WEATHER SUPPORT TO ARTCC'S AND OTHER AVIATION WEATHER DISSEMINATION ACTIVITIES

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1. PROBLEM

Aviation is affected by weather more than any other transportation system. The transitory and often short-lived nature of weather phenomena mandates the need for up-to-date information in the hands of air traffic controllers, dispatchers, and most importantly, the aircrews in flight. The luxury of uncrowded skies has long since vanished as the growth of aviation, both in numbers and increased performance, has created today's complex air traffic situation. This has resulted in more critical needs for weather information in planning, dispatching, controlling, and carrying out both the en route and terminal phases of flight.

In the past five years, there have been six major United States air carrier accidents that were weather-related, involving 548 fatalities. In most of these accidents, severe weather was a contributing factor to the accident. The National Weather Service (NWS) has the weather forecast and warning responsibility, along with the equipment to detect severe weather. However, there was still a need to ensure that observations, forecasts, and warnings of severe or hazardous weather were delivered efficiently to the pilot. Efficient weather information delivery was (and is) the key to our primary aviation goals—flight safety and economy. It was with this philosophy in mind that the NWS and the Federal Aviation Administration (FAA), aided by advice and counsel from the aviation community, developed the Center Weather Service Unit (CWSU) concept to provide weather support to the Air Route Traffic Control Center (ARTCC).

2. BACKGROUND

Twenty-three ARTCC's operate in the coterminous United States to control and maintain separation of aircraft. The Air Traffic Controller, at his console, can call up a selected number of current weather observations for airports in his sector but has no direct access to other weather information, except for that given to him verbally by the flow controller and by pilots with whom he is in contact. Weather radar returns on his console are normally eliminated, and his only knowledge of potentially hazardous convective activity in his sector comes from calling up a display showing a digital representation indicating two levels of intensity of radar returns. The flow controller receives information via teletype concerning forecasts and warnings of hazardous weather, but the only way this was relayed to the traffic controllers was verbally or by passing around pieces of paper. During periods of bad weather, when information is needed most, it might not be passed at all, because the controllers are too busy separating aircraft.

Over the years, NWS and FAA have attempted to improve on the dissemination of weather services to the aviation users.
a. In the early 1960's, a test program, called "Pilot to Forecaster Service" was initiated in Washington, DC, and in Kansas City, MO. Professional meteorologists in the Washington ARTCC and the NWS Kansas City Weather Forecast Office had voice contact with the aircraft through air/ground communications. The experiment continued until July 1, 1964, when it was determined the costs would be excessive if units were placed in all existing ARTCC's.

b. In 1971, a Severe Weather Avoidance Plan (SWAP) was established for the airway approaches to the New York area. The NWS furnished a meteorologist on a reimbursable basis to work at the New York ARTCC and advise Center personnel of thunderstorm development and movement throughout the ARTCC and adjacent areas. The objective was to route air traffic around potentially hazardous weather with minimum delay. This on-site weather support with adequate weather radar information greatly reduced the lagtime in making essential weather information available to the Center. The annual program continued during the 6-month period from April 1 through September 30. Through the years, however, the functions of the on-site NWS meteorologists were expanded to provide continuous weather surveillance and update the weather information for key Center personnel. Additional duties, such as participating in routine telephone conferences with Center and airport chiefs and their staffs between Washington and New York, developed rapidly.

Since 1976, the SWAP program has operated 7 days a week, from 1300Z to 0300Z, using two overlapping shifts. With the implementation of the CWSU program, SWAP became an integral part of the overall CWSU function of the New York ARTCC. Each day, a telephone conference call is conducted between the major air carriers operating in the New York ARTCC area to discuss the meteorological impacts within the Center's area of responsibility. This in itself is a valuable tool.

