hydrological training will be provided through a 2-week NWS Basic Operational Hydrology Course presented at the NWSTC (see section 3.19).

Similarly, those individuals meeting the Type B hydrometeorologist qualification standards will have a predominant background in hydrology; they should have received training in meteorology to meet the Type B hydrometeorologist qualification standards prior to attending the 3-week Hydrometeorology Course at COMET. The San Jose course or other college/university courses could fulfill this requirement. An initial outline for the COMET Hydrometeorology Course is contained in annex 2.

The first COMET Hydrometeorology Course will not be available until after the MARD courses are given; therefore, in the interim, HAS forecasters, DOHs, and service hydrologists will need to attend the MARD course to fulfill part of their requirement for training in the principles of mesoscale meteorology and hydrometeorology. When the COMET Hydrometeorology Course is available, there will need to be two courses offered per year until all offices are modernized. In the long term, one course per year will need to be offered for new employees and meteorologists crossing over to become HAS forecasters and service hydrologists from the Meteorological Intern Program. Primary support for the development of this course will come from the NWS hydrometeorologist assigned to COMET. Presentation of the course itself is expected to be by a university professor hired under contract for that purpose. It is necessary for that individual to have an extensive background in hydrometeorology, and it is highly desirable that the individual also be familiar with NWS hydrologic operations.

3.9 Advanced Hydrology/Hydrometeorology Workshop Series

All of the RFC forecasters and DOHs will require training via courses offered in the Advanced Hydrology/Hydrometeorology Workshop Series. This is a series of specialized workshops presented by experts from OH, principally in HRL, and upon occasion, as appropriate, by university professors under the umbrella of COMET. The workshops vary in length but typically last 1 week. Subject matter experts will travel to regional centers (usually these are RFCs) where the workshops are presented. Typically, the method of presentation will consist of a combination of lectures and hands-on training; however, the method can vary, depending on the actual subject area. The class size for these workshops will also vary depending upon the subject matter. Several forecasters from the host RFC as well as one (or possibly more) forecasters from other selected RFCs will be the principal attendees at the Advanced Hydrology/Hydrometeorology Workshops. Other individuals will be invited to attend as appropriate.

Distance learning modules will be developed in association with many of these workshops. Attendees at the workshops will be provided copies of Hydrology/Hydrometeorology reference workbooks so that they can be used later for refresher training. In many cases only one forecaster from other selected RFCs will attend the workshop; therefore, the module will be extremely valuable since that hydrologist can use it to help train other staff at his/her RFC. Workshop courses included in the series are:

- Hydrologic Models and Calibration; this workshop is designed to train hydrologists how hydrologic models operate and how to calibrate them for operational use. Following lecture presentations on the theory and principles, hydrologists will form small teams that will work together in practicing these principles. After each simulation is completed, the instructor will work individually with the teams providing instruction on how improvements can be made.

- NWSRFS OFS; this workshop trains the Hydrologic Forecaster to use both the interactive and batch NWSRFS OFS operationally. Training is performed off-line with canned/historical data sets so that after a forecast is created, it can be compared with the actual observed streamflow data. This workshop will be conducted in two parts. The first part, defined above, will be for all RFC operational forecasters. The second part will be for a smaller group of forecasters whose responsibility includes the NWSRFS system and file maintenance.

- ESP; this workshop provides the forecasters with the necessary training and background theory to enable them to create long-range, hydrologic forecasts utilizing both the present state variables of the hydrologic models and historical climatological data within the ESP model.

- Reservoir Operations; operational forecasting can be affected substantially by reservoirs that are operated by other agencies. This workshop will focus attention on what influence reservoirs have on forecast operations, how to take this into account, and how sensitive these factors are.

- Model Updating (including integration of remote sensing data); the state variables of hydrologic models must account for the total mass balance of the hydrologic basin and, therefore, must be reviewed periodically to bring them up to date as judged by observed data. Methods will be presented on how to update the models with remotely sensed snow data such as provided routinely by the National Operational Hydrologic Remote Sensing Center located in Minneapolis, Minnesota. Also, observed river conditions will be used to improve the estimates of current soil moisture conditions by applying Kalman filtering to the Sacramento Soil Moisture Accounting (SMA) model.

- Dam Break (DAMBRK) and Simplified Dam Break (SMPDBK); there are three levels of forecasting services that can be made available for dam breaks. The first approximation is available in a catalog form consisting of general engineering data that was inventoried several years ago. A much better estimate can be provided by applying the SMPDBK model. The best estimate can be prepared by using real-time data and the complete DAMBRK model. This workshop presents the capabilities and limitations of each procedure and goes into the background and theory of each procedure.

- The DWOPER Model; as a flood wave moves down a river channel, the backwater from tributaries, channel constrictions, dams, and tidal fluctuations significantly influence the shape of the flood wave. This workshop will teach hydrologic forecasters how to utilize the dynamic wave model for improved flood forecasting.

- Historical Data Analysis in Mountainous Areas; the calibration of hydrologic models in mountainous areas can be extremely difficult if the forecaster is not highly skilled in preparing the data. The orographic effects of precipitation are the primary factors; however, the factors of elevation and temperature (rain vs. snow) also complicate the situation. Forecasters can significantly improve their river basin calibrations by participating in this workshop.

- Precipitation Processing Systems; and the NEXRAD-based precipitation estimates that will be used in hydrologic forecasting will be supplemented with satellite data and in-situ precipitation data. This workshop will cover all aspects of the derivation of the precipitation estimates using various algorithms, quality control procedures, and finally, the interface with the operational forecast system.

- Flash Flood Program Workshop. This workshop covers the derivation and calculation of flash flood guidance at the RFC and use of flash flood guidance at the WFO and its use in Local Flood Warning Systems (LFWS). Training on LFWS will assure adequate expertise is obtained to work effectively with communities implementing an LFWS. Other training will thoroughly cover the hydrologic forecast models run in the WFOs. Areas covered include use of flash flood guidance, model parameters and their maintenance, QPF, and interpretation of model output. Additional training will include development techniques for flash flood guidance derivation at the RFC and parameter derivation in the WFO model for additional flood-prone locations.

3.10 Interactive RFC Operations

Staff of the HRL is developing advanced scientific application software techniques that will be used by forecasters to interactively perform forecast operations. HRL is also developing techniques to interactively quality control and analyze Stage II NEXRAD-based precipitation estimates to produce higher quality Stage III estimates. While these interactive application software techniques are currently being developed under the PROTEUS project, they will ultimately be transferred to AWIPS. Section 4.6.1 describes the training that will be provided to staff at PROTEUS-equipped RFCs. Similar training will be provided to all RFCs when the techniques have been transferred to AWIPS.

3.11 NEXRAD Training

All NWS operations personnel will attend a 4-week NEXRAD Operations Course in Norman, Oklahoma. Several precursor training modules will be taken in preparation for the 4-week course. A group of four precursor training modules on hydrometeorological precipitation processing has been produced by OH personnel with support by the Office of Meteorology (OM). Others have been assembled with support from the National Severe Storms Laboratory (NSSL) and the NWSTC. The precipitation processing training modules are in the form of a videotape which is supplemented by a workbook. The content of the modules is as follows: (1) introduction to the NEXRAD Hydrometeorological Precipitation Processing System; (2) an overview of the Stage I Precipitation Processing System, including material on the two software support functions; (3) detailed material on the five scientific algorithms in the State I Precipitation Processing System; and (4) overview of both the Stage II Precipitation Processing and Stage III Precipitation Processing Systems as well as an overall summary. The 4-week tri-agency NEXRAD Operations Course on Weather Surveillance Radar-88 Doppler (WSR 88-D) will be held at the NWS Norman, Oklahoma, Operational Training Facility (NWS NOTF). Initially, UNISYS will conduct the 4-week course; however, when the NEXRAD Joint Systems Program Office (JSPO) has certified the Government instructors, they will take over responsibility for training all students. The NWS Operations Course will consist of a combination of lectures and laboratories, using NEXRAD Principal User Processors (PUP). An outline of the first 4-week Operations Course is presented below. This course is subject to change as more experience is gained

by the instructors as to the needs of the students; however, the current course outline and presentation sequence is useful here to give a basic understanding of the contents of this course. Practical experience during lab sessions will reinforce the lecture material.

One member of the NEXRAD training team is a hydrometeorologist. It is that instructor's responsibility to produce, develop, maintain, and present training on all of the

WEEK	SUBJECT MATTER	TIME ALLOTMENT HOURS
1	Introduction to WSR-88D	3
	WSR-88D System Description	1
	WSR-88D Equipment Operation	1
	Introductory Notations and Definition	1
	WSR-88D Maintenance Overview	1
	Physical Principles of Doppler Radar	8
	Product Acquisition/Display Operation	13
	LAB/Reading Assignments	12
2	Exam #1	1
	Meteorology and Radar Interpretation	18
	WSR-88D Product Description	1
	LAB/Reading Assignments	20
3	Exam #2	1
	WSR-88D Product Description	14
	Algorithms	5
	LAB/Reading Assignments	20
4	Exam #3	1
	Algorithms	8
	Unit Control Position (UCP)	11
	Applications	2
	LAB/Reading Assignment	16
	Exam #4	1
	Critique	1

hydrometeorological aspects of the NEXRAD System to lead meteorological forecasters, HAS forecasters, meteorological and hydrological forecasters, service hydrologists and other hydrologists and employees of NWS. This includes the complete Precipitation Processing System and the Flash Flood Potential Subsystem, including the hourly rainfall projection functions of the algorithm. Training will also be provided on the Gage Data Support System (GDSS) which supports the Precipitation Processing System.

3.12 AWIPS User Training

Operator training on AWIPS will be provided in two distinct segments: (1) initial user training; and (2) routine user training. These training areas will be developed by the AWIPS contractor. The contractor will also be responsible for conducting initial user training. Routine user training will be an interactive training package that is always available through the AWIPS system. NWS is responsible for developing and conducting scientific training.

3.12.1 Initial AWIPS User Training

Initial AWIPS user training for the entire operational office staff will be conducted on-site by the contractor immediately following installation of the AWIPS equipment. This training will not be totally new to a few offices in the MARD area since the staff will have already gone through a basic level with the PROTEUS and DAR^{3}E II equipment. The "Initial AWIPS User Training" will be unique to each site's particular system configuration and shall enable the users to operate the site-level system in all operational and maintenance modes. Instruction will include "hands-on" use of the AWIPS system and shall also include identification of basic system malfunctions and how to take simple corrective actions. The contractor will provide instruction to each user on "day-to-day" operational usage of the system.

3.12.2 Routine User Training

Routine user training is an automated-interactive form of training. It will always be available at each site to allow the NWS to train new users and to provide refresher training for all experienced users.

3.13 AWIPS Systems Training

AWIPS systems training will be available for the AWIPS focal point, the SOO, the DOH, and the Electronics Systems Analyst from each office. A 2-week course will be provided by the AWIPS contractor at the NWSTC. Subject matter that will be covered includes AWIPS computer operation, system and application programming, support software, and AWIPS database and programming conventions. The last course the AWIPS contractor will teach will be a cadre course for the NWSTC employees who will provide AWIPS systems training after AWIPS is installed at all field sites.

3.14 ASOS User Training

The requirement for training hydrologists and hydrometeorologists on ASOS is not as lengthy as training for the other new technologies. Since ASOS will mainly be a provider of automated data (vs. manual, as in the past), hydrologists and hydrometeorologists will be required to understand the capabilities and limitations of how these observations are

(automatically) taken. ASOS training consists of four principal elements: (1) the ASOS User Manual; (2) ASOS Operator Training; (3) ASOS Network Manager Training; and (4) ASOS Maintenance Training. Since hydrologists and meteorologists will primarily be users of the data from ASOS, they will receive training in the form of a review of the ASOS User Manual. The ASOS User Manual will be prepared by the ASOS Program Office. This manual will be reviewed periodically and revised as necessary by the ASOS Program Office during the ASOS Operational Implementation Phase (1990-1994). Two additional aspects of ASOS training are required. First, the location where observations are taken, and second, where the data are stored for operational use. Both of these, plus information on the capabilities and limitations of the system, will be available in manuals provided by the ASOS program office. Further details on how and where the data are stored will be provided in the AWIPS database training.

3.15 Computer Operations and Systems Training

The NWS makes extensive use of computers in the hydrologic forecasting process. Large volumes of data are processed at high frequencies with hydrologic models and modeling systems. In order to utilize computers optimally in RFC operations, several major types of computer skills must be maintained by RFC hydrologists. These include:

- Applications software and languages such as FORTRAN, C, etc.;
- Operating systems such as UNIX and system commands, e.g. COPY, etc.;
- JCLs for Central Computer Facility/main frame computers;
- Overall computer system usage in the modernized NWS - backup - overall resource design, etc.;
- Software design techniques for optimum system performance; and
- Telecommunication software capabilities and design including use of modems - networks, etc.

Computer skills are needed by RFC hydrologists, and a wide variety of computer courses are offered by vendors as well as colleges and universities. Based on individual RFC needs, courses should be selected from local sources, if possible. In some circumstances, travel may be required for some courses.

3.16 RFC-Unique Systems

The two RFC-unique systems for which training will be provided are the RJE system and the replacement for the RFC Gateway system. The RJE system will eventually be replaced by the AWIPS which will provide the same functional capabilities. It is yet unclear whether

the replacement for the RFC Gateway system will eventually be replaced by AWIPS; currently it seems more likely that it will not be replaced by AWIPS. Significant training, especially the software component, will be required in either case.

3.16.1 RFC-RJE System

The replacement for the AFOS-based RJE system that allows RFCs to remotely submit batch jobs to the Central Computer Facility (CCF) is a stand-alone microcomputer-based system. This system not only enables RFC personnel to remotely submit batch jobs to the CCF but it enables direct interactive time share operations also. This state-of-the-art, off-the-shelf technology will enable the RFCs to transition into MAR AWIPS technology. Training on these systems will be by vendor-supplied user operations manuals. Central on-call assistance will also be available from staff in the Hydrologic Operations Division (HOD) and the staff at the CCF.

3.16.2 RFC Gateway System

The replacement for the Data General Eclipse S/140 RFC Gateway (DATACOL) System will be a microcomputer-based system. Additional new features are being included in this replacement system that will allow the handling of large gridded fields, e.g.,NEXRAD-based precipitation fields. Another important function of the replacement system will be the exchange of data between RFCs and external agencies, including ESP products as part of the WARFS Program. All of the functions in the RFC Gateway System are NWS-unique. Much of the technology for the basic system has been developed with NWS resources; in-house documentation and user manuals will be utilized in the training process. Initial setup and beginning operations will be provided by staff from the Hydrologic Systems Branch of OH.

3.17 Hydrologic Services (Correspondence) Course

The most recent version of the Hydrologic Services (Correspondence) Course is dated 1978; however, it was reprinted from the 1972 version. While much of the hydrologic subject matter is still current, considerable revision is necessary in many areas; efforts are underway to completely update this course. The current course has eight lessons, while the updated course will have thirteen lessons. The new lessons cover the following subject areas: Fundamentals of Hydrology, Precipitation and its Variability, Satellite Snow Cover and Airborne Gamma Snow Survey, Interdependence of Meteorology and Hydrology, and Developments in Real-Time Hydrologic Forecasting. The old lesson on Radar Hydrology is also being broadened in perspective and titled Remote Sensing of Precipitation.

The Hydrologic Services (Correspondence) Course will continue to be one of the components of the Forecaster Development Program as well as an element in the new Hydrologist Intern Program. Administration of the course will be conducted by the NWSTC

while revisions and updated lessons will be under the guidance of the Hydrometeorological Training Council. Subject matter experts for performing the revision and updating will generally be hydrologists and hydrometeorologists from across the entire NWS program under the leadership of the training instructor hydrologist position located at the NWSTC (see section 3.19).

3.18 Meteorology for Hydrologists

Meteorological distance learning modules in the form of CBL modules are being developed by COMET. Each RFC and WFO will have a special workstation in its facility that will be used exclusively for training. This PC-based workstation will not have current/live/real-time data but instead will have historical data sets integrated into the modules. These CBL modules and historical data sets will be used by forecasters as a tool to "learn how to forecast."

The first two modules are under development by COMET at this time and are planned to be available in the spring of 1991. They are on the subjects of "Interpretation of WSR-88D Data" and "Initiation of Convection." A module normally consists of 2 to 3 total hours of student instruction broken into lessons of about 20 to 30 minutes each. Both audio and visual media are used, and they are designed to be interactive with the student. Full motion video with dubbed audio is frequently mixed with more conventional text screens or image screens to deliver the lessons.

A large list of additional modules has been identified with each having specific lessons and learning objectives defined. The modules in this list have not been assigned any priority at this time. New modules will be added to the list as further needs are identified. The titles of the meteorological modules identified presently are:

Quasi-Geostrophic Diagnosis
Numerical Weather Prediction
Application of Statistics in Weather Prediction
The Weather Forecasting Process
Wind and Thermodynamic Ground-Based Profiling and Automated Surface Observation
Satellite-Based Observing and Profiling
Weather Observing Capabilities of the WSR-88D Doppler Radar
Mesoscale Forced Circulations
Mesoscale Instabilities and Free Circulations
Diagnosing the Potential for Convection
Convective Initiation
Thunderstorm and Mesoscale Connective System Types and Structures
Convection Associated with the Summer-Early Fall U.S Monsoon Circulation
Detecting and Nowcasting Severe Convective Weather Elements
Forecasting the Attendant Weather and Storm Surge of Land- Falling Hurricanes

Extratropical Cyclone Development
Stratiform Cloud and Precipitation Processes
Mesoscale Precipitation Systems in Winter Storms
Forecasting Winter Precipitation Type and Intensity
Turbulence and Convective Weather Hazards to Aviation
Fog, Low Stratus, and Icing Hazards to Aviation

Most hydrologists will require an introductory level understanding of basic meteorology prior to using the CBL modules listed above. Introductory level correspondence courses to provide this training are available from universities. For those hydrologists who have not completed the training that is identified in section 3.3, but require an introductory level training in meteorology, a correspondence course is highly desirable. Hydrologists needing this training should seek the advice of their regional Scientific Services Division to determine the most appropriate courses and their availability.

