Sources and Air Carrier Use of Aviation Weather Information

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Washington, D.C. 20591

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16. Abstract

This report is concerned with the use of weather information by air carriers. It describes the type of information obtained, the sources of that information, and the training provided to flight crews in the interpretation and use of weather information. Data from 17 major and regional airlines and seven vendors were included in this study. In addition, the results of a limited survey of airline pilots conducted by ALPA were used.

It was found that despite the fact that a great deal of terminal en route, and forecast weather information is available, flight crews often receive less information than they would like, and much of what they receive is not timely. Examples of weather not provided by some companies includes station weather observations or forecasts for the areas of departure, en route, or destination.

This report includes recommendations for the minimum amount and type of weather information that should be disseminated to airline flight crews for preflight briefings.

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PREFACE

This report is concerned with the use of weather information by air carriers. It describes the type of information obtained, the sources of that information, and the training provided to flight crews in the interpretation and use of weather information. Data from 17 major and regional airlines and seven vendors were included in this study. In addition, the results of a limited survey of airline pilots conducted by ALPA were used.

This report was prepared by the Operator Performance and Safety Analysis Division of the Office of Research and Analysis at the Volpe National Transportation Systems Center (VNTSC) for the Special Programs Branch of the Flight Standards Service of the Federal Aviation Administration.

This report was completed under the direction of VNTSC Program Manager M. Stephen Huntley, Jr. Research for the report and its preparation were the responsibility of John W. Turner of EG&G Dynatrend.

METRIC / ENGLISH CONVERSION FACTORS

ENGLISH TO METRIC

LENGTH (APPROXIMATE)

1 inch (in) = 2.5 centimeters (cm)
1 foot (ft) = 30 centimeters (cm)
1 yard (yd) = 0.9 meter (m)
1 mile (mi) = 1.6 kilometers (km)

AREA (APPROXIMATE)

1 square inch (sq in, in^2) = 6.5 square centimeters (cm^2)
1 square foot (sq ft, ft^2) = 0.09 square meter (m^2)
1 square yard (sq yd, yd^2) = 0.8 square meter (m^2)
1 square mile (sq mi, mi^2) = 2.6 square kilometers (km^2)
1 acre = 0.4 hectares (he) = 4,000 square meters (m^2)

MASS - WEIGHT (APPROXIMATE)

1 ounce (oz) = 28 grams (gr)
1 pound (lb) = .45 kilogram (kg)
1 short ton = 2,000 pounds (lb) = 0.9 tonne (t)

VOLUME (APPROXIMATE)

1 teaspoon (tsp) = 5 milliliters (ml)
1 tablespoon (tbsp) = 15 milliliters (ml)
1 fluid ounce (fl oz) = 30 milliliters (ml)
1 cup (c) = 0.24 liter (l)
1 pint (pt) = 0.47 liter (l)
1 quart (qt) = 0.96 liter (l)
1 gallon (gal) = 3.8 liters (l)
1 cubic foot (cu ft, ft^3) = 0.03 cubic meter (m^3)
1 cubic yard (cu yd, yd^3) = 0.76 cubic meter (m^3)

TEMPERATURE (EXACT)

$[(x - 32)(5/9)]\ °F = y\ °C$

METRIC TO ENGLISH

LENGTH (APPROXIMATE)

1 millimeter (mm) = 0.04 inch (in)
1 centimeter (cm) = 0.4 inch (in)
1 meter (m) = 3.3 feet (ft)
1 meter (m) = 1.1 yards (yd)
1 kilometer (km) = 0.6 mile (mi)

AREA (APPROXIMATE)

1 square centimeter (cm^2) = 0.16 square inch (sq in, in^2)
1 square meter (m^2) = 1.2 square yards (sq yd, yd^2)
1 square kilometer (km^2) = 0.4 square mile (sq mi, mi^2)
1 hectare (he) = 10,000 square meters (m^2) = 2.5 acres

MASS - WEIGHT (APPROXIMATE)

1 gram (gr) = 0.036 ounce (oz)
1 kilogram (kg) = 2.2 pounds (lb)
1 tonne (t) = 1,000 kilograms (kg) = 1.1 short tons

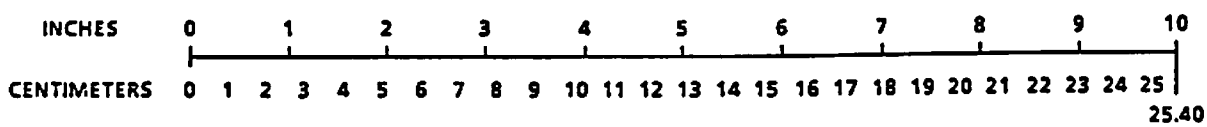
VOLUME (APPROXIMATE)

1 milliliter (ml) = 0.03 fluid ounce (fl oz)
1 liter (l) = 2.1 pints (pt)
1 liter (l) = 1.06 quarts (qt)
1 liter (l) = 0.26 gallon (gal)
1 cubic meter (m^3) = 36 cubic feet (cu ft, ft^3)
1 cubic meter (m^3) = 1.3 cubic yards (cu yd, yd^3)

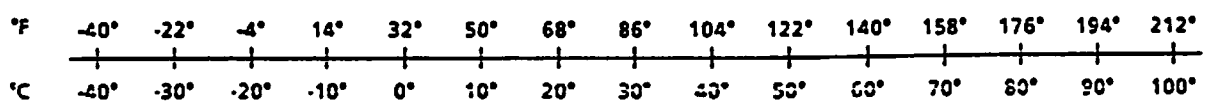
TEMPERATURE (EXACT)

$[(9/5)y + 32]\ °C = x\ °F$

QUICK INCH-CENTIMETER LENGTH CONVERSION



QUICK FAHRENHEIT-CELCIUS TEMPERATURE CONVERSION



For more exact and/or other conversion factors, see NBS Miscellaneous Publication 286, Units of Weights and Measures. Price $2.50. SD Catalog No. C13 10 286.

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EXECUTIVE SUMMARY

The Federal Aviation Regulations cover, in varying degrees, the subject of weather information: weather information sources allowed by regulation; weather information dissemination by the airlines to their crews for briefing; and, training of crews in the use and interpretation of weather information. This study was undertaken to determine to what extent the airline industry needs more specific guidance governing weather information to be provided to flight crews.

A study of 17 airlines, major and regional, was conducted. Fifteen were interviewed on-site, and two were contacted by telephone. Seven weather vendors were contacted to get a sampling of services available to the airlines. Four of these were visited on-site, two submitted information on their services, and the representative of another vendor was interviewed during a visit to a carrier at which he was present. Concurrently, ALPA (Airline Pilots Association) conducted a survey of airline pilots and kindly let us use the results for inclusion in our work.