c. In 1973, the FAA instituted an En Route Flight Advisory Service (EFAS) from four Flight Service Stations (FSS's) along the West Coast of the United States. FSS specialists were trained to provide current weather information and advisories directly to pilots in flight, using a discrete radio frequency. They also received and disseminated pilot reports. FSS specialists also had a direct line to a Weather Service Forecast Office (WSFO) if additional expertise was required. The initial 1973 EFAS program was so successful that the program has now been expanded to 44 locations across the United States (see Figure 1). The program, as it stands now, is directed principally toward providing service to general aviation pilots flying under visual flight rules (good weather conditions). Although it is not well adapted to serving the air carriers and other pilots flying under positive control, the FAA is currently investigating the feasibility of establishing another discrete frequency for air carrier contact with EFAS.

d. In 1975, the FAA, NWS, and the United States Air Force's Air Weather Service (AWS) collaborated in a jointly-manned (6 people) aviation weather facility at the Kansas City ARTCC. This unit operated 24 hours a day and collected and disseminated pilot reports, advised Center Controllers of weather affecting their sectors, and at night provided pre-flight weather to several military bases in the Kansas City area. The weather personnel had a radarscope (Plain View Display - PVD) identical to the controller and could talk to the en route pilots at the discretion of the controllers. The presence of the professional meteorologist working on-site once again proved the effectiveness of maintaining a dialogue with the controllers, interpreting weather products and issuing weather advisories within the Center. The procedures developed in Kansas City and in the New York ARTCC SWAP program were the pattern in formulating the current CWSU program.

e. In 1977, the FAA established a weather coordination duty position designed specifically for handling pilot reports and advisories of significant weather. The coordinator's function is to gather and relay
weather information within the Center, and to relay significant pilot reports to other designated facilities. The weather coordinator position is now an integral part of the CWSU operation, interfacing between the meteorologists and the controllers.

f. While tests and ongoing projects were continuing at individual ARTCC's, during the late 1960's NWS meteorological positions were established at the FAA's Central Flow Weather Service Unit (CFWSU). CFWSU is a part of the FAA's Air Traffic Control System Command Center (ATCSCC) located at FAA Washington Headquarters. The major function of the ATCSCC is to manage the complete National Airspace System (NAS) for the 48 coterminous United States, coordinate the operations of all Air Route Traffic Control Centers and regulate the flow of air traffic, particularly on high density routes and at high density airports.

The NWS meteorologists provide meteorological consultation and advice to senior air traffic controllers concerning weather conditions that may adversely affect the NAS during the next 24-hour period. This support is provided through detailed briefings of current and forecast weather several times a day. The CFWSU meteorologists also participate in SWAP programs for the entire East Coast of the United States, and coordinate with the CWSU's concerning weather affecting the ARTCC areas. In addition, they provide assistance to those Centers not yet staffed by CWSU meteorologists when adverse conditions affecting the normal flow of traffic occur or are expected to occur. The CFWSU meteorological staff is another of the important elements in providing weather support to the NAS.

Now that we have established the background and the various elements of the weather support provided to the NAS, let us move to the newly-established Center Weather Service Unit program. We will show how it functions and, also, how all these various elements described above are tied together.

3. CENTER WEATHER SERVICE UNITS

In accordance with a Memorandum of Agreement between the FAA and the National Oceanic and Atmospheric Administration (NOAA), three NWS meteorologists were assigned to each of 13 ARTCC's, beginning on April 17, 1978. The first 13 Centers were established based on air traffic flow demands and the occurrence of severe weather activity. The locations were: Atlanta, Houston, Chicago, Indianapolis, Cleveland, Washington, Boston, Fort Worth, Jacksonville, Memphis, Miami, New York, and Kansas City. (See Figure 1.) In the spring of 1980 Denver, Minneapolis, and Anchorage were staffed. On July 1, 1980 Salt Lake City and Seattle were staffed. Albuquerque, Los Angeles, and Oakland will be staffed on September 1, 1980. This will provide a total complement of 63 NWS meteorologists working in 21 Centers. A fourth position is also planned for each center during FY81.

Each CWSU is comprised of three professional meteorologists operating two shifts per day. Their objective is to provide meteorological consultation and advice to the air traffic facilities concerning forecast or actual adverse weather conditions which may affect air traffic operations or aircraft safety over any portion of an assigned ARTCC area. The meteorologists maintain a weather watch and evaluate observations and forecasts affecting aviation operations.