3.19 NWS Basic Operational Hydrology Course

A number of new RFC forecasters, service hydrologists and hydrologist interns will need to be hired as the NWS begins the MAR process. These new employees will need training in NWS Basic Operational Hydrology. They will have met the civil service requirements for the position for which they will have been selected; however, in very few cases will they have all the detailed background, knowledge, skills, and abilities necessary to completely understand the technology that will be used in the modernized NWS operational river, flood, and flash flood forecasting procedures. There are also some current employees who would benefit from this course. This course would also be beneficial to meteorologists, especially those crossing over to the hydrometeorologist series, in order to be able (in part) to qualify for the position of a HAS forecaster.

A new hydrologist/hydrometeorologist position will be added to the staff of the NWSTC. The primary responsibility of the NWSTC hydrologist/hydrometeorologist will be to develop and present a new residence course at the NWSTC. This will be the NWS Basic Operational Hydrology Course. By maintaining a close liaison with the HRL, the NWSTC staff hydrologist/hydrometeorologist will be able to keep the contents of the NWS Basic Operational Hydrology Course integrated with the applications software and procedures that are being developed by HRL for use in field operations. The NWSTC hydrologist/hydrometeorologist will also be assisted by other NWSTC resident instructors who are subject matter experts in areas such as meteorology, engineering, and administration, etc. A team effort will be used to instruct the students. Guidance on the course curriculum will come from the hydrometeorological training council (see section 4.1), augmented with a representative from the NWSTC. One of the additional responsibilities of the NWSTC hydrologist/hydrometeorologist includes close coordination with the COMET hydrometeorologist as well as staff at OH in the preparation of distance learning modules in hydrologic subject areas for field use.

The NWS Basic Operational Hydrology Course will be a 2-week course and will be offered three times a year. The class size of approximately 20 students is planned so that new hydrologists can be trained in NWS basic operational hydrology.

Some time would be available for the NWSTC hydrologist/hydrometeorologist to develop distance learning modules that would be utilized as both primary and refresher training material for forecasters. In addition, the NWSTC hydrologist/hydrometeorologist will spend selected periods of time in both RFCs and WFOs in order to maintain operational skills.

The draft curriculum for the 2-week course is provided in Annex 1. Upon completion of the 2-week residence training in NWS Basic Operational Hydrology at the NWSTC, a set of examinations will be given to each student. A certification of training in Basic Operational Hydrology will be provided to each student successfully passing the examinations.

3.20 Hydrology for Meteorologists

A fundamental understanding in the hydrological sciences is needed by meteorologists to assess the hydrologic situation, process the hydrometeorological data, and issue the public products. The subject areas directly applicable include: (a) Rainfall/Runoff Relations; (b) Unit Hydrographs; (c) Streamflow Measurements and Ratings; (d) River Routing; and (e) River Forecasting. Meteorologists will need training in these areas to operationally use the Flash Flood Forecasting Model (ADVIS) that has been implemented in the DAR^{3}E II workstation and will be implemented on AWIPS. A workbook covering these fundamental subject areas has been developed by Southern Region hydrologists for training meteorologists at the Norman WSFO. In addition, a CBL module also has been prepared to supplement the workbook. Refinements to these modules may be made based on feedback from the training that will be provided to the Norman, Oklahoma, forecasters.

Hydrological and hydrometeorological distance learning modules will be provided under the umbrella of COMET as well as from OH. Historical data sets will be integrated with these modules into the training workstation and will provide operational forecasters with tools to improve their forecasting skills. Individual hydrometeorological events can then be studied by WFO forecasters repeatedly with support from the SOO and the service hydrologist.

The titles of the hydrology and supporting modules currently planned by COMET are:

Hydrology for Meteorologists
Forecasting Excessive Convective Rains and Flash Floods
Forecasting Main Stem River Flooding

Additional details on the CBL covering Forecasting Main Stem River Flooding are available in annex 5.

The outline for the COMET CBL module on hydrology for meteorologists is shown below:

The Runoff Process;
Hydrographs and Unit Hydrographs;
Factors Affecting Hydrographs;
Factors Affecting Rainfall-Runoff Relation;
Measurement of Streamflow;
Precipitation Measurement, Including Radar Estimates;
Definition and Spectra of Floods;
Flash Flood Guidance and Local Forecast Models; and
Critical Rainfall Probabilities.

These modules are intended to provide the training that is required initially to meet the needs of the meteorologists. Additional modules will be developed as additional needs are identified. OH personnel will participate directly in this effort and will work closely with the NWS hydrometeorologist assigned to COMET and the hydrologist/hydrometeorologist assigned to the NWSTC (see section 3.19) in the preparation of these modules. Some of these modules will be in the form of workbooks and/or videos.

A number of hydrology topics will be covered at the COMET COMAP course through a selection of case studies or through occasional lectures and seminars. Forecasting Main Stem River Flooding is one of the curriculum topics that will be covered. It will consist of the following subelements:

FORECASTING MAIN STEM RIVER FLOODING

A. Synoptic Scale Patterns Associated with Widespread Heavy Rains;
B. Short-Range Quantitative Precipitation Forecasting;
C. WSR-88D-Based Precipitation Forecasting;
D. Diagnosing and Modeling the Flood; and
E. Preparation and Issuance of Flood Warnings.

Forecasting Flash Floods is another one of the curriculum topics and is also planned to be presented as a case study. The following subelements are currently planned to be covered:

FORECASTING FLASH FLOODS

A. Temporal and Spatial Spectra of Floods;
B. Definition and Types of Flash Floods;
C. Synoptic Scale Environments Associated with Excessive Rains;
D. Mesoscale, Cloud-Scale and Microphysical Aspects of Flash Floods;

E. Radar and Satellite Patterns Associated with Flash Floods;

F. A Methodology for Short-Term Forecasting of Excessive Rains; and

G. Hydrological Aspects of Flash Floods;
   1. Areal Flash Flood Guidance;
   2. ADVIS (Flash Flood Forecasting Model);
      (a) Antecedent Basin Conditions;
      (b) Rainfall-Runoff Relationships; and
      (c) Hydrographs and Unitgraphs;
   3. Hydrologic Capabilities of the DAR^{3}E II Workstation; and
   4. Dam Break Catalog.

Annex 6 contains additional information about the case study on Flash Flooding.

3.21 Operations of Hydrological and Climatological Networks Course

The current Operations of Hydrological and Climatological Networks Course has been held once per year; it has been attended by RFC hydrologists, service hydrologists, and CPMs. The full 3-week residence course at the NWSTC covered: (1) the operational aspects of hydroclimate program, (2) responsibilities of service hydrologists, (3) some limited basic hydrology, and (4) hydroclimate equipment care and maintenance.

With the creation of a new 2-week residence course in NWS Basic Operational Hydrology, the limited "basic hydrology" will be discontinued in the Operations of Hydrological and Climatological Networks Course, and emphasis (from a hydrological viewpoint) will be placed on (1) operational aspects of hydro- climate program and (2) responsibilities of the service hydrologist. Attendance will also focus on service hydrologists, hydromet techs, and the new DAPMs. The length of the course for the DAPMs and hydromet techs will continue to be 3 weeks; however, the course will be reduced in length to 2 weeks for the service hydrologists. The frequency of the course will increase from once per year to approximately three times per year due to the increase in the number of service hydrologists, hydromet techs, and DAPMs. The additional training that will be required by the Hydromet Techs and the DAPMs for duties other than those of the CPM is not identified here.

4.0 Training Support

There are a number of functions, activities, and other items that are closely related to field training. These are described in this section.

4.1 The Hydrometeorological Training Council

The Hydrometeorological Training Council (HTC) has been formed to provide technical and scientific direction concerning the formulation of curriculum for hydrometeorological training for the MAR NWS. The HTC is composed of the Chief of the HRL and hydrologists and meteorologists from the field and NWS Headquarters. The underlying principles of the HTC will be to ensure that the material presented is consistent with national policies and the agreed upon objectives for the professional development of the NWS hydrologists, meteorologists, and hydrometeorologists.

Recommendations for membership to the HTC are made by the Regional Hydrologists and Regional Scientific Services Division Chiefs. The field representatives are then selected by the Directors of OM and OH.

The HTC, through its chairman, the Chief of HRL, will be responsible for defining the future education and training needs for hydrology and hydrometeorology. While the types of courses and the methods by which the education and training will be presented will vary, the subject matter and content needs to be reviewed prior to presentation to the students. Early review of the subject matter outline by the HTC will assist all instructors by steering their efforts which, in the long, run will ensure that the training material meets the long-range requirements of the NWS. The Charter for the HTC can be found in annex 4.

Mr. Mike Callahan from the Louisville WSFO has accepted the service hydrologist position. Mr. Dave Zanzalari from the Middle Atlantic RFC has accepted the RFC hydrologist position. Mr. Bill Drzal from the Pittsburgh WSFO has accepted the field meteorologist position. Mr. Leroy Spayd has accepted the Headquarters meteorologist position. All four of the above individuals will serve during FY 91 and 92.

4.2 Hydrometeorological Training for HAS Forecaster

There will be an increased emphasis on hydrometeorology in the modernized NWS. Both the establishment of the HAS function in each RFC and the colocation of each RFC with a WFO will facilitate close hydrological and meteorological interactions. The RFC HAS forecasters will interact with all of the WFOs in their area of responsibility. The HAS forecasters will need education and practical experience in both the hydrological and meteorological sciences to perform this function most effectively. The new hydrometeorologist qualification standards specify the education and training required for those positions that will ultimately be filled by persons with hydrometeoro-

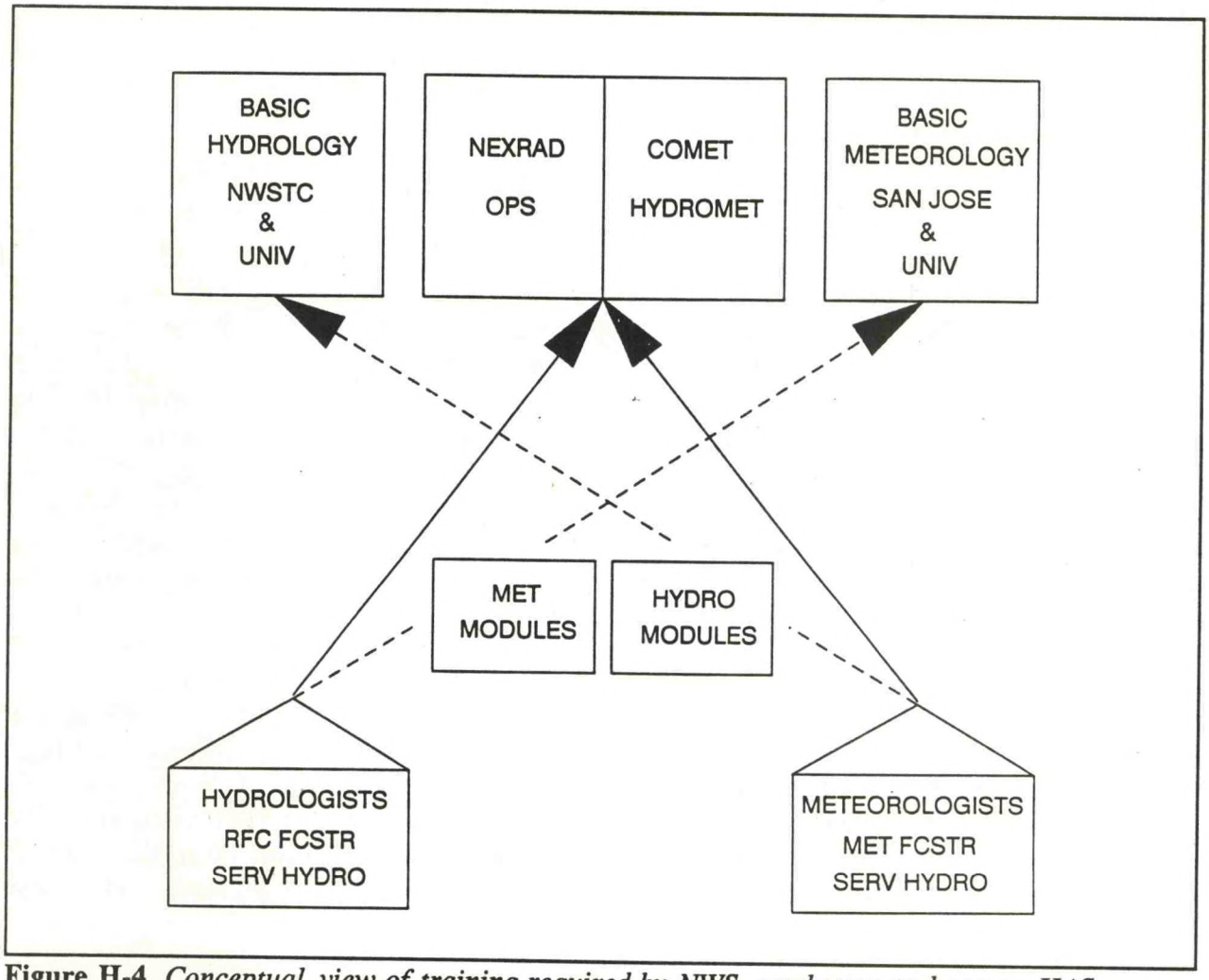

Figure H-4. *Conceptual view of training required by NWS employees to become HAS forecasters*

logical qualifications. Many NWS employees currently have the qualifications to apply for HAS forecaster positions or other positions which specify the need for hydrometeorological qualifications. Many additional NWS employees meet most of the requirements but will require some additional education and training. The type of training required of NWS employees who become HAS forecasters is presented conceptually in figure H-4. The dashed line from the lower left to the upper right indicates those NWS hydrologists seeking to meet the Type B qualification standards for HAS forecaster positions. They will need to expand their knowledge in meteorology. The San Jose course as well as meteorology courses at other universities can provide this training. Furthermore, a wide variety of meteorology (distant learning) modules are planned for development by COMET. The dashed line moving from lower right to the upper left indicates those NWS meteorologists seeking to meet the Type A qualification standards for HAS forecaster positions. They will need to develop and expand their

knowledge in hydrology. Colleges and universities will be a source for their training as well as the new NWS Basic Operational Hydrology Course that will be offered by the NWSTC. Hydrology (distant learning) modules are also planned by COMET which will be available for all meteorologists. The solid lines shown in figure H-4 extending diagonally upward from both the hydrologist and meteorologist portions of the NWS work force indicate that all HAS forecasters will be scheduled to attend the 4-week NEXRAD Operations training and the new 3-week Hydrometeorology course at COMET. As indicated earlier, the 2-week MARD course will be used temporarily until the 3-week COMET Hydrometeorology course is ready.

Hydrometeorological training, while focused towards the RFC HAS forecasters, will also be available for a wide range of individuals in the NWS. The objective is to encourage a greater understanding of both disciplines by most Headquarters and field personnel. One of the desirable factors in the selection of future managers is that they have education, training and practical experience in both the hydrological and meteorological sciences.

4.3 The Hydrologist Intern Program

The Hydrologist Intern Program has been fragmented in the past since no central policy has existed; regional variations that have existed have evolved over time. A central policy has been developed as part of this national training plan for the hydrology program. Included in the Intern Program are two residence training courses for new hydrologists conducted by the NWSTC. The first is the 2-week NWS Basic Operational Hydrology Course described in section 3.19. The second is the Operations of the Hydrological and Climatological Networks Course described in section 3.21. Other aspects of the NWS Forecaster Development Program that have traditionally been aimed at intern meteorologists will be used in the Hydrological Intern Program. This includes NWSTC-developed Remote Training Module material, an example of which is an orientation to the NWS directives Weather Service Operations Manual (WSOM) series. The description of the Hydrologist Intern Program is in the form of an Operations Manual Letter (OML) and is found in annex 3.

4.4 Training Records

Proper documentation of training is mandatory. While it is not necessary to maintain field training records at the same level as formal college/university transcripts, it is necessary to establish a formal record keeping process. This section describes two levels of training records that will need to be instituted.

4.4.1 MIC/HIC Responsibilities for Training Records

The MIC and HIC will need to take appropriate steps to ensure that proper records are maintained of the additional college/university-level course work taken by their staff. Records are needed of those courses identified in sections 3.2 through 3.5 of this plan

which have been completed. Copies of transcripts should be forwarded to the appropriate personnel office and kept with official personnel records. The primary responsibility for ensuring that proper training records are maintained rests with the employee; however, it is desirable that the HIC, with support from the DOH, establish and maintain a file for each employee that contains records of all of the 21 training requirements outlined in section 2. The level of details for entries into this file will vary, depending on the training requirement number. For example, an entry should be made into this file for each hydrology and hydrometeorology course that has been successfully completed to satisfy training requirement number 2 (18 semester hours of hydrology and hydrometeorology course work). However, only one entry is necessary when the individual satisfactorily completes training requirement number 19 (the NWS Basic Operational Hydrology course). When an individual transfers from one office to another, the supervisor should mail the training record folder to the new supervisor.