Most of the airlines contacted in this study use a combination of weather information sources - receiving all the FAA 604 and National Weather Service data, and utilizing the services of the weather vendors. Of the airlines studied, more than 50 percent utilize more than one vendor source. However, only 35 percent of the studied airlines take advantage of the customized services offered by the vendors. (It is not clear whether the customized services available from the weather vendors constitute a "source approved" by the NWS.) Customized services, such as tailored station forecasts, can be very useful to an airline. The forecasts provided by the NWS frequently have conditional remarks which are operationally limiting. They are also designed for a wide spectrum of users, rather than specifically for the airline industry. The forecasts available through many of the weather vendors are industry-specific and usually eliminate the conditional remarks which are operationally limiting. They have also been found, at least with some vendors, to be far more accurate than the forecasts of the NWS. However, unless the question of the legality of their use is resolved, many airlines will not use them. This is a question that needs resolution to provide clarification, and greater operational flexibility, for the airlines.

Weather information disseminated to the crews for prerelease briefing is another subject dealt with in the FARs. The regulation states that the crews must be given "all available weather reports and forecasts of weather phenomenon..." While there is a basic group of data which is given to most crews - SAs (hourly surface observations), FTs (terminal forecasts), NOTAMS, and SIGMETS - the regulation does not specify what precisely is required. Two of the studied airlines didn't provide NOTAMS, and three (including one major carrier) didn't provide SIGMETS. About 50 percent went

beyond the basic information and expanded it to include the areas around the stations in the flight plan. Less than 50 percent provided forecasts for the areas of departure, en route, destination, and alternate. Only one of the studied airlines provided SAs for stations along the route of flight.

On the subject of the training of crews about weather, the FARs are very specific concerning initial, transition, and upgrade training, and less specific with regard to recurrent training. The manner in which the airlines approach this training is not standardized. Some carriers need a directive specifying what they must do, and monitoring to assure that they comply.

The ALPA survey indicated that many of the respondents did not agree with the airlines about the amount of training provided, or needed, and the amount of weather information provided, or needed, for prerelease briefing. Most respondents felt that more training should be forthcoming to provide an information base from which to make proper flight planning decisions. Additionally, most felt they should have more information for prerelease briefing. The information requested ranged from more en route information, to accurate in-flight updates, to more graphics, to any kind of real-time information.

Of the airlines studied, over 50 percent were making an attempt to satisfy the regulations, and some were going far beyond that required of them. Slightly less than 50 percent were deficient in some way - either in what they gave their crews for prerelease briefing, or in the manner in which they trained their crews. In the latter group, some seemed deficient by intent, some for lack of clear direction, and some for a combination of the two. The study brought out the need for a directive of some kind which would give clear direction for standardization of at least the minimum requirements.

TSC recommends that the FAA consider the following actions:

1. Development of a national standard, on weather information and training, for POIs and FAA inspection teams to follow. District autonomy has led to confusion and non-standardization throughout the industry.

2. Forthcoming directives be applied to all segments of the industry, including nonscheduled airlines. The directive should consider the differing operational requirements of different segments of the industry, such as the regionals.

3. Provisions for clarification of the regulations dealing with the use of weather services other than those provided by the NWS and the FAA. The use of certain weather vendor services, such as tailored forecasts, has been disallowed by some FAA personnel, and allowed by others. This confusion can serve to give one

carrier a competitive edge over another which should not be there. The interpretation of which services are "a source approved" by NWS or the Administrator should be very clear.

4. Development of a core curriculum for initial training, with a thorough review in recurrent training. Any additional or innovative training which the carrier chooses to give should be allowed. The thorough annual, or semiannual, recurrent review should obviate the need for weather training in transition or upgrade. The core should not be subject to change without review at the Headquarter's level and a simultaneous change throughout the industry.

5. Weather information be made available at small, downline stations the same as that available in the major hubs. Some flights originate in a small station and never progress through a hub in a series of flights in a day. Because of that, they do not have the same access to weather information as those originating in the hubs.

6. Provision for a very specific requirement for the amount of weather information to be issued for flight planning. This should include, but not be limited to:

- SAs, SPs (if applicable), and FTs for the areas of departure, takeoff alternate (if required), destination, and alternate.
- FDs for the filed route of flight and at least one alternate route.
- FAs for all areas within 100 miles of the projected route.
- SAs and FTs for most of the stations within 100 miles of the projected route (this to give some indication of frontal movements and other trends)
- SIGMETS, AIRMETS, and PIREPS for the route of flight.

Graphics, such as radar summaries, are also recommended. Some of the above information would not be germane to the operation of a regional carrier, and that should be considered in setting down the guidelines. However, one thing that should be addressed is the lack of information available to the regionals. Many comments from the regionals indicated a dissatisfaction with the FSS/AFSS system. The inability to make timely contact, the lack of informed response, and the apparent lack of interest or tolerance on the part of personnel were comments cited in the ALPA survey. Some means of addressing this problem should be included in the recommendation that a specific amount of weather information be issued.

Many airlines are doing a good job in the area of weather information, but those who are not present the potential for serious problems. One of the best tools that an airline crew can possess is preparedness. It is incumbent on the FAA to assure that they possess that tool.

1. INTRODUCTION

The Federal Aviation Regulations cover, in varying degrees, the subject of weather information: weather information sources allowed by regulation; weather information dissemination by the airlines to their crews for briefing; and, training of crews in the use and interpretation of weather information. This study was undertaken to determine to what extent the airline industry needs more specific regulations governing weather information.

A study of 17 airlines, major and regional, was conducted. Fifteen were interviewed on-site, and two were contacted by telephone. Seven weather vendors were contacted to get a sampling of services available to the airlines. Four of these were visited on-site, two submitted information on their services, and the representative of another vendor was questioned during a visit to a carrier at which he was present. Also, ALPA (Airline Pilots Association) conducted a survey of airline pilots and made the results of the survey available to us.

The Weather Information Study dealt with in this report encompasses the acquisition of weather data by Part 121 and Part 135 air carriers (including the use of vendor services), their methods of disseminating weather information to the crews for briefing prior to flight departure, and how they train their crews in the use of the weather information.

1.1 REASON FOR WEATHER INFORMATION STUDY

In the airline industry, at the present time, there exists considerable confusion about what weather information is required to be provided crews for preflight briefing. In our opinion, the FARs dealing with the subject - 91.5, 121.599, 121.601, and 135.213 - are not sufficiently specific to provide clear direction on the matter. Some carriers, especially those in the regional ranks, expressed confusion over what is a legally required minimum of information that they must give their crews. Some also told of instances of one POI setting guidelines only to be contradicted by a subsequent POI, or an inspection team.

Because of this confusion, it became obvious that some standardization should be forthcoming, to at least set minimums for the amount and type of weather given, or available, to a crew prior to flight departure. And, that minimums should be established for the training of those crews in the use and interpretation of the weather data received, and the weather encountered in their daily operations. The study was to determine what current industry practice is, to make recommendations for minimum standards to be adhered to in the future, and to determine the need for further guidelines or regulations.