The CWSU meteorologists monitor major air traffic terminals in the ARTCC area and inform the flow controllers, the weather coordinator, and the CFWSU meteorologists of any weather changes that may affect the safe flow of air traffic. They also coordinate with NWS forecast offices to discuss updated area or terminal forecasts, as well as in-flight advisories concerning suddenly changing weather conditions. When such coordination is impractical, they modify and update those forecasts for internal use only, for the guidance of the ARTCC controllers and CFWSU meteorologists.
The CWSU meteorologists have the following specific responsibilities:

a. They monitor all weather reports, forecasts, and warnings issued by responsible Weather Service Offices in and near the area of concern and remain aware of any weather conditions which might adversely affect air traffic operations.

b. They work closely with the FAA officials having responsibilities and/or interests in aviation safety for their ARTCC area.

c. They provide detailed briefings of current and forecast weather several times per day for ARTCC area.

d. CWSU meteorologists act as consultants to the ARTCC controllers, EFAS specialists, and CFWSU meteorologists in situations where hazardous weather impedes the normal flow of air traffic, requiring the determination of alternate traffic patterns.

e. Using weather radar and satellite receiving equipment, along with other available data sources, the meteorologists alert ARTCC controllers to weather conditions affecting, or forecast to affect, air routes within their area of responsibility.

f. They ensure the efficient collection of PIREP's received at the ARTCC and their distribution into the weather communications network. Working with the weather coordinator, they obtain specific pilot reports over areas of concern. The meteorologists can also select specific aircraft from their PVD scope of the ARTCC radar.

g. They also participate in special forecast programs involving wind shear and other localized meteorological phenomena which could affect aircraft operations at specific airports.

h. The CWSU meteorologists conduct weather training sessions for air
traffic specialists and are themselves involved in various NWS training programs aimed at upgrading their use of satellite and radar information as it affects aircraft operations.

4. EQUIPMENT

Each CWSU is equipped as follows:

a. Access to the PVD scope of the ARTCC radar. It offers dual capability: broad band and narrow band display. While in the broad band mode, the radar presents the weather echoes as analyzed by computer and represented by radial lines (denoting the weaker echoes) and letter "H's" (denoting the stronger echoes). No range height indication or specific decibel determination is possible with the ARTCC radar. In the broad band, they can vary the gain and range and select the various narrow band PVD sectors. It is basically used as a qualitative aid to augment the weather data available from the NWS Weather Bureau Remote Radar (WBRR) machines, the hourly radar teletypewriter reports received on Service A, and the Radar Report and Warning Coordination Circuits (RAWARC).

b. Drops on the WBRR network. This allows dial-up capability via a facsimile receiver from selected NWS radar sites. In 1980-81, each CWSU will also have access to a General Time color weather radar remoting and display system. In 1981-82, a sectorization display system will be added that will provide the capability of selecting various sectors in more detail, allowing a closer examination of hazardous weather conditions.

c. A Geostationary Orbiting Environmental Satellite (GOES) photo recorder. This is tied directly to the closest National Environmental Satellite Service (NESS) Satellite Field Service Station (SFSS). In addition to the pictures received, the CWSU meteorologists benefit from the consultive service provided by the SFSS, especially when help is needed in interpreting the pictures or in helping to monitor a potentially troublesome weather situation.

d. Drop on Teletypewriter Service A. This allows the receipt of hourly and special observations, terminal and area forecasts, PIREP's, In-Flight Advisories (AIRMET's, SIGMET's, and Convective SIGMET's), etc.

e. Access to a request/reply circuit. This allows the retrieval of weather data not available on Service A and special programmed weather packages needed in daily operation.

f. Drop on the Radar Report and Warning Coordination Circuits (RAWARC). This fills the gap in radar and warning information issued by NWS offices that is not continuously available on the other circuits.

NWS and FAA automation plans in the next few years will help alleviate the textual weather data handling problem at ARTCC's through the use of high speed Cathode Ray Tube (CRT) terminals for the receipt and request of weather data (alphanumerics and graphics).

g. NWS National Facsimile Network (NAFAX) for the receipt of weather analysis and forecasts from the National Meteorological Center (NNC).