Some individuals will have acquired appropriate experience in a given subject area, over a period of time, that they will not need to take formal college/university course work to satisfy the training requirement. The appropriate person to make this determination is the individual's supervisor (MIC/HIC). A suggested method to document proficiency in a given subject area is for the HIC to enter a statement into an individual's performance plan, as a major activity, indicating that the individual will demonstrate this proficiency. In most cases specific criteria for evaluation of this proficiency will be necessary, and the HIC will typically, depending on the subject area, obtain advice from the DOH, regional headquarters, and the Chief of HRL on specific criteria for particular subject matter. The Regional Director, with input from regional staff, will be the determining individual for subject matter needed by those in HIC positions. Substitution of practical experience for formal course work will primarily be for employees who have been on the job for several years as journeymen forecasters, whereas newer employees will receive their additional knowledge primarily by taking formal course work at colleges and universities.

4.4.2 Central Record Keeping Office for On-Site Training

The NWSTC will maintain records for all NWS employees concerning those subjects where training has been conducted on site. This function will be provided for field office personnel who complete distance learning training material such as that developed by the NWSTC, NEXRAD (the precursor models including the OH NEXRAD videotape/workbook modules), COMET, or other organizations. By having one centralized location for all on-site training records, it can be readily determined what distance learning has been completed and when it was completed, especially when employees transfer from one field office to another.

4.5 Field Study Guides

The NWS has invested considerable time and resources to document many NWS-unique systems. These Operations Handbooks and User Manuals provide the basic documenta-

tion for field personnel to study and review the capabilities and features of these NWS-unique systems. Although training may be carried out on these systems in a formal manner, field personnel should devote self-study time initially to learn the basic systems. The most appropriate approach is to begin with the User Manuals, progress to discussions with program leaders in OH, or elsewhere as appropriate for questions and answers, and finally obtain hands-on experience using the system.

Hydrologic systems that have Operations Handbooks and User Manuals are summarized below:

NWSRFS

The NWSRFS User Manual series is a comprehensive set of documentation. Background, theory, and "how to" use the system from calibration to daily operations are provided.

GOES Data Collection Platform (DCP) Data Distribution System (DDS)/ Hydrometeorological Automated Data System (HADS)

The current GOES DCP DDS will be replaced with HADS. HADS has considerably greater features than the GOES DCP DDS; however, they are both based on the same data source. As HADS is implemented, users will receive a new Operations Handbook describing the enhanced system and its capabilities and features.

SHEF

The Standard Hydrometeorological Exchange Format (SHEF) is being documented as Weather Service Observing Handbook No. 4 and the SHEF Field Office Users Manual. In addition, a Computer Assisted Instruction (CAI) remote training module is available for IBM PC compatible systems.

DAMBRK

DAMBRK documentation provides users with the models' theoretical background as well as how to use the models. Documentation is provided on both the SMPDBK and the complete DAMBRK models. Additional information on dams throughout the Nation exists in a separate set of documentation referred to as the Dam Catalog; a computerized version of the Dam Catalog is available at all field offices. This catalog provides users with a first approximation of the flood that would occur in a worst case situation for a dam failure. Also, other information about the dam (height, volume of stored water, crest length, nearest downstream town) is provided.

National Remote Sensing Hydrology Program - Version 3.0 - A Users Guide

The National Operational Hydrologic Remote Sensing Center is managed by OH and consists of the Airborne Snow Survey Section and the Satellite Hydrology Section. The Center is located in Minneapolis, Minnesota, and the Users Guide is intended to provide field hydrologists with background as well as technical and administrative aspects of how the program functions. Procedures are described on the techniques used to collect, process, and distribute operational airborne snow water equivalent measurement data and satellite areal extent of snow cover measurement data.

4.6 Risk Reduction Training

Training will be provided for two special risk reduction systems, the PROTEUS system and the hydrologic component of the DAR^{3}E II system which will be installed at Norman, Oklahoma.

4.6.1 PROTEUS Training

The four RFCs participating in the PROTEUS project (Middle Atlantic RFC, Tulsa RFC, Missouri Basin RFC, and the Colorado Basin RFC) have been provided training for the specialized equipment and software that is being used in the project. It is not expected that any significant additional training will be required for the equipment already in use except for that provided in-house by existing RFC personnel. However, there will be special training required for the software currently being developed by the HRL staff on the scientific workstation components of the PROTEUS system. Two software applications being developed are a Stage III precipitation estimation procedure for WSR-88D-based precipitation products and the interactive NWSRFS OFS. A team of HRL subject matter experts will visit each of the PROTEUS field offices and provide hands-on training in the use of these applications software packages.

4.6.2 DAR^{3}E II Hydrologic Component Training

Initial DAR^{3}E II Hydrologic Component training was provided to the Denver, Colorado, WSFO forecasters in a 3-day exercise in February 1990. Lectures on the theory and the background of the features available in the DAR^{3}E II Hydro workstation were provided. In addition, 1 day was available for all lead meteorological forecasters to get hands-on experience.

Similar training will be provided for the lead meteorological forecasters at the Norman, Oklahoma, WSFO. It will be necessary for staff from Southern Region Headquarters and the Program for Regional Observing and Forecasting Service (PROFS) project office to provide training for Norman, Oklahoma, WSFO forecasters. The service hydrologist from the Norman, Oklahoma, WSFO will explain RFC products to the WSFO

forecasters, providing background information on how the products are prepared and their limitations. Southern Region Headquarters staff will provide instructions on the scientific principles that have been incorporated into the workstation, and the PROFS project office staff will teach the forecasters how to use the equipment. The training will consist of both lecture and lab exercises.

4.7 Professional Development Opportunities at Colleges and Universities

Full- and part-time university assignments as well as individual course work at colleges and universities will continue to be emphasized as a method to enhance the professional standing of the NWS work force. Individual initiative is required to take advantage of such programs. The assistance of the SOO and the DOH should be sought by each individual when they are preparing and/or updating their personal development plans. Interested forecasters may apply for full- or part- time assignment through the University Assignment Program (UAP). The NWS plans five full-time assignments annually. In addition to the full-time UAP, individuals may apply for the part-time UAP. Typically the part-time UAP is referred to as the 20/20 program where half of each week is devoted to work and the other half to classroom study. The 20/20 program can also be accomplished in different proportions. For example a 32/8 program can be established for individuals seeking to complete only one course during a given semester. This program is highly desirable especially if the necessary courses can be found at a local institution within the commuting area of the duty station. Full- and part-time assignments are intended to improve the employees' performance in their current position and enable individuals to eventually become qualified for higher-level positions. These assignments are competitive. There are also occasions when an individual finds a need to increase his or her knowledge and skills just in an area related to his or her present position. This often can be accomplished by taking only a few courses at a local institution. When this situation arises, the individual should pursue the opportunity by discussing the needs with his or her MIC/HIC. Support will be available if the request is reasonable and justifiable. In addition to all of the above, COMET has established an Outreach Program. Although COMET is recognized for the residence programs, designed to provide high-level courses in Boulder and other locations, and the distance learning program, designed to provide training material to field offices for on-site training, the Outreach Program is intended to foster cooperative activities between universities and NWS field offices. NWS meteorologists and hydrologists are encouraged to collaborate with universities in this manner and jointly develop proposals for research activities that are mutually beneficial. Details are available from regional Scientific Services Divisions and COMET.

The new hydrometeorologist qualification standards require that emphasis be placed on the relationship between the NWS and those universities offering baccalaureate or higher degrees in the hydrological and meteorological sciences. While there will always be opportunities for both hydrologists and meteorologists to supplement their major line of study with course work in the alternate discipline following completion of their college or

university study, it is highly desirable that colleges and universities which offer degrees in these two fields also offer their students the opportunity to graduate with a major in one of the disciplines and a minor in the other. This will lead to employees entering the work force with an education more suited to the needs of the modernized NWS. Therefore, a concentrated effort is being made to provide the background on the hydrometeorologist qualification standards to various universities. Already several universities have been contacted or have heard of the hydrometeorological qualification standards and have recognized the benefits that will be realized by their students if they have educational opportunities in both disciplines. Students entering the University of Arizona actually had this opportunity in the fall of 1990. Universities actively working with OH include:

- University of Arizona
- Massachusetts Institute of Technology
- Texas A and M
- University of Iowa
- Princeton
- Pennsylvania State University
- University of Oklahoma
- Purdue
- University of Illinois at Urbana
- South Dakota School of Mines and Technology

Managers in OH and many other NWS employees have been in contact with universities regarding the work force requirements for the modernized NWS. Through these personal contacts and close working relationships, understandings have been reached on how best to offer students the opportunity to obtain a stronger educational background that will enable them to build a career in the hydrometeorological sciences. More in-depth discussions and contacts with additional universities will be made in the future.

5.0 Resource Requirements

The resources required for the training described in this plan are projected on a fiscal year basis. Refinements will be made as new information is obtained. The estimates are believed to be, at this point in time, representative for the next few years. Once the current work force is adequately trained and steady-state is reached, costs are expected to diminish somewhat. In addition, approval of the hydrometeorologist qualification standards will help reduce training costs since most new employees entering the NWS will have satisfied some of the training requirements.

5.1 Training Resource Requirements

Resource requirements for training are presented in this section. These are the costs associated with travel, per diem, course material and course fees. In certain cases, salaries and PCS costs are identified if new employees are needed to develop and provide training.

5.1.1 No resources are required for training requirement number 1. Costs associated with training requirement number 1 will continue to be the responsibility of the individual seeking employment with the NWS.

5.1.2 A number of hydrologists will need additional course work to fully satisfy training requirement number 2. This need will continue through the mid-90's in order to fully prepare the work force to effectively carry out their duties in the MAR NWS. Resources for training requirement number 2 are based on an estimate that 50 field hydrologists will apply for and receive authorization to take additional hydrology course work. It is also assumed that each course will be 3 semester hours in length. Average course fees are based on $75.00 per semester hour plus $50.00 for books and materials.

50 courses/year x 3 semester hours per course x
$75 per semester hour = $11.5K

Books = 50 x $50 = $ 2.5K

Total estimated cost per year for
training requirement number 2 = $14.5K

Funding for training requirement number 2 is assumed to be covered by the UAP. There will be a need to increase the budget of the UAP somewhat to provide funding for this training requirement.

5.1.3 Resources for training requirement number 3 are based on an estimate that 40 hydrologists will apply for and receive authorization to take meteorology course work. Many hydrologists already have a basic background in meteorology. It is also assumed

that each course will be 3 semester hours in length. Average course fees are based on $75.00 per semester hour plus $50.00 for books and materials. Some of this requirement can also be met by hydrologists applying for and being accepted to take the Special Course for Meteorological Technicians at San Jose State University in California. Funding for this has already been planned for and is not counted here.

40 courses/year x 3 semester hours/course x
$75 per semester hour = $ 9K

Books = 40 x $50 = $ 2K

Total estimated cost per year for
training requirement number 3 = $11K

Funding for training requirement 3 is assumed to be covered by the UAP.

5.1.4 No resources are required for training requirement number 4 since meteorologists wishing to cross over to hydrometeorologist positions will already have met the meteorological requirements for the Type A hydrometeorologist position.

5.1.5 Resources for training requirement number 5 are based on an estimate that 50 meteorologists will apply for and receive authorization to take hydrology course work. It is also assumed that each course will be 3 semester hours in length. Average course fees are based on $75.00 per semester hour plus $50.00 for books and course materials.

50 courses/year x 3 semester hours/course x
$75 per semester hour = $11.5K

Books = 50 x $50 = $ 2.5K

Total estimated cost per year for
training requirement number 5 = $14K

Funding for training requirement number 5 is assumed to be covered by the UAP.

5.1.6 Resources for training requirement number 6 are included in the NWS Master Training Plan and are not re-identified here.

5.1.7 Resources for training requirement number 7 are covered somewhat in the NWS Master Training Plan and are included here for clarification purposes only. The DOHs will attend both the first week of the COMET COMAP course and also a 3-week Advanced Hydrology/Hydrometeorology Overview Course.

COMET COMAP COURSE (1 week)

2 DOHs x $95 per day x 6 days	=	$1.0K
2 DOHs x $400 travel	=	$1K

NWS Advanced Hydrology/Hydrometeorology Overview Course (3 weeks)

2 DOHs x $105 per day x 19 days	=	$4.0K
2 DOHs x $400 travel	=	$1K
Total estimated cost per year for training requirement number 7	=	$7.0K

Funding for the COMET COMAP Course is assumed to be part of the COMET budget.

5.1.8 Resources for training requirement number 8 are separated into two parts. The first part is for a new hydrometeorologist position that will be assigned to COMET, and the second part is for travel and per diem for students to attend the COMET Hydrometeorology course or, until the course is available, the 2-week MARD course. Ten positions have been identified for training in the MAR Demonstration and Implementation (MARDI) initiative. One of these positions will be for a hydrometeorologist that will be allocated to OH for assignment to the staff of the Director of COMET. This position will need to be hired during FY 91.

Salary, benefits and PCS costs for 1 GS-13 hydrometeorologist	=	$75K

HAS forecasters, service hydrologists, the DOH, and some hydrologic forecasters and meteorologists (primarily SOOs) will attend the 3-week COMET Hydrometeorology course. Until this course is available, students will attend the 2-week MARD Course. From the above listed positions that will need to attend the COMET Hydrometeorology course, it is expected that two classes of 20 individuals per class will be needed on an annual basis. Only HAS forecasters, DOHs, and service hydrologists will attend the MARD Course.

(MARD Course)

30 students x $95 per day x 12 days	=	$34K
30 students x $400 travel	=	$12K

(or COMET Hydrometeorology)

40 students x $95 per day x 19 days = $72K

40 students x $400 travel = $16K

Total estimated costs per year for training requirement number 8 = $46 to $88K

5.1.9 Resources for training requirement number 9 are for travel and per diem for the subject matter experts from HRL and staff from adjacent RFCs to attend workshops. HRL plans to conduct about six Advanced Hydrology/Hydrometeorology Workshops each year. Each workshop will average 1 week in length and will be presented by two subject matter experts from HRL. It is expected that at least six individuals from other RFCs will attend.

6 workshops x 8 hydrologists x $100 per day x 5 days = $24K

6 workshops x 8 hydrologists x $400 travel = $19K

Hydromet Reference Workbooks are planned to be prepared for use in association with the Advanced Hydrology/Hydrometeorology Workshops.

Total estimated cost per year for development of Distance Learning Modules = $20K

Total estimated cost per year for training requirement number 9 = $63K

5.1.10 Resources for training requirement 10 are for travel and per diem for HRL subject matter experts to visit and conduct a 1-week hands-on work session introducing the RFC staff to interactive processing and forecasting operations. Ultimately this will be on AWIPS workstations, but in the interim, training will be provided on the PROTEUS workstations (see also section 5.2.6). One trip is planned each year to two RFCs to train all RFC staff on interactive NWSRFS OFS operation. A second trip is planned each year to two RFCs to train the RFC staff (primarily the HAS forecasters) on the techniques to interactively quality-control and analyze Stage II NEXRAD-based precipitation estimates so as to produce higher quality Stage III estimates.

Funds for training requirement number 10 will not be necessary until AWIPS is installed in each RFC. Funds necessary to train the staff of those RFCs with PROTEUS equipment are identified in section 5.2.6.

2 training sessions x 2 trainers x $100 per day x 5 days = $2K

2 sessions x 2 trainers x $400 travel = $2K

Total estimated cost per year for training requirement number 10 = $4K

5.1.11 Resources for training requirement number 11 are included in the NWS Master Training Plan for all hydrologists to attend the NEXRAD Operation Training Course. They are not re-identified here.

5.1.12 Resources for training requirement number 12 are included in the NWS Master Training Plan for all hydrologists to receive AWIPS user training. These resources are not re-identified here.

5.1.13 Resources for training requirement number 13 are included in the NWS Master Training Plan for two individuals from each RFC to attend systems training on AWIPS at the NWSTC. These resources are not re-identified here.

5.1.14 Resources for training requirement number 14 (ASOS) are included in the NWS Master Training Plan and are not re-identified here.

5.1.15 Resources for training requirement number 15 are based on an estimate of one RFC staff member (from each RFC) attending a special computer system/software course each year; that course not being available locally. Vendor supplied subject matter and course material estimate is $1500.00 per course.

13 RFCs x 1 staff x $1500/course = $18K

13 staff x $400 travel = $ 5K

13 staff x $100 per day x 5 days = $ 6.5K

Total estimated cost per year for training requirement number 15 = $29.5K

5.1.16 Resources for training requirement number 16 are based on one staff member from OH traveling to each RFC and spending 3 days of instruction on the use of the replacement RFC Gateway System. No resources are required for the RJE training since that will be performed on site with vendor supplied user manuals.

13 RFCs x 1 OH staff x 3 days x $100 per day = $4K

13 RFCs x 1 OH staff x $400 travel = $5K

Total estimated cost per year for
training requirement number 16 = $9K

5.1.17 No special monetary resources are required for training requirement number 17, the Hydrologic Service Correspondence Course. It will be revised by existing staff and printed by the NOAA print shop. The latter will result in minimal expenditures which will be covered directly from OH funds.

5.1.18 Resources for training requirement number 18 are based on an estimate of two RFC staff members taking an introductory meteorology correspondence course per year. This is identified as separate from training requirement number 3 which is similar. The estimate is also based on the recommended course that has been identified in the training plan for the (Norman) WFO Emulation. It should be noted that the training identified here will take longer to complete than the approach proposed by the Southern Region.

13 RFCs x 2 staff per RFC x $200 per year = $5K

Total estimated cost per year for
training requirement number 18 = $5K

5.1.19 Resources for training requirement number 19 are separated into two parts. The first part is for the addition of a staff member to the NWSTC, and the second part is for travel and per diem for students to attend the NWS Basic Operational Hydrology Course at the NWSTC. Ten positions have been identified for training in the MARDI Initiative. One of these positions will be assigned to the NWSTC for hydrology training and will need to be hired during FY 91.