1.2 METHOD USED

To get a good cross section of replies from the airlines, both major and regional carriers were interviewed. Some were chosen for their preeminence in the industry, others because they were thought to be innovative, and still others because they had an industry reputation for corner cutting. Of the regional carriers interviewed, some were Part 121 by virtue of the size of aircraft flown, yet were small in number of aircraft flown. Others were a mixed operation of Part 121 and Part 135, and still others were Part 135 alone. In most cases both operations personnel, who collected and dispersed the weather information, and training personnel, who trained the crews, were interviewed. In the instances where this did not hold true, substitutes had to be found to provide what information they could at the time of the interview. In addition to on-site interviews conducted, two airlines were interviewed by phone, a Part 121 carrier, and a combination Part 121 and Part 135 carrier.

Four weather vendors were visited at their facilities with briefings on the services available and tours of the facilities. In addition, two were contacted by phone and provided material regarding the services they had available. The East Coast representative of another vendor was interviewed during a visit to one of the carriers. A listing of services available from these vendors is provided in Table 1-1.

To provide balance to the report, the results of a survey conducted by ALPA (Air Line Pilots Association) are provided to assess pilot response to the same basic questions asked of the airlines. ALPA sent out approximately 140 questionnaires. Of these, 80 were sent to the Central Air Safety Chairman and Local Air Safety Committee Chairman of 40 airlines. Others were sent to six members each of ten other concerned committees. Twenty-eight questionnaires were returned. These responses will be discussed in detail in Section 5.

TABLE 1-1. WEATHER SERVICES OFFERED BY VENDORS

	A	B	C	D	E	F	G
ALL FAA 604 DATA	X	X	X	X	X		X
ALL NWS DATA	X	X	X	X	X		X
NAFAX	X	X	X				
DIFAX	X	X	X	X	X		X
TAFS		X	X	X			X
METARS		X	X	X			X
INTERNATIONAL WINDS ALOFT		X	X	X			X
INTERNATIONAL GRAPHICS CHARTS		X	X	X			X
CRT VIEW - NWS RADAR SITES TO SATELLITE OVERVIEWS			X				
SATELLITE RECEPTION	X		X		X		X
PC-BASED WEATHER RETRIEVAL	X	X	X	X	X		X
SPECIFIC DATA GROUP RETRIEVAL/STORAGE		X	X	X			
24-HOUR METEOROLOGIST AVAILABILITY			X	X			
DATA STORAGE					X		X
MAINFRAME COMPUTER DEDICATION			X				X
SIGMETS	X	X	X	X	X		X
AIRMETS	X	X	X	X	X		X
NOTAMS		X	X	X	X		X
PIREPS		X	X	X	X		X
CUSTOMIZED SERVICES:							
TERMINAL FORECASTS		X	X				
UPPER AIR ANALYSIS		X	X				
HOURLY RADAR SUMMARIES		X	X	X			
SURFACE ANALYSIS		X	X	X			
SURFACE PROGNOSIS		X	X	X			
UPPER AIR FORECASTS		X	X				
FORECAST WINDS/TEMPERATURES ALOFT		X	X	X			
HIGH-LEVEL SIGNIFICANT WEATHER		X	X	X			
SEVERE WEATHER ALERTING		X	X				
ADDITIONAL GRAPHIC WEATHER CHARTS		X	X	X			X
TURBULENCE COMPUTER MODELS						X	
PRECIPITATION COMPUTER MODELS						X	
CLOUD COVER COMPUTER MODELS						X	
AVIATION DIGITAL FORECAST FORMAT OF SUITLAND							
WINDS ALOFT	X	X					

2. SOURCES OF AVIATION WEATHER

The sources of weather information for Part 121 carriers in the 48 contiguous States must be the NWS (National Weather Service), or a source approved by the NWS [FAR 121.101 (b)]. For a carrier going outside the 48 contiguous States, the source must be approved by the Administrator. For Part 135 operators, the sources of weather information may be the NWS, the Administrator, or, in VFR weather, the pilot, or someone else qualified to take observations (FAR 135.213). There is also a large secondary industry providing weather information of one kind or another to most of the airlines. The companies providing this information take NWS and FAA data and either transmit them unchanged through a computer terminal, or manipulate them in some manner to provide customized services such as tailored station forecasts, enhanced graphic charts, winds/temperatures aloft forecasts, etc. The means of transmitting the data vary from the use of land lines, to the use of multiple satellite relays, with software packages to satisfy the needs of most users.

2.1 VENDOR SOURCES

The study contacted seven vendors of aviation weather information. More exist, although the full list of products that they make available is not known. Of the vendors contacted, there is a wide divergence in the approach to providing the information. Table One, "WEATHER SERVICES OFFERED BY VENDORS," shows that of the seven vendors studied, six offer the full line of FAA 604 data, all NWS data, and DIFAX chart reproduction. Only three, (A, B, & C), provide NAFAX, and four, (B, C, D, & G), specify that they can provide TAFS, METARS, and international graphics charts and winds/temperatures aloft. As the area of customized services is approached, the field narrows considerably. Two of the vendors, (B & C), offer tailored terminal forecasts, and many other services which enhance the basic data available from the FAA and NWS circuits, and provide the subscribing airlines with more specific data. This greater specificity gives the airlines a more accurate picture of the weather situation and allows them greater operational flexibility. When the more esoteric vendor services are examined, such as the conversion of Suitland winds-aloft computer codes into Aviation Digital Format, only two of the vendors studied, (A & B), provided that service.

One company, (E), provides the following NWS and FAA weather information to their customers: convective outlooks, area forecasts, forecast winds aloft, terminal forecasts, NOTAMS, hourly surface observations, radar reports, narrative radar summaries, TAFS, PIREPS, AIRMETS, SIGMETS, convective SIGMETS, severe weather watches, last three SAs/FTs/NOTAMS from specific stations, and current SAs/FTs/NOTAMS from point

A to point B. They also offer 12-, 24-, 36-, and 48-hour prognoses, DIFAX charts of radar summaries, and weather depiction. To furnish this information, they provide the customer with a unit consisting of an AT-type PC and monochrome monitor, a printer capable of printing text and graphics, multiple modems to allow for transparent remote access simultaneously with use at the site, the software to manage the system, and a satellite receiving dish. The data is stored in a hard drive, updated as received, and retained for 12 hours. The weather information is tied in with the flight planning service provided through their computer. They do not utilize meteorologists to provide enhanced forecasts or analysis of the weather received.

In addition to providing the units to amass this raw weather data, they can also provide Automated Weather Observing Systems (AWOS), training for AWOS use in Supplemental Aviation Weather Reporting Stations (SAWRS), and archiving of weather information for future use in the event of an accident or incident. They are also working on other projects, including a runway ice detection system.