5. CWSU CENTER CONFIGURATION

The CWSU meteorologists and their equipment are located in the vicinity of the ARTCC "E" position complex. The "E" desk complex area of a Center is that part of the control room where the following personnel are generally located: assistant chief, flow controller, data systems specialist, military liaison specials, and now the newly added position of weather coordinator and meteorologist. Some variation of these position locations exists among the ARTCC's.

The "E" desk complex has never been updated to meet changing functions and requirements since the implementation of the automated en route system. Plans are now underway to modernize this complex to meet present and future functions and equipment requirements. This modernization will be in conjunction with the installation of new high speed communications equipment. (See Figure 2 for more detail about future "E" complex plans.)
CWSU PRODUCTS
CWSU BRIEFING

Center weather briefings are presented in accordance with the individual ARTCC staff requirements. They contain the following information.

ARTCC Designator CWSU BRIEFING
Time issued Day of Week Date

1. Synopsis - discussion of weather systems and their movements.
2. General Weather Outlook - weather, clouds, and visibility.
3. Terminal forecasts - of major hub airports, including surface wind forecasts.
4. Location of jet stream.
5. Freezing level.
6. Significant weather phenomena - thunderstorms, icing, turbulence, low-level wind shear, significant precipitation, hydroplaning.
7. Outlook - evening into next morning.

Example:

ZHU CWSU BRIEFING 2145Z MONDAY JULY 24, 1978

S Y N O P S I S . . . S T A T I O N A R Y F RONT EXTENDS FROM THE TX PANHANDLE NEAR ARLINGTON TO LOW PRES SYSTEM OVR SRN AR THEN EWD ACROSS KY AND NC INTO ATLANTIC OCEAN. HIGH PRESSURE WAS CNTRD OVR NY AND JUST OFF GA CST.

G E N E R A L W E A T H E R . . . C L D S 20-50 S C T V BKN WITH SCT TRW SRN TX TO FL ONLY 30 TO 130 MILES INLAND MOVING NW TO NNW AT 10-15 KTS. TOPS IN STRONGEST TSTMS LOCATED OVR SRN LA AND MS ARE ABV 500.

T E R M I N A L S . . . H O U / I A H AND NEW/MSY 20-40 SCT V BKN 120 BKN 250 BKN-OVC CHC 20 OVC 2TRW+ G35. AFT 02Z 120 SCT 250 SCT XCP PITCHY 2-5MI IN GF 102-14Z.

FREEZING_LVL...140-150_FT.

SIGNIFICANT_WEATHER...SCT_TRW_ACROSS_ZHU_AREA_FROM_SRN_TX_TO_FL_WILL_CONTINUE_NEXT_FEW_HOURS_WITH_ISOLATED_TOPS_ABOVE_500_FT. TRW_OVR_LAND_WILL_DECREASE_RAPIDLY_AFTER_SETSSET_BUT_DEVELOP_AGAIN_WITH_DAYTIME_HEATING_TUESDAY.

OUTLOOK...VFR_XCP_PITCHY_GF_10Z-14Z.

Meteorological Impact Statement

These are issued daily by the CWSU if any of the conditions listed below could impact air traffic operations. The statement is distributed to the appropriate FAA facilities within the umbrella of the ARTCC. It includes a discussion of any of the following conditions.

1. Severe Weather - Convective
2. Icing - Moderate or Greater (MOGR) and level
3. Turbulence - MOGR and level
4. Weather - snow, rain, freezing rain, etc.
5. Low ceilings and visibilities
6. Strong surface wind
7. Wind shear including gust fronts

ARTCC Designator
MET IMPACT STATEMENT
TIME_ISSUED_DAY_OF_WEEK_DATE

Example:

ZJX METEOROLOGICAL_IMPACT_STATEMENT
1545Z_TUE_JUL_11_1978


VOLUME_5, NUMBER_3, AUGUST_1980
FORMING_IN_SHORT_LINES_OR_CLUSTERST_MELESS_AFTTR_17Z_WITH_FEW_REACHING_LVL3. CELLS_MOVING_GENERALLY_SEW_10_KTS_AND_CONTINUING_THROUGH_00Z.