Salary - benefits and PCS costs for 1
Hydrologist = $75K

Initially one NWS Basic Operational Hydrology Course will be needed, but three courses per year are projected until all offices are modernized. Once this is achieved, it is projected that two courses per year will satisfy the long-term requirements of the NWS. Classes are expected to have twenty 20 each.

20 students x $70 per day x 12 days = $ 17K

20 students x $400 travel = $ 8K

Costs per class for training requirement 19 = $ 25K

Total first year resources needed for
training requirement number 19 = $100K

Total second and later years resources per year needed for training requirement number 19 = $125K

(Note: PCS cost offsets 1 class in the second and following years)

5.1.20 Resources for training requirement number 20 are included in the NWS Master Training Plan and will be provided by COMET and therefore are not re-identified here. Until these modules have been completed, the workbooks and the CBL module under preparation by personnel in the Southern Region will be used to fill the meteorologists needs.

5.1.21 Resources for training requirement number 21 are based on the estimate that 10 service hydrologists will need to attend the 2-week portion of the Operation of the Hydrological and Climatological Networks Course per year. (Note: Costs for hydro-met technicians are not identified here).

10 service hydrologists x $70 per day x 12 days = $ 8.5K

10 service hydrologists x $400 travel = $ 4K

Total estimated cost per year for training requirement number 21 = $12.5K

Funding for training requirement number 21 is assumed to be covered, as it currently is, from Office of Systems Operation (OSO) funds. It should be noted, however, that currently the costs are higher since the course is 3-weeks in length.

5.2 Some resources will be necessary for activities and functions in the support of the training and are identified in this section.

5.2.1 The resources required for the HTC are based on two trips per year.

3 HTC members x 2 trips per year x 5 days per trip x $95 per day = $3K

3 HTC members x $500 travel = $1.5K

Total resources required per year for the HTC = $4.5K

5.2.2 The resources required for HAS forecaster training are identified separately in previous sections.

5.2.3 The resources required for the Hydrologist Intern Program are not collectively identified here since they have been identified separately in previous section.

5.2.4 No special resource requirements are needed for maintaining training records. The record keeping process has been established to serve a wide variety of needs and there is no requirement to change it.

5.2.5 Field Study Guides and User Manuals will continue to be developed as a routine part of the evolution of projects and there is no need to separately identify resources for the creation or updating of these Guides and User Manuals. They will continue to be created and updated as a normal part of NWS operation.

5.2.6 Resources will be required for Risk Reduction Training. A continuing effort to develop the interactive Stage III precipitation analysis techniques and interactive river forecasting techniques is underway by HRL staff. As these techniques are revised, subject matter experts from HRL will need to train field staff on their use. Several trips are expected annually as refinements are made. The resource estimate is based on eight field trips per year.

8 trips x 5 days per trip x $95 per day	=	$4K
8 trips x $400 travel	=	$3K
Total annual estimated resources for Risk Reduction Training	=	$7K

5.2.7 The resources necessary to establish cooperative agreements with additional universities for Hydrological and Hydrometeorological education and training are considered to be part of the routine and normal responsibilities of OH and therefore are not separately identified here.

ANNEX 1

NWSTC 2-Week Basic Operational Hydrology Course

The following is a draft curriculum for the 2-week NWS Basic Operational Hydrology Course to be conducted at the NWSTC. A new hydrologist/hydrometeorologist will be added to the staff of the NWSTC. This NWSTC hydrologist/hydrometeorologist will spend approximately 3 weeks with selected Project Area Leaders of the HRL to design/develop the course material. Furthermore, the first course offered, while presented under the leadership of the NWSTC hydrologist/hydrometeorologist, may include selected HRL experts as well as experts from the field. In the longer term there will be less dependence on both the HRL and the field experts; however, a close liaison will be maintained in order to keep the course at the state of the art.

DRAFT CURRICULUM

NWSTC 2-Week Basic Operational Hydrology Course

WEEK 1

Mon	AM	Travel	
	PM	Welcome/Orientation	1 hr
		Hydrometeorological Data: Precipitation (Rain and Snow) Sensors	1 hr
		Temporal and Spatial Variability of Precipitation (Rain and Snow) and Elevation Zone (Temperature) Effects on Snow Melt	2 hrs
Tues	AM	Observed Precipitation Data Quality Control	1 hr
		Stage I, II, and III NEXRAD-based Precipitation Estimates	3 hrs
	PM	Stage I, II, and III NEXRAD-based Precipitation Estimates (Cont.)	4 hrs
Wed	AM	Stage I, II, and III NEXRAD-based Precipitation Estimates (Cont.)	4 hrs
	PM	Forecasted Precipitation (QPF)	3 hrs
		Mean Areal Precipitation	1 hr
Thur	AM	Temperature - Sensors and Networks and QC	1/2 hr
		Mean Areal Temperature	1/2 hr
		Evaporation - Sensors and Networks and QC	1/2 hr
		Mean Areal Potential Evaporation	1/2 hr
		Streamflow Sensors and Networks	1 hr
		Stage/Discharge Rating Curves and Quality Control	1 hr
	PM	Rainfall/Runoff Processes and Basic Modeling	4 hrs
Fri	AM	Snow Accumulation and Ablation Model and Model Updating with Remotely Sensed Snow Data	4 hrs
	PM	Temporal Distribution - Unit Hydrograph and Routing	4 hrs

DRAFT CURRICULUM

NWSTC 2-Week Basic Operational Hydrology Course (Cont.)

WEEK 2

Mon	AM	River Routing - Storage and Dynamic Models	4 hrs
	PM	Reservoir Routing - Level Pool Method and Outflow Controls	1 1/2 hrs
		Stage/Discharge Ratings - Synthetic and Extrapolation Techniques	1 1/2 hrs
		River Control Structures - Levees and Dams	1 hr
Tues	AM	NWSRFS Flood Forecasting - Historical Data Analysis and Model Calibration	4 hrs
	PM	NWSRFS Flood Forecasting - Historical Data Analysis and Model Calibration (Cont.)	1 hr
		NWSRFS Flood Forecasting - Software Procedures	3 hrs
Wed	AM	NWSRFS Flood Forecasting - Software Procedures (Cont.)	4 hrs
	PM	Flash Flood Forecasting - ADVIS, Dam Break, Flash Flood Guidance	4 hrs
Thur	AM	Extended Streamflow Prediction	3 hrs
		Regression Techniques for Water Supply Forecasting	1 hr
	PM	Forecast Operations	4 hrs
Fri	AM	Office Administrative Reports/Forms	1/2 hr
		Preparation of E-19 and E-19a	1 hr
		NWS Communications - NOAA Weather Wire/Radio, NWS Family of Services	1/2 hr
		Interfacing with the Media and General Public	1/2 hr
		Exam/Graduation	1 1/2 hrs
	PM	Travel	

ANNEX 2

COMET 3-WEEK Hydrometeorology Course

An initial outline has been assembled below to show the layout for the 3-week Hydrometeorology course conducted at COMET. Monday morning of the first week and Friday afternoon of the last week are to be reserved for travel. The three major components of the course are: (a) Mesoscale Meteorology, Cloud Physics, and Temperature Forecasting (3 days); (b) Precipitation Processing/NEXRAD-based plus QPF (i.e. Hydrometeorology) (8 days); and (c) Hydrology (3 days). Appropriate time will be made available at the first part of the first week and the last part of the third week to perform the "welcome/get acquainted" and "graduation/closing" for this COMET 3-week Hydrometeorology Course.

The Mesoscale Meteorological, Cloud Physics, and Temperature Forecasting portion of the course is expected to be split into three elements as defined below. Whenever possible, it is desirable to utilize as much of the course work as possible that has been developed for the COMAP and the MARD course:

- 1 1/2 days — Lecture on Mesoscale Meteorology and Cloud Physics, and Types of Synoptic and Mesoscale Precipitation Systems including Orographic Effects;
- 1 day — Case Studies/Workshops; and
- 1/2 day — Temperature Forecasting and determination of techniques necessary to assess rain versus snow lines for RFC snowmelt computation.

The Hydrometeorological focus can be subdivided into two major segments. First, the real-time precipitation estimates (NEXRAD-based); and second, the future precipitation estimates (QPF). These elements are defined as follows:

- 1 day — 1/3 day review of the Stage I Precipitation Processing Subsystem of NEXRAD; 2/3 day lecture on the Stage II Precipitation Processing System that will operate in the WFO AWIPS;
- 2 days — Stage III w/workshops and exercises; 1 1/2 days of case studies and 1/2 day lecture;
- 1 day — Long-Range QPF from NMC perspective; 1/2 day lecture and 1/2 day lab;

- 1 day — Medium- and Short-Range QPF from TDL Perspective; 1/2 day lecture and 1/2 day lab;
- 1 day — Applied WFO QPF Integration; 1/2 day lecture and 1/2 day of case studies; and
- 2 days — HAS forecaster assimilation of QPF products.

NOTE: The Eastern Region risk reduction activities at the Ohio Basin RFC and the associated WSFOs are expected to contribute significantly to the initial effort in providing training in Applied WFO QPF Integration and HAS forecaster assimilation of QPF products.

The Hydrology focus will be subdivided into three major elements. The first element will provide a focus on Basic Hydrology. The second element will address the application software that will operate in the WFO AWIPS. The third and final element will be directed to the activities at the RFC. These can be defined as follows:

- 1 day — Operational/Basic Hydrology:
  Includes precipitation accuracy, rainfall runoff, Unit Hydrographs, Stage/Discharge Relations, and River Routing;
- 1 day — WFO AWIPS Hydrology:
  Includes Utilization of RFC Flash Flood Guidance, Flash Flood Potential, Automated Product Formatters, and the ADVIS Flash Flood Model; it is expected that 1/2 day will be devoted to lecture and 1/2 day will be devoted to case study workshops; and
- 1 day — RFC Activities:
  Includes data processing, river forecasting, RFC product preparation, Flash Flood Guidance, Reservoir Operations, and Extended Streamflow Prediction; 2/3 of the day will be devoted to presentations and lectures and 1/3 of the day to case studies workshops.

ANNEX 3

Draft OML

The Hydrologist Intern Program

This annex contains a draft OML that will be distributed to all Office Directors and Regional Directors for formal review. Ultimately, WSOM Chapter E-80 will be revised and updated based on this Master Training Plan for Hydrometeorological Operations; however, it is anticipated that it will take somewhat longer to finalize the total master training plan since it is much broader in scope than the training for the Hydrologist Intern Program. As a result, this OML is intended to be filed with WSOM E-80. At a later date when the Master Training Plan for Hydrometeorological Operations is approved, WSOM E-80 will be updated and this draft OML will be incorporated into the updated E-80.

NATIONAL WEATHER SERVICE
SILVER SPRING, MARYLAND 20910

Operations Manual Letter

Date of Issue: To Be Determined	**Effective Date:** To Be Determined
In Reply Refer To: W/OH22	**File With:** E-80

Subject: Hydrologic Intern Program

Reference(s): WSOM E-80 Hydrologic Training Programs, Issuance 69-26, dated April 9, 1969

Purpose:

This Hydrologist Intern Training Program establishes the procedures to help hydrologist interns develop the basic knowledge and skills necessary to perform the professional duties of river and flood forecasting for the National Weather Service (NWS). The program provides on-the-job experience and training, supplemented by formal course work. The broadly stated goal of the program is to enable hydrologists to perform professional hydrologic duties at a River Forecast Center (RFC) or Weather Service Forecast Office (WSFO) or Weather Forecast Office (WFO)/Hydrologic Service Area (HSA) offices.

Qualifications, Selection, and Entry Levels:

The Office of Personnel Management (OPM) qualification standards for the Hydrology Series, GS-1315[1], will be used to determine the minimum qualifications for hydrologist intern positions. The basic requirements of these standards are either a bachelor's degree or higher in the appropriate physical science or engineering, or a combination of education and experience totaling 4 years. In either case, the education must have included at least 30 semester hours in any combination of courses in hydrology, physical science (including geophysical sciences), engineering science, soils, mathematics, aquatic biology, or the management or conservation of water resources. The course work must have included differential and integral calculus and physics. Normally, it is expected that a meteorologist crossing over from the meteorologist career field will have the minimum requirements. Applicants will be selected from appropriate OPM registers and from

[1]The Qualification Standards for the Hydrometeorological Series (GS-1355) is being established to more accurately reflect for NOAA/NWS the hydrological and hydrometeorological type jobs. Once this series has been officially approved, it will become another more representative standard under which individuals can enter the NWS hydrology program and become qualified.

qualified meteorologists who wish to cross over to the Hydrology Series. Normally, the hiring of hydrologists into the Hydrologic Intern Training Program will be at the GS-5 level; exceptionally well-qualified candidates may be hired at the GS-7 level, subject to OPM qualification standards. Nothing shall preclude hiring of fully qualified hydrologists for appropriate positions from other agencies, from among reinstatement eligibles, or from OPM registers at grades above the normal entrance level.

Assignments:

Interns will normally take two or more introductory training assignments. It is necessary that training include assignments at both RFCs and WSFOs (WFO)/HSA offices. Depending on interest, experience, and background, assignments to other offices, such as regional headquarters, may be considered. Hydrologist interns will advance to the GS-11 position if training and experience progress satisfactorily and time-in-grade requirements are met. The final assignment will be at an RFC which will serve as a staging ground for the final on-the-job training for service hydrologists, hydrometeorological analysis and support (HAS) forecasters and hydrologic forecasters. Focus will be on the development of forecasting skills. Hydrologist interns will receive a graduation certificate after completing the final assignment in the intern program to document satisfactory completion of the internship at the GS-11 level. Upon completion of the Hydrologic Intern Program, the individual becomes a graduate hydrologist intern. Advancement to journeyman level GS-12 position at an RFC or WSFO (WFO) will be competitive as vacancies occur and as time-in-grade and performance requirements are met. The employee will remain at the GS-11 graduate hydrologist intern level until selected for a GS-12 position.

Management:

Hydrologist intern positions will be created as opportunities arise. Normally these positions will be created at the colocated WSFO(WFO)/RFC. The minimum number of hydrologist interns that can be expected in a modernized RFC will be 1/3 of the combined number of positions of GS-12 hydrologic forecaster and hydrologist interns that are allocated to each RFC. These positions will be used to facilitate training. The hydrologist-in-charge (HIC)/meteorologist-in-charge (MIC) and the regional hydrologist will encourage frequent consultation and discussion with the intern during various training assignments. Each intern will also be assigned a training counselor. For those offices having reached a level of modernization which has enabled them to have a development and operations hydrologist (DOH) or a science and operations officer (SOO), that individual will serve as the training counselor for the hydrologist intern. The training counselor may upon occasion request the specific additional assistance of a senior hydrologist when the intern is assigned to an a RFC or the service hydrologist when assigned to a WSFO. In the absence of the DOH/SOO, the training counselor will be assigned by the HIC/MIC.

Within 30 days after assignment to each field office, the HIC/MIC and the training counselor will review the Hydrologist Intern Training Program (*see typical training program in ADDENDUM A), discuss it in detail with the intern, and develop a specific program for implementation within the framework of the RFC/WSFO (WFO) assignment. Discussions should include specific station activities as well as training opportunities available within the vicinity of the station. This activity should result in a specific personal development training plan for the hydrologist intern which is based on the above as well as the knowledge, skills and abilities, and prior training of the individual intern. A copy of this plan (see sample in Addendum B) should be forwarded to the regional hydrologist for overall program management purposes and to the National Weather Service Training Center (NWSTC) for central-record keeping purposes. A Hydrologist Intern Progress Report (see Addendum C) should be prepared by the training counselor twice a year on January 31 and July 31 and submitted through the HIC/MIC to both the regional hydrologist and the NWSTC.

Approximately 3 months before each training assignment is scheduled for completion, the regional hydrologist, along with the HIC/MIC will discuss the progress and accomplishments made by the hydrologist intern and consider future assignments. This discussion will determine: (1) if the intern has successfully completed his/her present training program, or if more time is needed; (2) the next station assignment; and (3) potential areas of special emphasis.

Upon subsequent assignment(s), a similar process of training plan review, development, assignment of a training counselor, preparation and submittal of progress report(s), and assessment will be conducted. During the individual's final assignment, the intern will work very closely with both a HAS forecaster and a hydrologic forecaster. Those forecasters will act as mentors to the intern as operational forecasting skills are developed.

Training:

Training will consist of on-the-job training at an RFC and WSFO (WFO), attendance at NWS-sponsored training classes (such as the NWSTC courses), and formal course work either by correspondence or attendance at a local college/university.

The hydrologist intern will receive training to become familiar with and reach specified levels of proficiency in the activities of the RFC and WSFO (WFO) to the extent allowed by his/her prior training and capabilities. These will include assisting on forecast shifts, procedure development, communications/computer operations, community preparedness, local flood warning programs, hydrometeorological network analysis, river basin activities, data collection and quality control, river gaging station assessment, review and preparation of E-19/E-19a, and other related station responsibilities.

The Typical Training Program (Addendum A) is a guide to general training subject areas and schedules. The specific training plan for the individual hydrologist intern shall identify in-house courses and specific college-level courses the intern is expected to complete. Addendum D lists manuals NOAA and NWS Technical Memoranda, Research Papers, and other documents which are appropriate to the Hydrologic Services Program which the intern should utilize and, as appropriate, become fully knowledgeable with.