At the other end of the spectrum is a vendor, (C), who has a highly computerized operation, including redundant mainframe computers and alternate power supplies, multiple satellite transmission capabilities, and meteorologists on duty, around- the-clock, to provide tailored forecasts and on-demand weather analysis for their clients. According to one of their customers who did a comparison study, they have a forecast accuracy rate of about 97 percent, compared to a NWS accuracy rate of below 50 percent. They are not, despite the depth and accuracy of services available, the most expensive weather vendor providing such services. Their weather database takes information from all NWS data, the FAA 604 circuit, DIFAX, and direct satellite readout from both U.S. GOES satellites. The GOES satellites, in turn, also tap data from the GMS (Japanese) satellite, the METEOSAT (Mediterranean and European) satellite and the TYROS (polar orbit) satellite. They distribute information to their customers through a system consisting of a CRT, a satellite receiving antenna, up to four printers, for text and graphics, and a data controller. To facilitate this, they have their own satellite receiving and transmitting station with a high-speed, 56 kilobaud data stream. This information is supplemented with their own forecast products including terminal forecasts, frontal movement forecasts, wind/temperature aloft forecasts, etc.

This vendor, in addition to a 24-hour-a-day staff of meteorologists, also has a full staff of engineers, technicians, programmers, and dispatchers to develop additional services, and provide technical support for the

existing services. They also provide a radar coverage capability for their customers, with regular or dedicated phone lines, which will give 60-mile to 240-mile range capabilities, precipitation levels, zoom and freeze capabilities, and time lapse sequences. This shows information which ranges from local site coverage up to full earth coverage, from satellite pictures. They provide aircraft specific flight plans for anywhere in the world. They have Doppler weather radar available, which they will set up on the customer's site.

Between the foregoing examples of differing technology are other companies which provide similar services. Most start by transmitting the basic data received through the NWS and FAA - i.e., hourly surface observations (SAs), special observations (SPs), terminal forecasts (FTs), area forecasts (FAs), winds and temperatures aloft (FDs), SIGMETS, AIRMETS, NOTAMS, pilot reports (UAs), and the host of other products put out by NWS and FAA - through a computer link similar to those mentioned. The more sophisticated vendors then enhance these with various forecasting techniques, and provide highly accurate terminal and area forecasts, frontal movement forecasts, winds-aloft forecasts (using either Suitland [National Meteorological Center] or Bracknell [United Kingdom Meteorological Center] observations), and other specialized weather products requested by their customers. Two, (C and D), have meteorologists on duty to provide verbal briefings on demand, and can also provide standard daily briefings for a carrier's entire system. They provide any or all of these services as single services, or a family of services, depending on client needs and budget.

Cost for these services is advertised as a per-unit cost for each service requested or utilized. In reality, information received from the airlines interviewed for this study indicates that in many cases a deal is struck, between the vendor and the airline, that may not reflect the advertised cost. Actual costs will be discussed in Section 2.3.

There is another type of vendor that provides very specialized products to the industry. One example of this is the company, (F), working on computer models for turbulence, precipitation, and cloud cover. Another example is a vendor, which was not contacted, which has developed software providing reception of a specified amount of weather information. This is useful to carriers with a limited route structure, such as small regional carriers, who have no need for weather other than that which pertains to their route structure. Only the weather information selected by the carrier is automatically printed on an hourly basis, as opposed to weather for the entire country. In addition, this software can be programmed to receive weather within

predetermined parameters of visibility and ceiling (below minimums for an approach for the carrier at a particular airport, as an example), changes in NOTAM status, SIGMETS, etc., and print that information on an as-reported basis. The receipt of the other-than-hourly information alerts the dispatchers, or their counterparts at Part 135 operators, to data affecting their flights of which they might otherwise be unaware.

2.2 OTHER SOURCES

The basic sources of weather information are the NWS (National Weather Service) and the FAA. Most weather information in the United States is gathered and disseminated by these two organizations, and is augmented by data from the Department of Defense (DoD), the U. S. Coast Guard, the air carriers, and contract weather observers. The information is available to users either by telephone long line from the National Meteorological Center, Suitland, Maryland or the Weather Message Switching Center, Kansas City, Missouri. It is also available via one of the GOES satellites through a satellite earth station.

In areas not manned by weather observers, there are other means of surface observation. Automated Weather Observing Systems (AWOS) provide varying degrees of weather information. AWOS 1 provides altimeter setting, wind speed and direction, temperature, dewpoint, and density altitude. AWOS 2 adds visibility to that information. AWOS 3 provides all AWOS 2 data and adds cloud/ceiling data. This data is accessible over a radio frequency, via the voice portion of a local navaid, and frequently via telephone. The information gathered by an AWOS can be used by a Supplemental Aviation Weather Reporting Station (SAWRS). In that case, personnel of a fixed base operator (FBO) or an airline, at an airport without full-time FAA or NWS personnel, use the data to issue weather observations approved by the Administrator. One such example is Aspen, Colorado. There are also Automatic Meteorological Observing Stations (AMOS) at about 90 remote, unstaffed, or part-time staffed, locations throughout the country. The full parameter AMOSs report temperature, dew point, wind speed and direction, pressure, and precipitation amount. The data recorded is automatically reported into the aviation weather network. At staffed AMOS locations, an observer may manually add observations, and calculations, of sky condition, visibility, weather, obstructions to vision, and sea level pressure. Partial parameter AMOSs report only some of these elements, normally wind. These observations are not normally disseminated through aviation weather circuits.

For most areas of the country, there are the chain of Flight Service Stations (FSS), and Automated Flight Service Stations (AFSS), which provide weather briefing and flight plan services for general aviation, and air carriers, as requested. Flight Service Station Specialists are certificated by the NWS as Pilot Weather Briefers. Although they cannot make original forecasts, they can provide full briefings on the conditions expected along a route of flight and at a destination. They can also provide abbreviated briefings and in-flight briefings.
For air carriers flying beyond the confines of the United States, there are also Terminal Aviation Forecasts (TAFS) and Surface Aviation Weather Reports in ICAO format (METARS). These can be procured from Carswell Air Force Base and are also available through the various national meteorological offices of the countries in which the flag carriers operate. In the instance of one carrier serving South America, (D), a combination of sources is used. In some of the countries in which they operate, they utilize the weather reports of the local flag carrier, forwarded by another U. S. flag carrier, Pan Am. For the balance of the countries they serve, they take the weather reports from the local governments and forward them to their Santiago, Chile, facility to be put into English computer language. They are then disseminated throughout South America in the stations where they are needed, or forwarded to the States for dissemination there.