GENERALLY_30-40_SCTD/BKN_CLOUDS_WITH_SCTD/BKN_LAYERS_TO_250. CONDITIONS_LOWER_BRIEFLY_TO_MVFR_IN_SCTD_TSTMS_AFTTR_17Z_WITH_BRIEF_IFR_IN_HEAVIER_PCPN. SURFACE_WIND_GENERALLY_W-SW_10_KTS_OR_LESS_EXCEPT_GUSTY_VICINITY_TSTMS.

Center_Weather_Advisory_(CWA)

The NWS area forecast centers have the final responsibility for the nationwide issuance of In-Flight Advisories (SIGMET's/AIRMET's). The CWA issued at the center is a NOWCAST of the In-Flight Advisory and terminal weather conditions. A NOWCAST is a description of existing conditions or a diagnosis of a given situation which can be used to make operational decisions. It sometimes is the only resource that a forecaster has when a weather change occurs. Examples are a sooner-than-expected development of a thunderstorm or the beginning of snow when none was anticipated. It allows the CWSU meteorologist to advise controllers of changing weather conditions and provide an updated forecast. In these situations rapid communications between the forecaster and aviation interests are vital.

There are three conditions in which the CWSU meteorologist will issue a CWA.

First, as an update to reflect changing conditions in the hourly convective SIGMET's (WST) issued by the National Severe Storms Forecast Center (NSSFC).

Second, when observed or forecast conditions meet SIGMET/AIRMET criteria based on current pilot reports and reinforced by existing meteorological conditions, the CWSU meteorologist could initiate a conference call with the aviation forecaster at either the Area Forecast Center or NSSFC, depending upon the circumstances. If the aviation forecaster, who will also be monitoring the situation, determines it necessary to issue a SIGMET/AIRMET, then the CWSU meteorologist
NATIONAL WEATHER DIGEST

will issue a CWA to allow leadtime while the SIGMET/AIRMET is being prepared. The CWA will be issued through the flow controller/weather coordinator to those affected sectors and FAA facilities for that meteorological phenomena and indicate that a SIGMET/AIRMET will be issued shortly.

The third condition in which a CWSU meteorologist will issue a CWA differs from the second in that the issuance will precede a conference call to the appropriate NWS facility. Issuance of a CWA before coordination will be primarily:

a. when time is of the essence and meteorological phenomena have an immediate effect on the safe flow of air traffic within the Center's area of responsibility, or

b. in other situations where meteorological phenomena affect the flow of air traffic but are not currently handled by a SIGMET/AIRMET.

The CWA will contain a valid time, usually of 1 hour; however, valid times may be anywhere up to 2 hours at the discretion of the meteorologist.

ARTCC Designator
CENTER WEATHER ADVISORY
Time Issued Day of Week Date

Example:

ZOB CENTER WEATHER ADVISORY 2141Z WED APR 19 1978

LN SVR TSTMS NOW IN E LITCHFIEFLD W CARETON SECTOR GOING RIGHT OVR DTW. 1/2 INCH HAIL RPTD LAST 5 MINS. WILL AFFECT DTW AREA NEXT 30 TO 45 MINS.

6. PLANS FOR THE FUTURE

During 1980, the remaining ARTCC's in the United States will be staffed with three-person CWSU's (see Figure 1 for locations). A fourth position will be added along with an upgrade in equipment and "E" position complex. Once we have a CWSU in all ARTCC's, we will finally have the machinery to help eliminate delays in the relay of vital weather information to controllers, Flight Service Stations, and EFAS specialists, along with other NAS personnel.