It is necessary for all hydrologist interns to successfully complete the following:

1. Weather Service in-house Hydrologic Services (Correspondence) Course.

2. NWSTC Remote Training Modules:

   - Introduction to the NWS (MMFDC210)
   - NWS Directives System (MMFDC211)
   - Training Guide for Operators of Automation of Field Operations and Services (AFOS) (MMFDC260)
   - Clear and Effective Communications (under development)
   - Forecast Products (under development)
   - Skew T Log P Diagram (MMFDC230)
   - Radar Basics for FDC (MMFDC240)
   - Radar Principles (MMRAD410)
   - Fundamentals of Radar Wave Propagation (MMRAD412)
   - Radar Reflectivity (MMRAD414)
   - Fundamentals of Weather Radar System (MMRAD420)
   - Beginning Doppler Principles for NEXRAD (MRRAD450)
   - Disaster Preparedness (under development)
   - Standard Hydrometeorological Exchange Format (SHEF) Computer-Assisted Instruction

3. NEXRAD Operations Course (including precursor training modules).

4. The Operations of Hydrologic and Climatologic Networks Course offered at the NWSTC (for those pursuing a career as a service hydrologist).

5. The NWS Basic Operational Hydrology Course (under development) offered at the NWSTC.

6. Review of National Weather Service River Forecast System - User Manual - Parts I-VII.

7. Review National Weather Service Flood/Flash Flood Watch and Warning Program (WSOM Chapter E-20).

8. Six semester hours of hydrological course work as defined within the Type A hydrometeorologist qualification standards. These courses, or their equivalent in practical work experience, include the following: a 3 semester hour introductory level Hydrology course (often called Engineering Hydrology); 3 additional semester hours in hydrology chosen from the following: Physical Hydrology or Hydrometeorology, Advanced Hydrology, Hydrological Forecasting, Snow Hydrology, River Mechanics, Hydraulics, Watershed Modeling, Open Channel Flow, Fluid Mechanics or Fluid Dynamics, and Hydrodynamics.

Over a period of time and as they become available, the hydrologist intern should also receive the following training provided by NWS:

1. Selected workshops from the Advanced Hydrology/Hydrometeorology Workshop Series sponsored by the Hydrologic Research Laboratory (HRL).

2. Selected training in Interactive RFC Operations.

3. User training in the Advanced Weather Interactive Processing System (AWIPS) operation.

4. Automatic Surface Observing System (ASOS) User Training.

5. Training in the optimal use of computers for hydrologic forecasting (especially for those pursuing a career as an RFC forecaster).

6. Training in introductory meteorology for hydrologists.

For those hydrologist interns wishing to meet the qualification standards for a Type B hydrometeorologist, it is desirable that they make progress towards the hydrology, remote sensing, and meteorology course work that are defined in the Type B hydrometeorologist qualification standards.

Elbert W. Friday, Jr.
Assistant Administrator
for Weather Services

ADDENDUM A

HYDROLOGIST INTERN TRAINING PLAN

GS-5/7/9 HYDROLOGIST INTERN

RFC Assignment: (1 year minimum)		Approximate Times
1.	Orientation RTMs MMFDC210 and MMFDC211.	1st week
2.	Communications - Computers/AFOS RTM MMFDC260.	1st - 4th week
3.	AWIPS User Training (when available).	1st - 4th week
4.	Basic Hydrologic Data Collection Remote Training Module on SHEF.	1st - 6th week
5.	ASOS User Training (when available).	1st - 6th week
6.	Hydrologic Services Correspondence Course.	2nd - 4th month
7.	Basic Hydrologic and Forecast Familiarization, Continued Data Collection including Equipment and Techniques, Forecast Dissemination, Operations of Hydrologic and Climatological Networks Class* and the NWS Basic Operational Hydrology Class*.	2nd - 6th month
8.	Computer Training (as needed and available) may include JCL as well as FORTRAN, etc.	3rd - 7th month
9.	Selected Workshops in the Advanced Hydrology/Hydrometeorology Workshop Series.	7th - 12 month
10.	Introductory Meteorology for Hydrologists.	7th - 12th month
11.	River Forecast Shifts with Close Supervision.	7th - 12th month

12.	Successfully Complete the Hydrology Course Work Defined within the Type A Hydrometeorologist Qualification Standards and the Meteorology Course Work Defined Within the Type B Hydrometeorologist Qualification Standards, if needed.	8th - 24 month
13.	Hydrologic Development Assignments such as Storm Studies, Rainfall-runoff, Routing and Unitgraph Assignments.	9th - 24th month
14.	Introduction to Multi-Sensor Precipitation Estimation Techniques.	12th - 24th month
15.	Interactive RFC Operations	12th - 24th month

<u>WSFO/(WFO) Hydrologic Service Area (HSA) Assignment:</u>
(1 year minimum)

1.	Orientation RTMs MMFDC210 and MMFDC211.	1st week
2.	Communications, AFOS, NOAA Weather Radio, and RTM MMFDC260.	1st - 4th week
3.	AWIPS User Training (when available).	1st - 4th week
4.	ASOS User Training (when available).	1st - 6th week
5.	Orientation with River Forecast Points and Flood-Prone Areas in HSA.	1st - 2nd month
6.	Data Collection and Forecast Dissemination, Remote Training Module on SHEF Operations of Hydrological and Climatological Networks class* and the NWS Basic Operational Hydrology Class*.	1st - 6th month
7.	Basic Course in Meteorology (if required).	1st - 6th month
8.	RTM: Clear and Effective Communications (under development).	3rd - 5th month

9.	Surface Observations and Synoptic Codes (certification is not required).	4th - 6th month
10.	Introduction to Dam Break Catalog.	2nd - 12th month
11.	River and Flood Warning Issuance and Dissemination.	2nd - 12th month
12.	E-19/E-19a Preparation, Substation Visitations, 2- to 4-week Assignment Assisting the CPM/DAPM on Network Operations.	4th - 8th month
13.	Substation Management - Administrative Reports.	7th - 12th month
14.	RTMs MMFDC240 and MRRAD450.	7th - 9th month
15.	Satellite Interpretation (NWS Handbook 6).	7th - 9th month
16.	Community Preparedness (Flash Flood). Activities and Interagency Visits to Local Water Agencies.	7th - 12th month
17.	Successfully Complete the Hydrology Course Work Defined within the Type A Hydro-meteorologist Qualification Standards and the Meteorology Course Work Defined within the Type B Hydrometeorologist Qualification Standards, if needed.	8th - 24th month
18.	Become Familiar with Responsibilities of the Service Hydrologist to Train Meteorologists in Hydrology Duties.	12th - 24th month

* The specific time of attendance at the "Operations of Hydrologic and Climtological Networks" and the NWS Basic Operational Hydrology classes offered at the NWSTC may need to be adjusted depending upon class-size allocation.

GS-11 HYDROLOGIST INTERN

RFC Assignment:

1.	Orientation and Familiarity with RFC Area of Responsibility.	1st - 4th week
2.	Discussion of Goals for Present Assignment and/or Future Considerations.	1st month
3.	Additional Courses in Hydrology, Hydraulics, and Computer Systems, as appropriate (will have already completed the Hydrology Course Work Defined within the Type A Hydrometeorologist Qualification Standards)	1st - 12th month
4.	Operational Shifts with Moderate Oversight from the Mentor.	1st - 6th month
5.	Familiarity with NWSRFS and Supporting Manual and Tech Papers.	1st - 6th month
6.	Significant Procedural Development - Unit Hydrographs, Rating Tables, Routings, etc.	1st - 6th month
7.	Orientation Visits to Hydrologic Information and User Agencies including: U.S. Army Corps of Engineers (USCE), U.S. Geological Survey (USGS), U.S. Bureau of Reclamation (USBR), Soil Conservation Service (SCS), Power Agencies, State Water Resources Agencies, etc.	2nd - 6th month
8.	Operational Shifts with Minimal Oversight from the Mentor.	7th - 12th month
9.	Additional Meteorological Course Work for Hydrometeorologist Qualification Standards.	7th - 12th month
10.	Development of Local Flash Flood Forecast Procedures for Communities, including On-site Inspections.	7th - 12th month

11.	Calibration of Small River Basins using NWSRFS Routines.	7th - 12th month
12.	Familiarity with the SMPDBK Model.	10th - 12th month
13.	Adaptive River and Flood Forecasting.	6th - 12th month
14.	Familiarity with RFC HAS Function.	6th - 12th month
15.	Graduate Intern.	12th month

ADDENDUM B

INTERN GS -____

PERSONAL DEVELOPMENT TRAINING PLAN

(Should be adapted to meet local needs)

This checklist contains the specific course work, training, and knowledge skills and abilities (KSA) which will normally be demonstrated/accomplished by the hydrologist intern before progression to the next grade level. The checklist can be adapted to local station and individual needs. Most items in the checklist are abbreviated from the training plan activities. The intern's GWPAS plan will provide detailed explanation of these activities and criteria for evaluation.

Interns acquiring the required KSAs ahead of schedule are encouraged to begin work on those required at the next grade level. Early completion will not accelerate promotion but will provide the intern with greater freedom in scheduling later development work.

Certain skills normally need to be mastered before the intern can stand shift alone. These should be learned first and are marked with an asterisk (*).

Hydrologist Intern's Name_____

Duty Station_____

Date Plan Implemented_____

Intern's Signature_____

Station Mgr. Signature_____

PROGRESS REVIEW

	Initials/Date	Initials/Date	Initials/Date	Initials/Date
Intern	_____	_____	_____	_____
Stn Mgr.	_____	_____	_____	_____

This checklist should be reviewed semiannually and/or as needed and copies provided to the employee and maintained with the employee's performance plan.

ADDENDUM B (Cont.)

Training Area	Target Date	Check if Accomplished or Demonstrated	Training Counselors Initials and Date

ADDENDUM C

HYDROLOGIST INTERN PROGRESS REPORT

To be submitted to the regional hydrologist and the NWSTC January 31 and July 31.

NAME	GRADE	POSITION

STATION	DATE OF REPORT

Orientation (Station and Hydrology Program) Completed. YES___NO___

(List of Training Activities and Dates Completed.)

HIC/MIC SIGNATURE	INTERN'S SIGNATURE

ADDENDUM D

Reference Documents and Manuals:

The indicated references below are a suggested minimum list of documents and manuals that interns should become fully knowledgeable with and utilize as appropriate. A brief description of the references is included.

1. National Weather Service Operations Manual: The WSOM is the primary instrument of the National Weather Service Directives System. It is divided into nine parts.

   Part A — Includes a description of the directives system itself. Policies, procedures, and practices are included in parts B through H for the following functions:

   Part B — Data Acquisition, especially Chapter B-17, Substation Management;

   Part C — Basic/Public Services, especially Chapter C-41, Hurricane Warnings;

   Part D — Specialized Services of Aviation, Marine, Agriculture, and Fire Weather;

   Part E — Hydrologic Services. All hydrologist interns should be thoroughly familiar with Part E;

   Part F — Climatologic Services;

   Part G — Communications;

   Part H — Design, Procurement, Installation, and Maintenance of Facilities and Equipment;

   Part I — Includes directives not involved in one of the other parts.

2. Station Duty Manual: An up-to-date SDM is essential in the conduct of station operations. It is the source of information about actions to be taken on the station; specifically, it answers questions on the "What, Where, When, How and Why" of actions. Topics that the SDM might cover are local river forecasting techniques, maintenance of equipment, display of hydrological and meteorological information, addresses, phone numbers, and back-up communications. The SDM provides reference to other available documents, including those described here, and in particular, references are made to appropriate WSOM chapters.

3. Technical Procedures Bulletins (TPB): The TPB series provides descriptions of central forecast guidance products such as numerical analyses, prediction models, and statistical guidance.

4. NOAA Technical Memorandums (TM): NOAA TMs are used to report on work in progress, to describe technical procedures and practices, to report to a limited distribution list, and for various other types of reporting at the discretion of mainline component directors. Mainline components that produce TMs include, but are not limited to, OH, TDL, NMC, and each region of the NWS.

5. Technical Attachment (TA) to Region Staff Notes: Region TAs serve a similar purpose as TMs but are shorter in length. They do serve an additional purpose of enabling rapid dissemination of information.

6. Geostationary Operational Environmental Satellite (GOES) Data Collection Platform (DCP) Data Distribution System (DDS) Operations Handbook: This handbook provides documentation on how data that are collected from Automatic Hydrologic Observing System (AHOS) sites via both satellite (AHOS-S) and telephone (AHOS-T) are processed and distributed to field offices. Instruction is also provided on the procedures that are necessary to interact with the system to obtain more frequent data. This handbook will be replaced with the HADS Operations Handbook as HADS is implemented across the Nation.

7. National Remote Sensing Hydrology Program - Version 3.0 - A Users Guide: This Users Guide provides field personnel with background as well as technical and administrative aspects of the National Remote Sensing Hydrology Program which is operated by the National Operational Hydrologic Remote Sensing Center (NOHRSC). Procedures are described on the techniques used to collect, process, and distribute operational airborne snow water equivalent measurement data and satellite areal extent of snow cover measurement data.

8. Specialized Hydrologic Publications: Most of the river stage data acquired and used by the NWS in the hydrologic program originates at sites operated by the USGS. On navigable streams or in areas where the USCE has built flood protection works, some river stage and reservoir level information comes from sites independently operated by the USCE. RFCs are on the appropriate mailing lists and maintain libraries of data applicable for their service areas.

    a. Daily River Stages - This NWS publication has been discontinued. Annual issues contained miscellaneous information concerning each station, including extreme stages. Corrigenda notes served to correct or update prior issuances. Daily River Stages were included in tabular form. The last issue was for calendar year 1971. The publication has been succeeded by item b.

b. River Forecasts Provided by the National Weather Service - NOAA/NWS-Vol. 1, 1972, was distributed in February 1973. Vol. 3, 1974, was distributed in October 1975. The publication is very similar to item a in content, except that tables of daily river stages are no longer included. Extreme stages are listed for NWS stations.

c. Water Resources Data for (STATE) - Part 1, Surface Waters - USGS Water Resources Division, District Office (for state named): This is an annual publication on water year (October 1 - September 30) basis, is dated as of the calendar year in which the water year ends, and is usually made available within the subsequent water year. It is published in cooperation with the various Federal, state, and local agencies concerned. Effective October 1, 1960, this publication replaced a previous serial number publication of the USGS which was issued by major drainage basins, the largest of which were subdivided into separate volumes. The state publication is frequently still spoken of as a Water Supply Paper, the common name of the former publication.

d. Miscellaneous special publications of the USGS on such topics as Flood Frequencies, Specific Flood Reports, etc., ordinarily in a serially numbered sequence.

e. Reports on Flood and Flood Damage in the (named) District during (year) - USCE District. These are annual reports issued by the respective Engineer Districts covering the title topics in considerable detail. A file of these reports provides an excellent historical reference.

f. Flood Plain Information Studies - USCE District. These studies are accomplished by USCE District Offices in cooperation with the state and community concerned. The report is a valuable tool in examining flood history of a river reach, in evaluating a flood stage for the reach, and to identify extent and nature of past and possible future flooding. The resulting document contains reference to present NWS Flood Warning Services, has details of past flooding, provides maps outlining flood areas, and shows expected heights and profiles of two theoretical floods. These theoretical floods are known as the Intermediate Regional Flood and the Standard Project Flood.

g. Hydrologic Services Manual: Specialized manual designed at each HSA office which contains hydrologic documents, directions, summaries, etc., pertinent for service in that area (Ref. WSOM E-04). NOTE: HSA offices will only have one Hydrologic Services Manual for their own office. RFC's will have one for each HSA office within the RFC area of responsibility.

9. Selected Technical Memoranda, Technical Papers and Textbooks

a. Selected Technical Memoranda, Technical Papers and Textbooks on Precipitation, Temperature, and Evaporation

Ahnert, P.R., Hudlow, M.D., Johnson, E.R., Greene, D.R., and Dias, M.P.R., "Proposed 'On-Site' Precipitation Processing System for NEXRAD, Preprints, 21st Conference on Radar Meteorology, AMS and Alberta Research Council, Canadian Meteorological and Oceanographic Society, Edmonton, Alberta, Canada, September 19-23, 1983, pp. 378-385.

Ahnert, Peter R., Hudlow, Michael D., and Johnson, Edward R., "Validation of the 'On-Site' Precipitation Processing System for NEXRAD," Preprints, 22nd Conference on Radar Meteorology (AMS), Zurich, Switzerland, September 10-14, 1984.

Ahnert, Peter R. Krajewski, Witold F., and Johnson, Edward R., "Kalman Filter Estimation of Radar-Rainfall Field Bias," Preprints of the 23rd Radar Meteorology Conference, Snowmass, Colorado, September 1986.

Atlas, David (Editor), Radar in Meteorology, American Meteorological Society, 1989.

Barrera, Daniel F., and Schaake, John C., "On the Use of NWS-RAFS Output Fields to Initialize 2D Multilayer Trajectory Models of Orographic Precipitation," published in the proceedings of the Conference on Operational Precipitation Estimation and Prediction, Anaheim, California, February 1990, 8 pp.

Bissell, V.C., and Peck, E.L., "Measurement of Snow at a Remote Site: Natural Radioactivity Technique," Advanced Concepts and Techniques in the Study of Snow and Ice Resources, National Academy of Sciences, Washington, D.C., 1974, pp. 604-613.

Bowles, D.S., Duffy, C.J., Georgakakos, K.P., Krajewski, W.F., and Seo, D.J., "Stochastic Interpretation of Precipitation Data from Multiple Sensors," paper presented at Chapman Conference on Modeling of Rainfall Fields, Caracas, Venezuela, March 24-27, 1986.

Chin, Edwin H., and Vogel, John L., "On Relationships Between the Main Storm and its Antecedent Precipitation," paper presented at the Eighth Conference on Hydrometeorology, American Meteorological Society, Kananaskis Park, Alta, Canada, October 22-26, 1990, pp. 50-55.