2.3 SOURCES UTILIZED BY THE AIR CARRIERS

Traditionally, the larger carriers had meteorology departments of their own, and produced whatever products they desired from the basic FAA and NWS data. Since deregulation, and the accompanying economic constraints on the carriers, only four of the major carriers studied have meteorology departments remaining, and the departments are often pressed to justify their existence. The other major carriers, and many of the regional carriers, avail themselves of one or more of the vendor services. Table 2-1, "WEATHER SERVICES UTILIZED BY AIRLINES," gives a representation of what services are utilized from the vendor services available. All but one of the majors, and half of the regionals, receive the full FAA 604 data. The full range of NWS data is received by all the regionals and all but one of the majors. All the carriers contacted use some form of PC-based weather data retrieval. The availability of a meteorologist on call for consultation is utilized by all the majors and only one of the regionals. The numbers are far smaller when it comes to the utilization of customized services. Less than half of the majors, (A, C, & D), use tailored forecasts that are provided by the vendors, and only two regionals, (K & Q), do, despite the fact that those who use them state that they provide them far greater accuracy. The other majors studied

TABLE 2-1. WEATHER SERVICES UTILIZED BY AIRLINES

	MAJORS								REGIONALS									
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
ALL FAA 604 DATA	X	X		X	X	X	X		X	X	X				X		X
FAA 135 LINE						X											
ALL NWS DATA		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
NAFAX				X	X		X										X
DIFAX		X			X	X	X			X							
TAFS	X	X		X	X	X	X										
METARS	X	X		X	X	X	X										
INTERNATIONAL WINDS ALOFT	X	X	X	X	X	X	X										
INTERNATIONAL GRAPHICS CHARTS			X		X	X	X										
CRT VIEW - NWS RADAR SITES TO SATELLITE OVERVIEWS		X	X	X	X	X	X					X					X
SATELLITE RECEPTION	X	X		X	X	X	X										X
PC-BASED WEATHER RETRIEVAL	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SPECIFIC DATA GROUP RETRIEVAL/STORAGE									X	X	X	X					X
24-HOUR METEOROLOGIST AVAILABILITY	X	X	X	X	X	X	X					X					
DATA STORAGE						X											
MAINFRAME COMPUTER DEDICATION																	
SIGMETS (IF NOT SPECIFICALLY FROM FAA OR NWS DATA)			X					X	X	X	X	X	X		X		X
AIRMETS (IF NOT SPECIFICALLY FROM FAA OR NWS DATA)								X	X	X	X		X		X		X
CUSTOMIZED SERVICES:																	
TERMINAL FORECASTS	X		X	X							X						X
UPPER AIR ANALYSIS																	
HOURLY RADAR SUMMARIES																	
SURFACE ANALYSIS																	
SURFACE PROGNOSIS																	
UPPER AIR FORECASTS																	
FORECAST WINDS/TEMPERATURES ALOFT	X	X						X				X	X	X			
HIGH-LEVEL SIGNIFICANT WEATHER																	
SEVERE WEATHER ALERTING							X										
ADDITIONAL GRAPHIC WEATHER CHARTS			X			X											
TURBULENCE COMPUTER MODELS																	
PRECIPITATION COMPUTER MODELS																	
CLOUD COVER COMPUTER MODELS																	
COMPANY METEOROLOGY DEPARTMENT		X			X	X	X										

provide their own tailored forecasts through their meteorology departments.

Some carriers utilize as many as three vendors - one as a primary source, the other two as backups. The choice of vendors varies from carrier to carrier. In some cases, the decision is influenced by the ability of the vendor to deliver a certain group of products at a price compatible with the carrier's budget. In other cases, budget does not appear to be a constraint, as in the case of those using multiple vendor services. The rationale behind the use of multiple services was explained by the carriers. One explanation was as follows: the primary vendor provides all, or most, of the products needed at a favorable price. The second vendor provides a single service which, in itself, is superior to one provided by the first vendor (such as a flight plan using Bracknell winds aloft vs. one using Suitland winds). When looked at in an overall package, it may not be as economically favorable, so just that particular service is used. The third vendor is contracted on a strictly as-used basis - i.e., no charge being levied unless utilized, and utilized only if the primary vendor service is unavailable.

One of the trunk carriers which still has its own meteorology department, (B), receives all FAA and NWS data and still uses various services from six vendors to supplement this. From Kavouras they use RADAC, radar coverage of 127 NWS radar sites. From ARINC they receive winds aloft forecasts. From Alden they get radar coverage of about 80 NWS sites as a backup to RADAC. From UPI they lease a dedicated phone line to Washington, DC for their DIFAX output. They receive TAFS and METARS from Carswell AFB. From Lockheed they receive some flight plans out of Lockheed Jet Plan, although their meteorology department, per se, does not utilize Lockheed Met Plan. They use all this input of data as a basis for their own forecasting. They estimate their annual cost for the use of vendor services, and the receipt of satellite NWS data, at $720,000 to $1,080,000. This is in addition to approximately $750,000 per year for the cost of meteorology personnel. They justify this expense by tracking their accuracy, compared to NWS accuracy, and extrapolating the disruption under which their entire route system would operate if forced to use just NWS and/or FAA data.

One of the major supplemental carriers, (E), handles nothing but freight. Their entire operation is based on time constraints, since any package delivered late is delivered free of charge. A forecast below minimums for a destination will cause them to schedule diversion of the aircraft to another station, with subsequent trucking of the cargo to the original destination, and the attendant costs. Therefore,

accurate weather forecasting is extremely important. They feel that NWS forecasts, with their conditional remarks, are restrictive and inaccurate, and the use of those alone would cost them many thousands of dollars each day in late deliveries. For this reason, although they use NWS and FAA data, they also contract for sequence reports from one vendor, Kavouras, receive NAFAX and DIFAX through another, Alden, use two other vendors for redundant coverage, and utilize McIdas for their own forecasting. McIdas is a University-of-Wisconsin-designed forecasting tool which will provide for multiple overlays of graphic depictions (such as winds aloft over a surface analysis chart). They feel this, used in conjunction with their meteorologists' expertise, provides a forecast capability far superior to the NWS, and thus is justifiable in terms of cost. Their estimated cost per year is $400,000, a reduction from the estimated $1,000,000 per year they were spending previously.

The other end of the spectrum, in the trunk carriers, is (C). This is a carrier that uses two vendor services, one as a backup, but is unable to justify the continuing operation of a meteorology department. They gather basic NWS data, and have one service, Lockheed Met Plan, as a backup. The primary service they use, Kavouras, provides the basic weather information, twice daily system weather briefings, and transmission of radar coverage from the NWS radar sites, for use in their operations area. They estimate a cost of about $75,000 per year for some services and don't know the cost of others. They provide their pilots weather briefings that include surface observations (SAs), special observations (SPs), terminal forecasts (FTs), and NOTAMS for the stations of departure, destination and alternate, SIGMETS, abbreviated winds-aloft forecasts, and SAs and SPs for a small number of en route stations. Although the carrier indicated that area forecasts were included in the weather briefing package, they were absent from the sample dispatch packages shown the study team. This format holds true for all flights, whether 300 miles or 3,000 miles, according to the people interviewed. The one exception is the international weather package, which includes some graphics, which is legally required to be given any international departure at the station where it departs the continental limits of the United States.