7. OTHER AVIATION PROGRAMS WHICH IMPACT DISSEMINATION ACTIVITIES

In May 1978, the NWS centralized the production of its SIGMET's for convective activity at NSSFC in Kansas City, MO. One of the objectives in this centralization was to eliminate the redundancy of forecast issuance for convective activity. It also places this program in our National Weather Center which is responsible for the issuance of severe weather watches and warnings. The convective SIGMET format was designed in such a way that pilots and dispatchers would have the ability to rapidly plot this information either on the ground or in the air.

Much work has also gone into the testing and development of voice response dissemination systems by the FAA. A test program in Washington, DC and Columbus, OH during 1980 using touch-tone voice response (VRS) technology has been an eye-opening reminder to the aviation community of what can be done if both technology and resources are used properly. Pilots using this VRS system can now obtain the latest hourly observation terminal forecast, winds aloft, alert weather watches, and convective SIGMET's along their route of flight.

To support this new technology, much work has gone into the standardization of aviation products used in these systems. Right now, hourly observations, terminal forecasts, winds aloft, pilot reports, and In-Flight Advisories are all transmitted in fixed format. Pilot reports - one of our only forms of observation aloft - are now being processed more efficiently because of their standardization. For the first time, pilot reports transmitted by private, military, and commercial pilots traversing the country are collected, processed, and put into bulletins. Plans are now underway to begin to plot these pilot reports automatically. This, of course, will be of benefit to both Flight Service Station specialists and Weather Service specialists who provide briefings around the country, and will assist forecasters to quickly assimilate large quantities of weather information. Of course, other
users of our aviation products will also benefit from this new concept for the use of PI REP's. Our In-Flight Advisory Program uses a fixed format for each of the AIRMET's and SIGMET's, and convective SIGMET's issued in this country. This will allow vital warning information to be placed automatically via voice response technology on many of the FAA's dissemination outlets; for instance, AIRMET's and SIGMET's could be placed automatically on the VOR's where the en route pilot has easier communication access to them.

Another program being developed in conjunction with the FAA is our Aviation Route Forecast (ARF) technique. This concept involves meteorological input of from one to 14 variables pertinent to en route operations (bases, tops, in-flight weather remarks, in-flight visibility, turbulence, icing, freezing level, etc.). Using interactive graphical techniques, it will allow this information to be available to the FAA Voice Response System. Input using this technique will be interpolated to gridded points on a numerical weather data base. Algorithms being developed will scrutinize this information and produce a route forecast in 2-hour to 4-hour time frames between any two points in the country. Along with this capability will come that of producing a whole new graphical package containing the same input variables used in the route forecast portion; for example, isolines of bases of clouds, freezing levels, etc. The promise of the ARF technology, along with the other developments mentioned earlier, will someday allow the pilot to pick up a telephone, enter the route of flight planned to be taken, and have the computer provide the latest synopsis, hourly observations, pilot reports, terminal forecasts, NOTAMS, winds aloft, and, of course, a route forecast along the path of flight, all automatically using voice response technology.

To let the imagination go one step further, the day is not too far away when a pilot will be able to interface directly with a home television, using the technology available now. The Weather Service is developing a device with the Department of Agriculture called the Green Thumb machine which is currently demonstrating the feasibility of such a concept. Aviation, in particular, general aviation could certainly use a similar service to get the needed information for a safe flight.

And, finally, the A.M. WEATHER series is currently being carried over 225 Public Broadcasting System (PBS) TV stations. Each day, Monday through Friday, three NOAA meteorologists provide two live telecasts at 6:45 and 8:45 A.M. Satellite technology is used through the production of videotaped satellite loops. Seven other satellite relays of the program daily move A.M. WEATHER across the country. Though geared to aviation, the program also highlights those weather conditions that could impact the agriculture and marine communities. But the major emphasis is to provide the aviation community with a good, professional morning weather briefing right in the pilot's own home.

A.M. WEATHER is a team effort of NOAA, the FAA, Aircraft Owners and Pilots Association (AOPA), and other members of the aviation community.

As can be seen, a lot is happening, much of which has finally allowed the aviation meteorological programs to move forward and improve. A lot more remains to be done until we have reduced the number of weather-related aircraft accidents in this country, and are able to produce, and disseminate, forecasts that will satisfy the growing demands of the aviation community.

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