Colebeck, S.C., Anderson, E.A., Bissell, V.C., Crook, A.G., Male, D.H., Slaughter, C.W., and Wisenet, D.R., "Snow Accumulation, Distribution Melt, and Runoff," EOS, Transactions, American Geophysical Union, Vol. 60, No. 21, May 22, 1979, pp. 464-471.

Farnsworth, Richard K., Jettmar, R. Uwe., Young, G. Kenneth, and Schaake, John C. Jr., "Design of Operational Precipitation and Streamflow Networks for River Forecasting," Water Resources Research, Vol. 15, No. 6, December 1979, pp. 1823-1832.

Farnsworth, Richard K., and Canterford, Raymond P., "Satellite Rainfall Estimation for Hydrologic Forecasting," Technical Papers, ACSM-ASP Convention, March 9-14, 1980, St. Louis, Missouri, ASP 46th Annual Meeting, pp. 97-105.

Farnsworth, R.K., Thompson, E.S., and Peck, E.L., "Evaporation Atlas for the Contiguous 48 United States," NOAA Technical Report NWS 33, U.S. Dept. of Commerce, Washington, D.C., June 1982, 26 pp.

Farnsworth, R.K., and Thompson, E.S., "Mean Monthly, Seasonal, and Annual Pan Evaporation for the United States," NOAA Technical Report NWS 34, U.S. Dept. of Commerce, Washington, D.C., December 1982, 82 pp.

Fiore, J.V., Farnsworth, R.K., and Huffman,G.J., "Quality Control of Radar-Rainfall Data with VISSR Satellite Date," Preprints of the 23rd Radar Meteorology Conference, Snowmass, Colorado, September 1986.

Frederick, Ralph H., Myers, Vance A., and Auciello, Eugene P., "Five- to 60-Minute Precipitation Frequency for the Eastern and Central United States," NWS Hydro 35, National Weather Service, Silver Spring, Maryland, June 1977. (PB-272-112)

Georgakakos, K.P., and Hudlow, M.D., "Quantitative Precipitation Forecast Techniques for Use in Hydrologic Forecasting," Proceedings, Technical Conference on Mitigation of Natural Hazards through Real-Time Data Collection Systems and Hydrological Forecasting, WMO, State of California, Dept. of Water Resources, and NOAA, Sacramento, California, September 19-23, 1983, pp. 12-13.

Goodyear, H.V., and Riedel, John T., "Probable Maximum Precipitation, Susquehanna River Drainage Above Harrisburg, PA," Hydrometeorological Report No. 40, National Weather Service, Silver Spring, Maryland, 1965.

Greene, D.R., "Hydrologic Application of Digital Radar Data," Preprints, 16th Radar Meteorology Conference, 1975, pp. 353-360.

Greene, Douglas R., Hudlow, Michael D., and Farnsworth, Richard K., "A Multiple Sensor Rainfall Analysis System," Preprint Volume: Third Conference on Hydrometeorology, August 20-24, 1979, Bogota, Colombia, American Meteorological Society, Boston, Massachusetts, pp. 44-53.

Greene, D.R., Nilsen, J.D., Saffle, R.E., Holmes, D.W., Hudlow, M.D., and Ahnert P.R., "RADAP II, An Interim Radar Data Processor," Preprints, 21st Conference on Radar Meteorology, AMS and Alberta Research Council, Canadian Meteorological and Oceanographic Society, Edmonton, Alberta, Canada, September 19-23, 1983, pp. 404-408.

Hansen, E. Marshall, Fenn, Douglas D., Schreiner, Louis C., Stodt, Richard W., and Miller, John F., "Probably Maximum Precipitation Estimates - United States Between the Continental Divide and 103rd Meridian," Hydrometeorological Report No. 55A, National Weather Service, Silver Spring, Maryland, March 1984 (PB-89-120-695).

Hansen, E. Marshall, Schreiner, Louis C., and Miller, John F., "Application of Probably Maximum Precipitation Estimates - United States East of the 105th Meridian," Hydrometeorological Report No. 52, National Weather Service, Silver Spring, Maryland, 1982 (PB-83-118-166).

Hansen, E. Marshall, and Schwarz, Francis K., "The Meteorology of Important Rainstorms in the Colorado River and Great Basin Drainages," Hydrometeorological Report No. 50, National Weather Service, Silver Spring, Maryland, 1982 (PB-82-185-414).

Hershfield, D.M., "Rainfall Frequency Atlas of the United States for Durations From 30 Minutes to 24 Hours and Return Periods From 1 to 100 Years," WB Tech Paper No. 40, (reprinted 1962), Oversized, 115 pp.

Ho, Francis P., and Riedel, John T., "Seasonal Variation of 10-Square Mile Probably Maximum Precipitation Estimates, United States East of the 105th Meridian," Hydrometeorological Report No. 53, National Weather Service, Silver Spring, Maryland, 1980 (NUREG/CR-1486).

Hudlow, Michael D., "Use of Digital Radar Data in Operational Hydrology," ASCE National Meeting on Water Resources Engineering, Meeting Preprint 1911, February 1973, 28 pp.

Hudlow, Michael D., "Mean Rainfall Patterns for the Three Phases of GATE," Journal of Applied Meteorology, AMS, 18, December 1979, pp. 1656-1669.

Hudlow, M.D., Greene, D.R., Ahnert, P.R., Krajewski, W.F. Sivaramakrishnan, T.R., Johnson, E.R., and Dias, M.P.R., "Proposed Off-Site Precipitation Processing System for NEXRAD," Preprints, 21st Conference on Radar Meteorology, AMS and Alberta Research Council, Canadian Meteorological and Oceanographic Society, Edmonton, Alberta, Canada, September 19-23, 1983, pp. 394-403.

Hudlow, Michael D., "Video Digitization, Integration, and Processing Techniques," Chapter 9, Report of Seminar on the Application of Radar Data to Tropical Cyclone Forecasting, Bangkok, Thailand, October 1984, 27 pp.

Hudlow, Michael D., and Maheshwari, R.C., "Estimation of Rainfall Rates/Amounts from Digitized Radar Data," Chapter 10, Report of Seminar on the Application of Radar Data to Tropical Cyclone Forecasting, Bangkok, Thailand, October 1984, 15 pp.

Hudlow, Michael D., and Maheshwari, R.C., "Recent Development and Futuristic Projections in Radar Technology for Weather Monitoring," Chapter 13, Report of Seminar on the Application of Radar Data to Tropical Cyclone Forecasting, Bangkok, Thailand, October 1984, 22 pp.

Hudlow, Michael D., Farnsworth, Richard K., and Ahnert, Peter R., "NEXRAD Technical Requirements for Precipitation Estimation and Accompanying Economic Benefits," Hydro Technical Note-4, Office of Hydrology, National Weather Service, NOAA, Silver Spring, Maryland, December 1984 (Revised April 1985), 49 pp.

Johnson, Edward R., and Bras, Rafael L., "Short Term Rainfall Prediction: A Non-Stationary Multivariate Stochastic Model," Ralph M. Parsons Laboratory for Water Resources and Hydrodynamics Report 223, Massachusetts, April 1978, 247 pp. (Available only from Massachusetts Institute of Technology; price is $15.00 as of December 1976.)

Johnson, Edward R., Peck, Eugene L., and Krajewski, Witold F., "Adaptation of Multisource Remotely Sensed Data for Hydrologic Modeling," presented at and published in the proceedings of the Nineteenth International Symposium on Remote Sensing of Environment, Ann Arbor, Michigan, October 21-25, 1985, 10 pp.

Johnson, Edward R., and Bras, Rafael L., "Multivariate Short-Term Rainfall Prediction," Water Resources Research, Vol. 16, No. 1, February 1980.

Koch, Roy W., "Dependence of Seasonal Precipitation and Runoff Volumes in the Pacific Northwest on an Index of the El Nino Southern Oscillation," presented at United States/Peoples Republic of China Flood Forecasting Symposium and Workshop, Portland, Oregon, March 29 - April 4, 1989.

Krajewski, W.F., and Crawford, K.C., "Objective Analysis of Rainfall Data from Digital Radar and Rain-Gage Measurements," presented at AWRA International Symposium on Hydrometeorology, Denver, Colorado, June 13-17, 1982, 13 pp.

Krajewski, W.F., and Hudlow, M.D., "Evaluation and Application of a Real-time Method to Estimate Mean Areal Precipitation from Rain Gage and Radar Data," Proceedings, Technical Conference on Mitigation of Natural Hazards Through Real-Time Data Collection Systems and Hydrological Forecasting, WMO, State of California Dept. of Water Resources, and NOAA, Sacramento, California, September 19-23, 1983, pp. 18-19.

Krajewski, Witold F., and Georgakakos, Konstantine P., "Synthesis of Radar-Rainfall Data," Water Resources Research, Vol. 21(5), May 1985, pp. 764-768.

Krajewski, Witold R., "Quality Control of Hydrometeorological Data," Preprints of the Second International Conference on Interactive Information and Processing systems for Meteorology, Oceanography, and Hydrology, Miami, Florida, January 13-16, 1986.

Krajewski, Witold F., "Radar-Rainfall Data Quality Control by the Influence Function Method," Water Resources Research, Vol. 23, No. 5, May 1987.

Lamereaux, Wallace W., "Modern Evaporation Formulas Adapted to Computer Use," Monthly Weather Review, January 1962, pp. 26-28.

Larson, Lee W., "Approaches to Measuring 'True' Snowfall," Proceedings, 29th Annual Meeting, Eastern Snow Conference, Oswego, New York, February 3-4, 1972, pp. 65-76.

Larson, Lee W., "An Application of the Dual-Gage Approach for Calculating 'True' Solid Precipitation," presented at the 53rd Annual Meeting of the AGU, Washington, D.C., April 17-21, 1972, 18 pp.

Larson, L.W., and Peck, E.L., "Accuracy of Precipitation Measurements for Hydrologic Modeling," Water Resources Research, Vol. 10, No. 4, August 1974, pp. 857-863.

Larson, Lee W., "An Application of the Aerial Gamma Monitoring Techniques for Measuring Snow Cover Water Equivalents on the Great Plains," Proceedings, Symposium on Snow Management on the Great Plains, Bismarck, North Dakota, July 29, 1975, 14 pp.

Miller, J.F., Frederick, Ralph H., and Tracey, Robert J., et al., "Precipitation Frequency Atlas of the Western United States - Montana, Wyoming, Colorado, New Mexico, Idaho, Utah, Nevada, Arizona, Washington, Oregon, California," NOAA Atlas 2, National Weather Service, Silver Spring, Maryland, 1973.

Maddox, R., "A Methodology for Forecasting Heavy Convective Precipitation and Flash Flooding," NOAA NWS Digest 4, No. 4, NOAA/ERL, Boulder, Colorado, 1979.

Miller, John F., and Schward, Francis K., "Probable Maximum Precipitation and Snowmelt Criteria for Southeast Alaska," Hydrometeorological Report No. 54, National Weather Service, Silver Spring, Maryland, 1983 (PB-84-104-371).

NOAA NSSL-67 - Radar Rainfall Pattern Optimizing Technique, NOAA Tech Memo, March 1974 (Available only from the National Technical Information Service (NTIS), Springfield, Virginia 22161; Acquisition No. COM-74-10906/7GA).

NOAA FMH No. 11 - Weather Radar Observations.

NOAA TECH PROCEDURE BULLETIN No. 239 - The Excessive Rainfall Potential Outlook, 1978.

O'Bannon, Timothy, and Ahnert, Peter, "A Study of the NEXRAD Precipitation Algorithm Package on a Winter-Type Oklahoma Rainstorm," Preprints of the 23rd Radar Meteorology Conference, Snowmass, Colorado, September, 1986.

Orwig, Charles E., and Peck, Phillip A., "Use or Misuse of Quantitative Precipitation Forecasts (QPF)," presented at United States/Peoples Republic of China Flood Forecasting Symposium and Workshop, Portland, Oregon, March 29 - April 4, 1989.

Pasteris, Phillip A., and Hartman, Robert K., "Automated Data Acquisition Techniques for Forecasting Pacific Northwest Rivers," presented at United States/Peoples Republic of China Flood Forecasting Symposium and Workshop, Portland, Oregon, March 29 - April 4, 1989.

Patterson, Vernon L., Hudlow, Michael D., Pytlowany, Peter Jr., Richards, Frank P., and Hoff, John D., "GATE Radar Rainfall Processing system," NOAA Tech Memo, EDIS 26, Center for Environmental Assessment Services, NOAA, U.S. Dept. of Commerce, Washington, D.C., May 1979, 34 pp.

Peck, Eugene L., "Discussion of Problems in Measuring Precipitation in Mountainous Areas," Symposium on Distribution of Precipitation in Mountainous Areas, Geilo, Norway, August 1972, WMO, OMM No. 326, Vol. I, Geneva, Switzerland, pp. 5-16.

Peck, Eugene L., "Relation of Orographic Winter Precipitation Patterns to Meteorological Parameters," Symposium on Distribution of Precipitation in Mountainous Areas, Geilo, Norway, August 1972, WMO/OMM No. 326, Vol. II, Geneva, Switzerland, pp. 234-242.

Peck, E.L., and Bissell, V.C., "Aerial Measurement of Snow Water Equivalent by Terrestrial Gamma Radiation Survey," Bulletin, International Association of Hydrological Sciences, Vol. XVIII, No. 1, March 1973, pp. 47-62.

Peck, Eugene L., VanDemark, Scott S., and Fritzsche, Allen E., "Gamma Radiation System for Aerial Snow Surveying," Minutes of the International Seminar on Organization and Operation of Hydrological Services in Conjunction with the 5th Session of the WMO Commission for Hydrology, Ottawa, Canada, July 15-16, 1976, 19 pp.

Peck, Eugene L., VanDemark, Scott C., and Fritzsche, Allen E., "Airborne Snow Survey Development Using the Gamma Method," Proceedings, Aerial Techniques for Environmental Monitoring Topical Symposium, American Nuclear Society, Las Vegas, Nevada, March 7-11, 1977, 10 pp.

Peck, Eugene L., "Hydrometeorology," AMS Bulletin, Vol. 59, No. 5, May 1978, pp. 609-612.

Peck, Eugene L., Carroll, Thomas R., and VanDemark, Scott C., "Operational Aerial Snow Surveying in the United States," Hydrological Sciences Bulletin, Vol. 25, No. 1, March 1980, pp. 51-62.

Peck, Eugene L., "Design of Precipitation Networks," (The Horton Memorial Lecture, presented at the AMS Conference on Flash Floods, March 18-20, 1980, Atlanta, Georgia) AMS Bulletin, Vol. 61, No. 8, August 1980, pp. 894-902.

Reeves, Robert W., Ropelewski, Chester F., and Hudlow, Michael D., "Relationship Between Large-Scale Motion and Convective Precipitation During GATE," Monthly Weather Review, American Meteorological Society, 197, pp. 1154-1168, September 1979.

Schaake, John C., Jr., "Importance of the Hydrologic Rainfall Analysis Project (HRAP) Grid for Operational Hydrology," presented at United States/Peoples Republic of China Flood Forecasting Symposium and Workshop, Portland, Oregon, March 29 - April 4, 1989.

Schaefer, Garry L., and Johnson, David E., "Development and Operation of the Snowpack Telemetry (SNOTEL) System in the Western United States," presented at United States/Peoples Republic of China Flood Forecasting Symposium and Workshop, Portland, Oregon, March 29 - April 4, 1989.

Schofield and Oliver, "A Scheme for Estimating Convective Rainfall from Satellite Imagery," NOAA NESS 86, NOAA Tech Memo, 1977.

Schreiner, Louis C., and Riedel, John T., "Probably Maximum Precipitation Estimates, United States East of 105th Meridian," Hydrometeorological Report No. 51, National Weather Service, Silver Spring, Maryland, 1978 (PB-287-925).

Seo, D.J., Krajewski, Witold F., and Bowles, David S., "Stochastic Interpolation of Rainfall Data from Rain Gages and Radar Using Cokriging, 1. Design of Experiments," Water Resources Research, Vol. 26, No. 3, March 1990, pp. 469-477.

Seo, D.J., Krajewski, Witold F., and Bowles, David S., "Stochastic Interpolation of Rainfall Data from Rain Gages and Radar Using Cokriging, 2. Results," Water Resources Research, Vol. 26, No. 3, March 1990, pp. 469-477.

Seo, D.J., and Smith, J.A., "Radar-Based Short-Term Rainfall Prediction," paper presented at the Eighth Conference on Hydrometeorology, American Meteorological Society, Kananaskis Park, Alta, Canada, October 22-26, 1990, pp. 143-146.

Shedd, Robert C., "Interactive Precipitation Processing for the Modernized National Weather Service," paper presented at the Proceedings of the Seventh International Conference on Interactive Information and Processing Systems for Meteorology, Oceanography and Hydrology, New Orleans, Louisiana, January 13-18, 1991.

Shedd, Robert C., Smith, James A., and Walton, Mark L., "Sectorized Hybrid Scan Strategy of the NEXRAD Precipitation Processing System," published in the Preprints of the International Symposium on Hydrological Applications of Weather Radar, University of Salford, Salford, England, August 14-17, 1989, paper B-4.

Shope, William G., Jr., "The U.S. Geological Survey's Use of Satellite Technology for the Collection of Hydrologic Data," presented at United States/Peoples Republic of China Flood Forecasting Symposium and Workshop, Portland, Oregon, March 29 - April 4, 1989.

Sittner, Walter T., "Discussion pertaining to the article, 'Temporally and Aerially Distributed Rainfall' by John David Dean and Willard M. Snyder," Journal of the Irrigation and Drainage Division, ASCE, Vol. 102, No. 4, June 1977, 4 pp.