The regional carriers run the gamut from having pilots self-brief at FSSs to elaborate weather gathering rivaling some of the trunk carriers, and surpassing others. Since they are, by definition, "regional" in character, a poor forecast, or a badly phrased conditional remark in a forecast, can close down their entire operation for a period of time - sometimes days at a time. A conditional remark, indicating the possibility of weather conditions which may be below the approach or departure minimums for the carrier, would be

legally limiting. Should a limiting, conditional remark in a forecast encompass their entire operating area, a not unusual situation, they may be forced to suspend operations throughout their entire route structure.

Many regionals use the weather provided through the computer system of the major airline with which they are code sharers. Of the regionals contacted for the study, most utilize some services from the vendors, with over half of them using the vendor weather as their primary source. In the cases of the regionals utilizing customized services, they felt that the weather data supplied by the vendor provided information, such as tailored forecasts, unavailable through the airline computer system. Even wholly owned subsidiaries, in some cases, were given autonomy to make their own decisions, economically, in the matter of weather data sources, as long as they could justify those decisions operationally.

One case was seen of a regional, (N), with no major carrier affiliation, contracting for weather information from a major carrier. They used this as a least-cost alternative. This situation arose through a combination of circumstances. Initially there had been a FSS at the field where the regional was based. The carrier's pilots self-briefed at the FSS and got whatever information they needed. The FSS was combined into one of the new AFSSs and moved to another location. In the same physical location as the old FSS was a U.S. Weather Bureau facility which refused to allow the pilots access to the weather information they had. The carrier's pilots also had problems receiving briefings from the new AFSS, brought on by the inability to get through on the telephone, at times, or the lack of cooperation on the part of the AFSS personnel. As a consequence, in order to assure that they could receive weather information whenever they needed it, they contracted to receive it through a major carrier's computer system. They contracted for a minimal amount of information, at a cost of $400 per month, and this is the only weather information source they use at their home base. They provide their crews with SAs, SPs and FTs for the stations of departure, destination and alternate, and the crews are expected to get any other information en route from the controllers, or by a radio call to a FSS.

Some carriers, both major and regional, contract with a vendor, such as System One, to provide a flight planning service which includes weather. Flight plans for each specific flight are provided, along with a carrier-specified amount of weather information for each flight. In some cases, this is the only weather information used. As has been mentioned, one major carrier, (C), professed to receive area forecasts as part of the weather package provided their

crews, but in the sample package they gave the study team, no area forecasts were included. FAR 121.601 states, in part, "...before beginning a flight, the dispatcher shall provide the pilot in command with all available weather reports and forecasts of weather phenomena that may affect the safety of flight,..." While area forecasts are not specifically spelled out in the regulation, it is the opinion of the study team that they were intended to be included. If that is the case, the intent of the regulation is not being met.

As can be seen above, although there is a wealth of weather information available from the vendors, only a part of it is utilized by the airlines. The opportunity to receive very complete information is there, although the price can vary considerably from source to source. Some of the vendors provide a package of services at a reasonable cost, but many airlines do not take full advantage of these services to provide a full range of data to their crews for prerelease briefing. Section 3 illustrates that many of the airlines studied provide little beyond the basic data to their crews, despite the information available to them. In most cases, the reason given is economics. However, in the case of one of the majors with a very high meteorology budget, (B), the amount of information provided their crews for standard prerelease briefing is less than that provided by two of the regionals for their crews. The services are available, albeit in varying degrees, depending on the vendor, but in most cases, the full range of vendor services is not utilized.

3. WEATHER INFORMATION AVAILABLE TO AIRLINE CREWS

3.1 INFORMATION PROVIDED IN DISPATCH PACKAGES FOR PRERELEASE BRIEFING

The weather information provided to flight crews for prerelease briefing should logically follow a set formula - i.e., the company spending the most money on amassing weather information should provide the most information to their crews. This isn't the case. One of the small regionals, (N), spends $4,800 per year for weather information, and gives a bare minimum of information to their crews (hourly sequence reports and station forecasts for the stations of departure, destination, and alternate). One of the trunk carriers, (B), which spends over $1,000,000 per year for weather services, and has one of the few remaining meteorology departments, only amplifies that information by adding route and area forecasts, SIGMETS (if applicable), tropopause and wind/temperature aloft data, and an alphanumeric summary of radar reports. This trunk carrier, however, does have other information available to the crews, at most stations, if they desire it. Another major carrier, (F), is one of the best examples of providing a full weather briefing. They do this for one of the lower annual costs, while still maintaining a meteorology department. Their annual cost for services was given as $161,600, exclusive of labor costs and the cost for some incoming circuits (they didn't have those costs available). The weather briefing they provide their crews is very detailed. They provide SAs, SPs, FTs, and field conditions for the stations of departure, takeoff-alternate, destination, and alternate. They provide both FAA and company NOTAMS for departure and takeoff-alternate stations, for stations in the en route area, and for stations in the area of the destination and alternate. They provide SAs for the entire en route area. They give information on the tropopause and winds/temperatures aloft forecasts. In addition, they have a source of information unique in the industry. They have a turbulence plot chart of the continental United States, with overlays of known mountain wave areas, provided with each weather briefing package. Turbulence is tracked through their own frequent pilot reports and through the plotting of winds and fronts aloft. If active areas exist, the crews are given notices with geographical coordinates which, when plotted on the turbulence plot chart, give them a graphic representation of where turbulence exists. (The turbulence plot charts are issued mainly to domestic crews unless an international crew will be transiting a known area of turbulence.) International crews, subject to being rerouted by ATC, are also given winds aloft forecasts for alternate routes. In addition, this airline's crews routinely receive field condition reports with all weather briefing packages.

An additional step being anticipated by this carrier is the start of automated reports from en route flights, having Inertial Navigation (INS) on board, about three times per hour. This will require the addition of a black box to record, and transmit, wind speed and direction, and outside air temperature from the INS, and G-forces (indicative of turbulence) from the aircraft's central air data computer. This information will be transmitted through the ARINC Communication Addressing and Reporting System (ACARS) to a discrete company address, and will be used as a further tool for the forecasting of turbulence.

One of the major Part 121 supplemental carriers, (E), still retains a meteorology department which has a very heavy input into not only weather briefing of crews, but also the selection of flight plan routes, and the routing of flights. Their weather briefing packages include SAs, SPs, and FTs for the areas of departure, destination, and alternate, and for stations all along the route of flight. (The latter allows the crew to follow weather trends and frontal movements.) Included also are customized route forecasts, FAA SIGMETS, and company-prepared equivalents of SIGMETS. Graphics are also provided. Domestic flights receive radar summary charts, weather depiction charts, and four wind-and-temperature-aloft charts for varying altitudes. International flights receive six wind-and-temperature-aloft charts for varying altitudes, a 24-hour prognosis chart for winds and temperatures aloft, for the intended altitude of the flight, a high-level-significant-weather chart for the ocean being crossed, and a significant-weather chart for the continent of destination.