Smith, D., NOAA VIDEO - More About MDR - Theory and Practice of Heavy Rainfall Using Manually Digitized Radar Data, NWS Southern Region, 1980.

Smith, J.A., and Karr, A.F., "A Statistical Model of Extreme Storm Rainfall," submitted to Journal of Geophysical Research.

Smith, J.A., and Krajewski, W.F., "Statistical Modeling of Space-time Rainfall Using Radar and Rain Gage Observations," Water Resources Research, Vol. 23, No. 10, October 1987, pp. 1893-1900.

Smith, J.A., and Krajewski, W.F., "Estimation of the Mean Field Bias of Radar Rainfall Estimates," submitted to Journal of Applied Meteorology.

Smith, James A., Shedd, Robert C., and Walton, Mark L., "Parameter Estimation for the NEXRAD Hydrology Sequence," published in Preprint of the Proceedings of the 24th Conference on Radar Meteorology, American Meteorological Society, Tallahassee, Florida, March 27-31, 1989, pp. 259-263.

Vogel, John L., Bartlo, Frank, and Corrigan, Peter, "Climatological Characteristics of Heavy Convective Storms in the Pacific Northwest," paper presented at the Eighth Conference on Hydrometeorology, American Meteorological Society, Kananaskis Park, Alta, Canada, October 22-26, 1990, pp. 225-228.

Walton, Mark L., and Johnson, Edward R., "An Improved Precipitation Projection Procedure for the NEXRAD Flash-Flood Potential System," Preprints of the 23rd Radar Meteorology Conference, Snowmass, Colorado, September 1986, 4 pp.

Walton, M.L., Smith, J.A., and Shedd, R.C., "NEXRAD Hydrometeorological Processing," presented at the Next Generation Weather Radar (NEXRAD) Hydrometeorology Symposium, Norman, Oklahoma, October 25-26, 1988.

Williams, Philip Jr., and Peck, Eugene L., "Terrain Influences on Precipitation in the Intermountain West as Related to Synoptic Situations," Journal of Applied Meteorology, Vol. 1, No. 3, September 1962, pp. 343-347.

Zurndorfer, Edward A., "Assessing the Effects of Additional Data on Precipitation Frequency Analyses in the United States," paper presented at the Eighth Conference on Hydrometeorology, American Meteorological Society, Kananaskis Park, Alta, Canada, October 22-26, 1990, pp. 221-224.

Zurndorfer, Edward A., Schwarz, Francis K., Hansen, E. Marshall, Fenn, Douglas D., and Miller, John F., "Probable Maximum and TVA Precipitation Estimates with Areal Distribution for Tennessee River Drainages Less than 3,000 mi^2 in Area," Hydrometeorological Report No. 56, National Weather Service, Silver Spring, Maryland, October 1986, 224 pp. (PB-87-143-699).

b. Selected Technical Memoranda, Technical Papers and Textbooks on Hydrologic Modeling

Anderson, E.A., "Development and Testing of Snow Pack Energy Balance Equations," Water Resources Research, Vol. 4, No. 1, February 1968, pp. 19-37.

Anderson, Eric, "Techniques for Predicting Snow Cover Runoff," Proceedings, International Symposium on the Role of Snow and Ice in Hydrology, Banff, Canada, September 6-13, 1972, IAHS-AISH Publication No. 107, Vol. 2, pp. 840-863.

Anderson, Eric A., "A Point Energy and Mass Balance Model of a Snow Cover," NOAA Technical Report NWS-19, U.S. Dept. of Commerce, Silver Spring, Maryland, February 1976, 150 pp.

Anderson, Eric, "National Weather Service River Forecast System, Snow Accumulation and Ablation Mode," NOAA Tech Memo NWS HYDRO-17, U.S. Dept. of Commerce, Silver Spring, Maryland, November 1973. (Out of print. Available only from the National Technical Information Service (NTIS), Springfield, Virginia 22161: Acquisition No. COM-74-10728).

Anderson, Eric A., and Peck, Eugene L., "Snowmelt Modeling by the U.S. National Weather Service," presented at Northern Research Basin Symposium-Workshop, Snow Accumulation and Ablation Models Symposium, Fairbanks, Alaska, August 15-19, 1977, 12 pp.

Anderson, Eric A., "Streamflow Simulation Models for Use on Snow-covered Watersheds," Proceedings, Modeling of Snow Cover Runoff, AGU, AMS, Corps of Engineers and NWS, Hanover, New Hampshire, September 26-29, 1978, pp. 336-350.

Anderson, E.A., and Colbeck, S.C., "The Permeability of a Melting Snow Cover," Water Resources Research, Vol. 18, No. 4, August 1982, pp. 904-908.

Brazil, Larry E., Krajewski, Witold F., "Optimization of Complex Hydrologic Models Using Random Search Methods," Reprinted from Engineering Hydrology Proceedings, HY Div/ASCE/Williamsburg, Virginia, August 3-7, 1987.

Brazil, Larry E., "Multilevel Calibration Strategy for Complex Hydrologic Simulation Models," NOAA Technical Report NWS 42, U.S. Department of Commerce, Washington, D.C., February 1989, 196 pp.

Burnash, R.J.C., et al., A Generalized Streamflow Simulation System: Conceptual Modeling for Digital Computers, Joint Federal-State River Forecast Center, Sacramento, California, 1973.

Carroll, Thomas R., and Larson, Lee W., "Application of Airborne Gamma Radiation Snow Survey Measurements and Snow Cover Modeling in River and Flood Forecasting," presented at 49th Annual Western Snow Conference, St. George, Utah, April 14-16, 1981, pp. 23-33.

Curtis, David C., Mitchell, Robert L., and Schaake, John C., Jr., "A Deterministic Runoff Model for Use in Flash Flood Planning," Proceedings, AMS Conference on Hydrometeorological Aspects of Flash Floods, Los Angeles, California, May 2-3, 1978, pp. 143-151.

Day, G.N., Hudlow, M.D., and Schaake, J.C., Jr., "Discussion of 'Limitations on Seasonal Snowmelt Forecast Accuracy' by D.P. Lettenmaier, July 1984," Journal of Water Resources Planning and Management, ASCE, Vol. 111, No. 4, October 1985, pp. 499-501,

Day, Gerald N., "A Methodology for Updating a Conceptual Snow Model with Snow Measurements," NOAA Technical Report NWS 43, U.S. Department of Commerce, Washington, D.C., March, 1990, 133 pp.

Eagleson, Peter S., Dynamic Hydrology, McGraw-Hill, Inc., New York, 1970.

Fleming, George, Computer Simulation Techniques in Hydrology, American Elsevier Publishing Co., Inc., New York, 1972.

Leavesley G.H., and Stannard, L.G., "A Modular Watershed Modeling and Data Management System," presented at United States/Peoples Republic of China Flood Forecasting Symposium and Workshop, Portland, Oregon, March 29 - April 4, 1989.

Monro, John C., "Direct Search Optimization in Mathematical Modeling and a Watershed Model Application," NOAA Tech Memo NWS HYDRO-12, U.S. Dept. of Commerce, Silver Spring, Maryland, April 1971.

Peck, Eugene L., "Catchment Modeling with the United States National Weather Service River Forecast System," Minutes of Symposium on Mathematical Models in Hydrology, Bratislava, Czechoslovakia, September 8-13, 1975, 7pp.

Peck, Eugene L., "Catchment Modeling and Initial Parameter Estimation for the National Weather Service River Forecast System," NOAA Tech Memo NWS HYDRO-31, U.S. Dept. of Commerce, Silver Spring, Maryland, June 1976, 80 pp.

Peck, Eugene L., and Anderson, Eric A., "Operational Use of Snow Accumulation and Ablation Model in the United States," presented at Northern Research Basin Symposium-Workshop, Snow Accumulation and Ablation Models Symposium, Fairbanks, Alaska, August 15-19, 1977, 5 pp.

Peck, Eugene L., and Carroll, Thomas R., "Advantages of Conceptual Models for Northern Research Basin Studies," presented at Third Symposium-Workshop conducted by the IHP Regional Working Group on Northern Research Basins, Quebec City, Quebec, Canada, June 11-15, 1979, 16 pp.

Schaake, John C., Jr., "Use of Mathematical Models for Hydrologic Forecasting in the National Weather Service," Proceedings of Environmental Protection Agency Conference on Modeling and Simulation, Cincinnati, Ohio, April 19-21, 1976, 5 pp.

c. Selected Technical Memoranda, Technical Papers and Textbooks on Rivers and Reservoirs

Chang, Howard H., "FLUVIAL-12, Mathematical Model for Erodible Channels," presented at United States/Peoples Republic of China Flood Forecasting Symposium and Workshop, Portland, Oregon, March 29 - April 4, 1989.

Fread, D.L., "Technique for Implicit Dynamic Routing in Rivers with Tributaries," Water Resources Research, Vol. 9, No. 4, August 1973, pp. 918-926.

Fread, D.L., "A Dynamic Model for Stage-Discharge Relations Affected by Changing Discharge," NOAA Tech Memo NWS HYDRO-16, U.S. Dept. of Commerce, Silver Spring, Maryland, November 1973 (Revised September 1976).

Fread, D.L., "Numerical Properties of Implicit Four-Point Difference Equations of Unsteady Flow," NOAA Tech Memo NWS HYDRO-18, U.S. Dept. of Commerce, Silver Spring, Maryland, March 1974.

Fread, D.L., "Implicit Dynamic Routing of Floods and Surges in the Lower Mississippi," presented at American Geophysical Union Spring Meeting, Washington, D.C., April 8-11, 1974, 26 pp.

Fread, D.L., "Discussion of 'Comparison of Four Numerical Methods for Flood Routing' by R.K. Price, July 1974," Journal of the Hydraulics Division, Vol. 101, No. HY3, ASCE, March 1975, pp. 565-567.

Fread, D.L., "Theoretical Development of an Implicit Dynamic Routing Model," presented at Dynamic Routing Seminar, Lower Mississippi River Forecast Center, Slidell, Louisiana, December 13-17, 1976; Revised November 1978, pp. 92-95.

Fread, D.L., "The Development and Testing of a Dam-Bread Flood Forecasting Model," Proceedings, Dam-Break Flood Routing Model Workshop, U.S. Water Resources Council, October 18-20, 1977, Washington, D.C., 32 pp.

Fread, D.L., and Smith, G.F., "Calibration Technique for 1-D Unsteady Flow Models," Journal of the Hydraulics Division, ASCE, Vol. 104, No. HY7, July 1978, pp. 1027-1044.

Fread, D.L., "NWS Operational Dynamic Wave Model," Verification of Mathematical and Physical Models in Hydraulic Engineering, Proceedings, 26th Annual Hydraulics Division Specialty Conference, American Society of Civil Engineers, University of Maryland, College Park, Maryland, August 9-11, 1978, pp. 455-464.

Fread, D.L., "Capabilities of NWS Model to Forecast Flash Floods Caused by Dam Failures," Preprint Volume: Second Conference on Flash Floods, Atlanta, George, March 18-20, 1980, American Meteorological Society, Boston, Massachusetts.

Fread, D.L., "Flood Routing: A Synopsis of Past, Present, and Future Capability," Proceedings: International Symposium on Rainfall-Runoff Modeling, Mississippi Stage University, Mississippi, May 18-22, 1981, pp. 521-541.

Fread, D.L., "Some Limitations of Contemporary Dam-Break Flood Routing Models," Preprint 81-225: Annual Meeting of American Society of Civil Engineers, St. Louis, Missouri, October 27, 1981, 15 pp.

Fread, D.L., "Computational Extensions to Implicit Routing Models," Proceedings of Conference on Frontiers in Hydraulic Engineering, ASCE Hydraulics Division, Cambridge, Massachusetts, August 9-12, 1983, pp. 343-348.

Fread, D.L., "Applicability Criteria for Kinematic and Diffusion Routing Models," paper presented at 1983 American Water Resource Conference, San Antonio, Texas, October 1983.

Fread, D.L., "Channel Routing," Chapter 14, Hydrological Forecasting, (Editors: M.G. Anderson and T.P. Burg) John Wiley & Sons, 1975, pp. 437-503.

Fread, D.L., "Breach: An Erosion Model for Earthen Dam Failures," January 1985, 34 pp.

Fread, D.L., "Flood Routing Models and the Manning n," published in the Proceedings of the International Conference on Channel Flow and Catchment Runoff, University of Virginia, Charlottesville, Virginia, May 22-26, 1989, pp. 699-708.

Fread, D.L., and Lewis, J.M., "Real-Time Hydrodynamic Modeling of Coastal Rivers," Proceedings of Applications of Real-Time Oceanographic Circulation Modeling Symposium, Johns Hopkins University Applied Physics Laboratory, Laurel, Maryland, May 23-24, 1985, 18 pp.

Fread, D.L., and Lewis, J.M., "Parameter Optimization for Dynamic Flood-Routing Applications with Minimal Cross-Sectional Data," presented at and published in the proceedings of ASCE Water Forum '86 World Water Issues in Evolution, Long Beach, California, August 4-6, 1986.

Fread, D.L., "The NWS DAMBRK Model: Theoretical Background/User Documentation," published for in-house use, June 29, 1988, 306 pp.

Fread, D.L., McMahon, G.F., and Lewin, J., "Limitations of Level-Pool Routing in Reservoirs," Third Water Resources Operations Management Workshop on Computerized Decision-Support Systems for Water Managers, Fort Collins, Colorado, June 27-10, 1988.

Fread, D.L., and Lewis, J.M., "FLDWAV: A Generalized Flood Routing Model," Proceedings of the National Conference on Hydraulic Engineering and International Symposium on Model-Prototype Correlation of Hydraulic Structures, Colorado Springs, Colorado, August 8-12, 1988.

Fread, D.L., "NWS Models that Forecast Dam-Breach Floods," published in the proceedings of the WMO Technical Conference on the Hydrology of Disasters, Geneva, Switzerland, November 2-3, 1988.

Fread, D.L., "Numerical Flood Routing Models Used in NWS," published in the proceedings of the PRC/US Flood Forecasting and Hydrologic Information Seminar, Portland, Oregon, March 29-April 4, 1989.

Fread, D.L., and Wiele, S., "SMPDBK: NWS Simplified Dam-Break Forecasting Model," (revision of former document by Wetmore, S., and Fread, D.L., June 1983), in-house publication of model users internal/external to NWS, January 15, 1991.

Helwa, Mohamed F., "Discussion of 'Flow Depth in Sand-Bed Channels' by W.R. Brownlie, July 1983," Journal of Hydraulic Engineering, ASCE, Vol. III, No. 4, April 1985, pp. 739-740.

Lewis, Janice M., and Hwang, Guang-Jiunn, "An Assessment Study of Five Sediment Transport Models," Proceedings of the Third International Symposium on River Sedimentation, Jackson, Mississippi, March 31-April 4, 1986.

Ostrowski, Joseph T., "National Weather Service Products Useful for Reservoir Regulation," presented at the ASCE Workshop on Reservoir Systems Regulation, University of Colorado, Boulder, Colorado, August 13-17, 1979.

Smith, David T., and Reed, David B., "A Centennial Survy of American Floods - Fifteen Significant Events in the United States, 1890-1990," NOAA Technical Memorandum NWS SR-133, U.S. Dept. of Commerce, Fort Worth, Texas, October 1990.

Smith, George F., "Operational Dynamic Wave Forecast Program User's Guide," presented at Dynamic Routing Seminar, Lower Mississippi River Forecast Center, Slidell, Louisiana, December 13-17, 1976, Revised June 1978, 70 pp.

d. Selected Technical Memoranda, Technical Papers and Textbooks on Hydrologic Forecasting

Adams, III, T.E., "Graphical User Interface Concepts for Hydrologic Forecasting in the Modernized Weather Service," paper presented at the Proceedings of the Seventh International Conference on Interactive Information and Processing Systems for Meteorology, Oceanography and Hydrology, New Orleans, Louisiana, January 13-18, 1991.

Anderson, Eric A., "The National Weather Service River Forecast System and its Application to Cold Regions," paper presented at and published in the proceedings of the Sixth Northern Research Basins Symposium/Workshop, Houghton, Michigan, January 29, 1986.

Armstrong, Bobby L., "Overview of the National Weather Service River Forecast System," presented at United States/Peoples Republic of China Flood Forecasting Symposium and Workshop, Portland, Oregon, March 29 - April 4, 1989, pp.???.

Brazil, Larry E., and Hudlow, Michael D., "Calibration Procedures Used with the National Weather Service River Forecast System," Preprint Volume, IFAC Symposium on Water and Related Land Resources Systems, Case Institute of Technology, Case Western Reserve University, Cleveland, Ohio, May 28-31, 1980, pp. 371-380.

Brazil, Larry E., and Laurine, Donald P., "Applications of Computer Graphics in National Weather Service River Forecasting," 1981 Joint Automatic Control Conference, Vol. II, University of Virginia, Charlottesville, Virginia, June 17-19, 1981, pp. TP-6D.

Brazil, Larry E., and Smith, George F., "Interactive Forecasting with the National Weather Service River Forecast System," Proceedings of the International Symposium on Real-time Operation of Hydrosystems, Waterloo, Ontario, Canada, June 24-26, 1981, pp. 673-684.

Chow, Ven Te, Maidment, David R., and Mays, Larry W., Applied Hydrology, published by McGraw-Hill, Inc., New York, 1988, 572 pp.

Clark, Robert A., "Hydrological Information and Forecasting in the USA," presented at United States/Peoples Republic of China Flood Forecasting Symposium and Workshop, Portland, Oregon, March 29 - April 4, 1989.

Cudworth, Arthur G., Jr., Flood Hydrology Manual, U.S. Dept. of Interior, Bureau of Reclamation, U.S. Government Printing Office, Washington, D.C., 1989, 243 pp.

Curtis, David C., and Smith, George F., "The National Weather Service River Forecast System -- Update 1976," paper presented at the International Seminar on Organization and Operation of Hydrological Services in Conjunction with the 5th Session of the WMO Commission for Hydrology, Ottawa, Canada, July 15-16, 1976, 15 pp.

Day, G.N., and VanBlargan, E.J., "The Use of Hydrometeorological Data in the NWS Extended Streamflow Prediction Program," Preprint Volume: AMS Fifth Conference on Hydrometeorology, Tulsa, Oklahoma, October 17-19, 1983, 8 pp.

Day, G.N., "Extended Streamflow Forecasting Using NWSRFS," Journal of Water Resources Planning and Management, ASCE, Vol. 111, No. 2, April 1986, pp. 157-170.

Day, Gerald N., Schaake, John C., and Ellis, J. Hugh, "A Direction Toward Improved Streamflow Forecasting in the Western Mountains," published in the Proceedings of the 1989 Western Snow Conference, Fort Collins, Colorado, April 18-20, 1989.

Davis, Robert S., and Drake, Theresa Rossi, "Using Radar Data Processor (RADAPII) and Interactive Color Radar Display (ICRAD) for Flash Flood Forecasting," presented at United States/Peoples Republic of China Flood Forecasting Symposium and Workshop, Portland, Oregon, March 29 - April 4, 1989.

Dietrich, Thomas L., "Basic Hydrology Principles," NOAA Tech Memo, NOAA NWS WR-136, Dept. of Commerce, Silver Spring, Maryland, January 1979.

Dietrich, Thomas L., "Hydrology Practicum," NOAA Tech Memo, NOAA NWS WR-158, Dept. of Commerce, Silver Spring, Maryland, September 1980.

Ferral, R.L., Strem, E.T., and Morin, A.J., "The Use of Microcomputers in Hydrologic Data Collection and River Forecasting," presented at United States/Peoples Republic of China Flood Forecasting Symposium and Workshop, Portland, Oregon, March 29 - April 4, 1989.

Fread, Danny L., Smith, George F., and Day, Gerald N., "The Role of Real-time Interactive Processing in Support of Water Resources Forecasting in the Modernized Weather Service," paper presented at the Proceedings of the Seventh International Conference on Interactive Information and Processing Systems for Meteorology, Oceanography and Hydrology, New Orleans, Louisiana, January 13-18, 1991.

Georgakakos, Konstantine P., and Hudlow, Michael D., "Quantitative Precipitation Forecast Techniques for use in Hydrologic Forecasting," AMS Bulletin, Vol. 65, No. 11, November 1984, pp. 1186-1200.

Georgakakos, Konstantine P., "A Flash-Flood Prediction System," Proceedings, Symposium on Tropical Hydrology and 2nd Caribbean Islands Water Resources Congress, San Juan, Puerto Rico, May 5-8, 1985, pp. 121-124.

Georgakakos, Konstantine P., "On-the Design of National, Real-Time Warning Systems with Capability for Site-Specific, Flash Flood Forecasts," AMS Bulletin, March 1986.

Georgakakos, Konstantine P., and Brazil, Larry E., "Flood Prediction and Warning Systems," presented at and published by Department of Hydraulics, School of River, Channel and Harbour Engineering, Polytechnic University of Catalunya, Barcelona, Spain, March 1987.

Georgakakos, Konstantine P., and Smith, George F., "On Improved Hydrologic Forecasting - Results from a WMO Real-time Forecasting Experiment," Journal of Hydrology, 114, 1990, pp. 17-45.

Hudlow, M.D., and Brazil, L.E., "Technological Developments in Hydrologic Forecasting Within the U.S. National Weather Service," presented at AWRA International Symposium on Hydrometeorology, Denver, Colorado, June 13-17, 1982.

Hudlow, Michael D., "United States Requirements for a Comprehensive Hydrologic Forecasting System as Illustrated by the 1988 Drought," presented at United States/Peoples Republic of China Flood Forecasting Symposium and Workshop, Portland, Oregon, March 29 - April 4, 1989.

Hudlow, Michael D., Smith, James A., Walton, Mark L., and Shedd, Robert C., "NEXRAD - New Era in Hydrometeorology in the United States," published in the Preprints of the International Symposium on Hydrological Applications of Weather Radar, University of Salford, Salford, England, August 14-17, 1989, paper B-1.

Jones, Kenneth C., "Soil Conservation Service Water Supply Forecasting," presented at United States/Peoples Republic of China Flood Forecasting Symposium and Workshop, Portland, Oregon, March 29 - April 4, 1989.

Larson, Lee W., "Operational Hydrologic Forecasting in the National Weather Service," presented at United States/Peoples Republic of China Flood Forecasting Symposium and Workshop, Portland, Oregon, March 29 - April 4, 1989.

Linsley, Kohler, and Paulhus, Hydrology for Engineers, Third Edition, McGraw-Hill, New York, 1986.

Monro, John C., and Larson, Lee W., "Precipitation Modeling in Mountainous Areas for the National Weather River Forecast System," Proceedings, Symposium on Precipitation Analysis for Hydrologic Modeling, Davis, Calif., June 26-28, 1975, AGU, pp. 189-199.

Monro, John C., and Anderson, Eric A., "National Weather Service River Forecasting System," (Proc. Paper 10549) Journal of the Hydraulics Division, Vol. 100, No. HY5, ASCE, May 1974, pp. 621-630.

Morris, David G., "A Categorical, Event-Oriented Flood Forecast Verification System for National Weather Service Hydrology," NOAA Tech Memo NWS Hydro-43, U.S. Dept. of Commerce, Silver Spring, Maryland, June 1988.

Pabst, Arthur F., "Parameter Updating with a Single Event Real-Time Flood Forecasting Model," presented at United States/Peoples Republic of China Flood Forecasting Symposium and Workshop, Portland, Oregon, March 29 - April 4, 1989.

Page, Donna, "The Interactive NWS River Forecast Program," presented at the Proceedings of the Seventh International Conference on Interactive Information and Processing Systems for Meteorology, Oceanography and Hydrology, New Orleans, Louisiana, January 13-18, 1991.

Peck, E.L., "River System Modeling for Operational Forecasting," Proceedings, Symposium on the Use of Computer Techniques and Automation for Water Resources Systems, Economic Commission for Europe, Washington, D.C., March 26-28, 1974, 7 pp.

Ray, Peter S., Editor, Mesoscale Meteorology and Forecasting, American Meteorological Society, 1986, 793 pp.

Shafer, B.A., "Design and Implementation of an Automated Centralized Forecasting System (CFS)," presented at United States/Peoples Republic of China Flood Forecasting Symposium and Workshop, Portland, Oregon, March 29 - April 4, 1989.

Speers, Douglas D., P.E., "Forecasting for Flood Control Operations in the Columbia River," presented at United States/Peoples Republic of China Flood Forecasting Symposium and Workshop, Portland, Oregon, March 29 - April 4, 1989.

Staff, Hydrologic Research Laboratory, "National Weather Service River Forecast System, Forecast Procedures," NOAA Tech Memo NWS HYDRO-14. U.S. Dept. of Commerce, Silver Spring, Maryland, December 1972. (Out of print. Available only from the National Technical Information Service (NTIS), Springfield, Virginia 22161; Acquisition No. COM-73-10365).

Stallings, Eugene A., "Improved Flood Forecasting System for the Susquehanna River Basin," presented at United States/Peoples Republic of China Flood Forecasting Symposium and Workshop, Portland, Oregon, March 29 - April 4, 1989.

Twedt, Tom M., Schaake, John C. Jr., and Peck Eugene L, "National Weather Service Extended Streamflow Prediction," Proceedings, Western Snow Conference, Albuquerque, New Mexico, April 19-21, 1977, 9 pp.

Walton, Mark L., Johnson,Edward R., Ahnert, Peter R., and Hudlow, Michael D., "Next Generation Weather Radar Flash Flood Potential System," presented at the U.S. Army Corps of Engineers Fifth Remote Sensing Symposium, Ann Arbor, Michigan, October 28, 1985. (Note: Symposia never published. Papers available.)

Walton, Mark L., Johnson, Edward R., Ahnert, Peter R., and Hudlow, Michael D., "Proposed On-site Flash-Flood-Potential System for NEXRAD," Preprint Volume, Sixth Conference on Hydrometeorology of the American Meteorological Society, Indianapolis, Indiana, October 29, 1985, pp. 122-129.

Wiele, Stephen M., and Smith, George F., "Improved Hydrologic Forecasting with the Interactive NWS River Forecasting Program," paper presented at the Proceedings of the Seventh International Conference on Interactive Information and Processing Systems for Meteorology, Oceanography and Hydrology, New Orleans, Louisiana, January 13-18, 1991.

World Meteorological Organization, "Guide to Hydrological Practices," WMO No. 168, Geneva, Switzerland, 1974.

ANNEX 4

CHARTER
HYDROMETEOROLOGICAL TRAINING COUNCIL
NATIONAL WEATHER SERVICE

I. Purpose

NOAA/NWS is progressing into a MAR program that will result in an improvement in weather and hydrologic warning and forecast services in the United States. The work force will have available to their use highly sophisticated new hardware and software technologies for carrying out their responsibilities.. As the NWS begins to implement and use these new observing systems and exercise the applications software in this decade, the knowledge and skills of the work force will need to be increased dramatically.

II. Scope

The master training plan for the Hydrometeorological Service Operations for the 1990's covers a broad range of education, training, and professional development needed to bring the skills of the work force to a high level which is necessary to maintain the hydrologic services to the Nation as we begin MAR. The scope of the HTC is focused on the transfer of scientific and technological knowledge of hydrologic and hydrometeorological sciences to the NWS forecasters to support the modernization program.

III. Membership

The HTC will be composed of the following individuals each for a 2-year term:

- One meteorologist from NWS Headquarters selected by the Director of OM.
- One field meteorologist. The chief from each of the NWS regional Scientific Services Division will recommend a meteorologist from his/her region to the Director of OM. The Director of OM, will select one field meteorologist to the council.
- One RFC hydrologist. Each of the NWS regional hydrologists will recommend an RFC hydrologist from his/her region to the Director of OH. The Director of OH will select one RFC hydrologist to the council.
- One service hydrologist. Each of the NWS regional hydrologists will recommend a service hydrologist from his/her region to the Director of OH. The Director of OH will select one service hydrologist.

- o The chairperson of the (CHC) will be the Chief of HRL who will also serve as a hydrologist from NWS Headquarters.

At the conclusion of the first 2-year term for the members, a request will be made for volunteers to serve 1 additional year so that a complete turnover in the membership does not occur.

IV. Associate Membership

One hydrologist from the NWSTC and one hydrometeorologist from COMET will serve as associate members to the HTC. The primary responsibility of the associate members is to provide advice to the HTC on training that will be provided by the NWSTC and COMET.

V. Responsibilities

The HTC shall have the following responsibilities:

a. To review the curriculum of course work for the various courses that are proposed for training and professional development of the NWS Hydrometeorological work force.

b. To recommend new course material for the hydrometeorological work force based upon advances in the scientific understanding of new technologies.

c. To consult with and serve as an advisory council to the Chief of HRL on scientific, technical, and training procedures.

d. To promote maintenance of high scientific and professional standards.

e. To prepare evaluation reports as needed on aspects of the hydrometeorological training program of the NWS for submission to the Director of OH.

VI. Meetings

Meetings shall be called by the chairperson at least once yearly. Additional meetings shall be called by the chairperson as the need arises. Meetings may be held by conference call or at a central location, depending on the nature of the meeting.

ANNEX 5

COMET CBL on Main Stem River Flooding

The duration of the COMET COMAP course will be 8 weeks and will consist of several components including orientation, introductory lecturer, major case studies, minor case studies, forecast simulations in displaced real time (DRT), daily real time forecast activities, and introduction to the applied research process. One of the topics will address main stem river flooding. A CBL module is planned for this topic also as outlined below:

PROPOSED COMPUTER-BASED LEARNING (CBL) MODULE

Title: Forecasting Main Stem Flooding

Keywords: Precipitation, runoff, infiltration, flood routing

Subsections:

1. Flood Spectrum and Definition of Main Stem Flooding
2. General Circulation and Synoptic Scale Patterns Associated with Continuous or Rapidly Repeating Heavy Rains
3. Effects of Snow Melt
4. Factors Affecting Flood Flow
5. Factors Affecting Infiltration Capacity
6. Causes of Extraordinary Floods
7. Flood Routing Through Reservoirs and River Channels
8. Effects of QPF and Temperature Forecasts on RFC River Models
9. RFC River Forecasting

Learning Objectives: After completing this module, the operational forecaster should be able to:

- Describe general circulation and synoptic scale weather patterns associated with widespread, long duration or rapidly repeating heavy rains
- Recognize the combination of factors that lead to extraordinary floods
- Identify factors that affect infiltration capacity and flood flow
- Interpret and apply precipitation estimates from the WSR-88D radars
- Interpret guidance from NMC related to precipitation outlooks
- Interpret RFC forecasts exceeding flood stage and issue public flood forecasts

One method of presenting this CBL is to divide it into five "caselettes."

Caselette #1 - Major Storm Develops

The first caselette would deal with the synoptic scale weather patterns of a major storm having the probability of producing precipitation of sufficient quantity to cause major flooding. Medium-range (36-72 hour) QPF products will be entered into the RFC hydrologic models. It is recognized that QPFs for this time frame will be somewhat uncertain; therefore, training will be highly relevant so that meteorologists, hydrologists, and hydrometeorologists can account properly for this uncertainty. The WFO forecasters must also understand this uncertainty since they will apply their skills in preparing the short-range QPF from the NMC products.

Caselette #2 - The Storm Commences

Incorporation of digital short-range QPF products into RFC hydrologic models offers the highest potential for increasing the lead time in warning people of an impending flood. The accuracy of the QPF product directly impacts the accuracy of the flood forecast. Teaching meteorologists, hydrometeorologists, and hydrologists the present and future techniques that are being applied to QPF forecasting and the limitation associated with these techniques will enable them each to apply this knowledge in their operations.

Caselette #3 - The Storm Commences

This caselette will cover the three stages of precipitation estimation: the NEXRAD precipitation processing subsystem (Stage I); the multisensor precipitation analysis (Stage II) for each NEXRAD radar umbrella area; and the mosaicking of all the precipitation estimates within a given RFC area (Stage III). The complete integration of the three stages of precipitation processing provides the RFC with the precipitation data input needed to drive their hydrologic models. This caselette will subsequently bring the SOO, the HAS forecaster, and the DOH together in a close working relationship to understand the activities, responsibilities, and needs of each other.

Caselette #4 - The RFC in Action

Modeling the flood in the RFC is a continuous process where adjustments and updating are constantly required as time progresses. In that regard, this caselette will have to "back-up" in time and essentially start at the time when it was recognized that a major storm was developing and NMC prepared the QPF. As time is stepped forward with this caselette, the SOO, DOH, and HAS forecaster will learn the details of how changes in the input to the hydrologic model cause changes in the forecasted hydrograph (primarily from precipitation causing the runoff but could include runoff due to snowmelt). This caselette is drawn to a conclusion with the process by which the RFC conveys the forecast hydrograph both to the appropriate WFO(s) and also to the necessary other Federal action agencies.

Caselette #5 - Flood Warning from the WFO

The daily flood situation statements from the HAS forecaster in the RFC, combined with the WFO forecaster's local assessment of the weather, will "kick off" the process of issuing the flood warning from the WFO. This caselette will, therefore, start some time prior to the time when the actual forecast is received in the WFO from the RFC. The caselette will also go completely through the flood beginning before the river goes above flood stage with significant detail presented as the flood crest is reached. Follow-up flood statements as the river begins to recede and finally fall back below flood stage will also be part of the caselette. It will be very appropriate to demonstrate those aspects of this function where the WFO public forecaster interacts with the products created automatically by the River Forecast Formatter software. Finally, this caselette will conclude with a discussion of the process by which the WFO/HSA office hands off the flood wave to the WFO with HSA responsibilities for the downstream area.

Variation in the Main Stem River Flooding CBL

As data become available on various main stem river flooding episodes, three types of these case studies will be made available. The classic example will involve a flood where a major river such as the Mississippi is impacted. In this example the total duration might last for weeks as flooding occurs far distant from where the precipitation originally fell. The second example will cover a case that involves snow melt flooding due to a rapid snow melt event and could also include a rain on snow event. The third example will address flooding in a major industrial valley. This example will highlight the critical nature of good call-to-action plans and the lead times that are necessary to allow the removal of machinery and equipment from the industrial center.

ANNEX 6

COMET Major Case Study on Flash Flooding

The major case study on flash flooding presented at the COMET COMAP course will integrate and apply those aspects of the introductory lecture material which are utilized in the flash flood program with a real life case example. Attention will be focused on the areal flash flood guidance and headwater guidance provided to the WFOs from the RFCs and the NEXRAD-based Flash Flood Potential system. The forecasters will also be given details on the hourly projected rainfall estimates that will also be available from NEXRAD. Together, these products will be utilized by forecasters operationally to make decisions where and when flash flood watches and warnings should be issued. This new technology will greatly increase the lead time available to issue these products. Learning the capabilities and limitations of the integrated components is of major importance to the flash flood program.

The ADVIS flash flood forecasting model as implemented in the DAR^{3}E II workstation will be presented and training will be provided on how to utilize this application software. The DAR^{3}E II workstation capabilities with respect to the Dam Catalog will also be presented in order for forecasters to obtain first-hand experience in forecasting flash floods caused by dam failures.

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