This carrier uses a flight plan format developed by a foreign flag carrier, KLM; however, they insert their own forecast winds and temperatures aloft for the final product. Also, all flights are flight-planned around areas of significant weather prior to departure. (The meteorology department makes the primary input for that decision.) In addition, should their forecasts predict weather to be below minimums for a particular destination, they will advise routing to reroute the aircraft to another station, and to set up a trucking operation between the reroute station and the original destination for delivery of the cargo. Meteorology claims, although the study team did not confirm this with any crews, that crews en route will phone patch through to meteorology for guidance around a line of thunderstorms rather than seek information from the ATC controller working the flight.

This company, because of the constraints encountered with timely delivery, has a heavy reliance on its meteorology department, and they in turn, have a very heavy input into

the entire operational process. This helps to account for the fact that they do not appear to have difficulty justifying expenditures for weather information.

One of the regionals studied, a wholly owned subsidiary of a major carrier, is a combination Part 121 and Part 135 operator, (Q). They spend less than $25,000 annually on weather collection and dissemination, not counting the labor costs of their operations department, but they give their crews a thorough weather briefing package. Their Part 121 and Part 135 crews receive identical briefing packages, unlike some other combination carriers interviewed. The packages consist of route and area forecasts, SAs, SPs and FTs for stations of departure, destination, and alternate. Also included are AIRMETS, SIGMETS, and alphanumeric representations of radar plots.

Table 3-1, "WEATHER BRIEFING PROVIDED CREWS," shows that, of the airlines studied, all provided the basic SAs, SPs and FTs for the stations of departure, takeoff alternate (if needed), destination, and alternate. This group of information is what is considered, by the airlines studied, to be the "legally required" minimum. One carrier, (F), added field condition reports routinely, and all but two, (I & N), provided NOTAM information. Additional information is added by the airlines desiring to provide more than just the basics. As an example, the table shows that seven of the airlines, five majors and two regionals, provided SAs, SPs, and FTs for not just the specific stations involved in the flight plan, but also for the stations in the areas surrounding those stations. Area forecasts received similar treatment. Five major airlines and five regionals provided forecasts for the departure area, the en route area, the destination area, and the alternate area. One major and one regional provided only en route area forecasts, and one regional provided forecasts for the area of the stations in the flight plan. Four of the airlines studied, (C, I, N, & O), provided no area forecasts at all.

As can be seen from the foregoing illustrations, the amount of weather information provided crews for flight planning varies considerably. Of the four major airlines that have meteorology departments remaining, one of them, (B), provides less information to their crews than two of the regionals, (H & L). This would appear to disprove the theory that the airline spending the most money amassing weather information would, logically, provide the most information to their crews.

TABLE 3-1. WEATHER BRIEFING PROVIDED CREWS - PRIOR TO DEPARTURE

	MAJORS								REGIONALS									
	A	B	C	D	E	F	G		H	I	J	K	L	M	N	O	P	Q
POINT OF ORIGIN																		
SAs	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X
SPs	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X
FTs	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X
FIELD CONDITIONS						X												
NOTAMS	X	X	X	X	X	X	X		X		X	X	X	X		X	X	X
TAKEOFF ALTERNATE (IF NEEDED)																		
SAs	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X
SPs	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X
FTs	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X
FIELD CONDITIONS						X												
NOTAMS	X	X	X	X	X	X	X		X		X	X	X	X		X	X	X
DESTINATION																		
SAs	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X
SPs	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X
FTs	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X
FIELD CONDITIONS						X												
NOTAMS	X	X	X	X	X	X	X		X		X	X	X	X		X	X	X
ALTERNATE																		
SAs	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X
SPs	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X
FTs	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X
FIELD CONDITIONS						X												
NOTAMS	X	X	X	X	X	X	X		X		X	X	X	X		X	X	X
PROVIDED FOR AREA OF DESTINATION, DEPARTURE, OR ALTERNATE																		
SAs	X		X		X	X	X		X				X					
SPs	X		X		X	X	X		X				X					
FTs	X		X		X	X	X		X				X					
FIELD CONDITIONS						X												
NOTAMS	X				X	X	X		X				X					
AREA FORECASTS																		
DEPARTURE AREA	X	X		X		X	X		X		X	X	X	X				X
EN ROUTE AREA	X	X		X	X	X	X		X			X	X	X			X	X
DESTINATION AREA	X	X		X		X	X		X		X	X	X	X				X
ALTERNATE AREA	X	X		X		X	X		X		X	X	X	X				X
EN ROUTE SAs	X					X												
SIGMETS	X	X	X	X	X		X		X	X	X	X	X	X		X		X
AIRMETS									X	X	X	X	X	X		X		X
TROPOPAUSE	X	X	X	X	X	X	X						X					
WINDS/TEMPERATURES ALOFT	X	X	X	X	X	X	X		X	X	X	X	X	X		X		X
TURBULENCE PLOTS						X												
METEOROLOGY DEPARTMENT		X			X	X	X											

3.2 SOURCES AVAILABLE FOR ADDITIONAL BRIEFING PRIOR TO RELEASE

In the hub stations of the trunk carriers, besides the weather information provided for prerelease briefing, there is additional information available, including graphic representations of radar summaries, millibar charts, surface analysis charts, etc. Table 3-2 "...ADDITIONAL SOURCES AVAILABLE PRIOR TO DEPARTURE," indicates that only one of the regionals, (Q), provides this information. One of the majors, (F), also has, in their home base, a radar display unit that will display any of the NWS radar sites in the country. The crews can use this to provide information about stations along their route of flight. Away from the hubs, the amount of information available is reduced. Stations for the major carriers have at least a computer terminal from which the crew, or the operations agent working the flight, can get further information, such as a special observation, or a more recent forecast.

Three of the four major carriers, (B, E, F, & G), with meteorology departments remaining provide direct line access to those departments. All of the majors, and five of the regionals studied provided direct line access to their dispatch departments, or, as in the case of the regionals, their operations departments, for additional information.

What appears to be unique, at least to date, is a system being installed on a trial basis by one of the regional carriers, (Q). This consists of an additional CRT (cathode ray tube) in the cockpit of an aircraft, which will show the coverage of a NWS radar site, real time. (Initially this will be for one radar site near one of the carrier's busier terminals.) The signal will be tapped off the NWS radar and will be relayed to the aircraft via a FM signal. If the initial system proves successful, additional radar sites and FM relays will be added. The ultimate goal will be the capability for a crew to sit on an airport ramp, in their aircraft, and get a real-time radar representation of any area on their route of flight which is covered by NWS radar. Presently, the system is not expensive in relation to the amount of information available. The planned purchase cost is $8,000 per unit, with a charge, for air time, of $45 per month. If this system works out even half as well as projected, it could be a quantum leap forward in the ability of a crew to flight plan accurately.

In some regionals, such as (N) and (I), the main recourse to additional weather information is a telephone call to a FSS, or the weather briefing in USA TODAY. (And, if a remark made by the pilot of a major carrier to one of the study team members is accurate, some of the trunk carrier pilots profess

TABLE 3-2. WEATHER BRIEFING PROVIDED CREWS - ADDITIONAL SOURCES AVAILABLE PRIOR TO DEPARTURE AND EN ROUTE SOURCES AVAILABLE

	MAJORS										REGIONALS						
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
DIRECT LINE TO -																	
METEOROLOGY					X	X	X										
DISPATCH	X	X	X	X	X	X	X	X			X	X	X		X		
FSS OR AFSS	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
CHARTS OR REPORTS	X	X	X	X	X	X	X										X
RADAR COVERAGE (NOT AIRCRAFT)							X										
EN ROUTE SOURCES AVAILABLE																	
	MAJORS										REGIONALS						
ACARS		X				X	X										
ARINC	X	X	X		X	X	X	X			X	X	X				
PHONE PATCH TO -																	
METEOROLOGY					X		X										
DISPATCH		X	X	X		X	X	X			X	X	X				X
COMPANY RADIO				X								X	X		X		X
RADIO CALL TO FSS OR AFSS	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
METEOROLOGY DEPARTMENT		X			X	X	X										

to prefer USA TODAY as their primary source.) While the call to a FSS or AFSS is available to all, the pilots of the majors almost never utilize it, and many of the pilots of the regionals prefer to get their information elsewhere. Many of the regional pilots cite the inability to make timely telephone contact. Another common complaint arises when they can get through and encounter FSS personnel who appear not to know the job, or who show a lack of sensitivity to the needs of the air carrier pilot, or indicate a lack of tolerance with the requests for information. Many complaints from regional pilots and some from major carrier pilots were received regarding this dissatisfaction with the FSS and AFSS system.

3.3 SOURCES AVAILABLE FOR ADDITIONAL BRIEFING EN ROUTE

Once a flight for a Part 121 carrier has departed, any significant changes in route or destination weather should be reported to them by the dispatcher. This is mandated in FAR 121.601 (c), and is followed in some cases. There have been many instances, increasing in recent years, with dispatchers being required to handle more and more flights because of economic constraints, where this requirement has been overlooked. This was indicated in the questionnaires returned from the ALPA survey. In those instances, the crews are left to fend for themselves with regard to timely weather updates. Table Four, "... EN ROUTE SOURCES AVAILABLE," (see p. 27), shows that with five of the majors studied, the crew has the capability of initiating a phone patch with dispatch to receive weather updates. Of the other two, one provides a phone patch direct to the meteorology department. Some carriers, such as (B) and (F), utilize a ground to aircraft data link, such as ACARS, to send updates to the crews. Even with this capability, the dispatcher must put the information into the system before it can be of use to the crew. Others, such as (E), utilize the ARINC radio network to forward the information, and some carriers, such as (D), have their own radio network.

With the regional carriers, especially the wholly Part 135 operators, the usual recourse to additional weather information en route is a radio call to a FSS, or contact with the controller working the flight. Most small carriers have no radio network of their own. However, some regionals which are code sharers with major carriers, such as (Q), use the radio network of the major carrier for phone patches. In this particular case, the regional has a highly organized operations department which can provide additional information. Most regionals expressed a desire to have a radio network of their own for communications throughout their system, but were unable to have one due to economic constraints.

The higher tech solutions, such as ACARS, are utilized only by major carriers. Of the carriers studied, none of the regionals, and only four of the majors, used ACARS. Of the four majors utilizing it, only one, (B), had it installed on most of their fleet. They use it for automatic transmission of "Out-Off-On-In" times and for transmission of weather information in alphanumeric form. The others had it only on certain aircraft types. According to the carriers currently using ACARS, this system will be expanded to cover more aircraft, and to allow the capability to transmit additional data, including crude graphics representations. Other carriers expressed a strong interest in acquiring ACARS or a similar data link system. The software is also being

developed (see Section 3.1) to allow automatic weather data transmission from aircraft in flight which have a data link and INS (Inertial Navigation System). This would eliminate the human factor in pilot reports and would transmit data about three times per hour. With the database that could be amassed from having many aircraft use this type of system, it would be easy to analyze upper air fronts, jet streams, and temperature curves, and predict turbulence far more accurately than can be done today.

The low tech solutions, such as calling a FSS or an ATC controller to get weather information, will continue to be prevalent in the regionals because of economic constraints. The one notable exception is the company mentioned in Section 3.1 which is trying the CRT for NWS radar coverage in their aircraft. This innovation could have a far-reaching effect on all carriers transiting areas which have NWS weather radar coverage available, and is a good example of the emphasis some airlines continue to place on providing good weather information to their crews. The ability of a crew to adequately plan a flight depends not only upon the expertise and experience of the crew, but also upon the amount of information available to that crew. Those with small amounts of information available to them must depend more heavily on their expertise and experience to avoid potentially dangerous situations. Those with large amounts of information can better flight plan to avoid situations which might place them in potentially dangerous positions. From this, one could conclude that providing a large amount of current weather information to crews both before and after departure could lead to greater safety of flight.

The basic data given most crews from the airlines studied consisted of SAs, SPs, FTs, and NOTAMS for the stations of departure, destination, and alternate. Of the airlines studied, there are two which represent the opposite ends of the spectrum. One of the smaller regionals, (N), which pays $4,800 per year for computer weather from one of the major carriers, gives their crews SAs, and FTs for the stations of departure, destination, and alternate. One of the majors, (F), spends $161,600 per year, plus labor costs and the cost of some circuits. Yet they put out a more complete weather package than another of the majors, (B), which spends over $1,000,000 per year. They give their crews SAs, SPs, FTs, and field condition reports for the areas of departure, T/O alternate (if required), destination, and alternate; FAA and company NOTAMS for the stations of departure, T/O alternate, and the areas of destination, departure, and en route; SAs for the entire en route area; FDs and tropopause data; and, turbulence plots presenting SIGMET-type information and more. Another of the regionals, (Q), gives their crews the same information as the major in the above illustration, with

minor exceptions. They do not give field condition reports, nor do they provide SAs, SPs, FTs, and NOTAMS for the areas of destination, departure, and alternate, since, with their smaller route structure they feel that area forecasts for the stations and en route area suffice for that. Yet their annual cost is less than $16,000. This gives some indication of the lack of correlation between the amount of money spent in collecting weather information and the final product received by the crews for prerelease briefing. Although the regional mentioned obviously has to provide far fewer weather packages on a daily basis, the costs proportionally are disparate. Another point can be made from the above data. There is, again, only a limited relationship between the size of the carrier, whether they are Part 121 or Part 135, and the weather briefing package they give to their crews.

4. TRAINING OF AIRLINE CREWS IN WEATHER INFORMATION USE AND INTERPRETATION

The FARs on initial, transition, and upgrade training - FAR 121.419 (a) (iii) and 135.345 (a) (3) - are very specific. FAR 121.419 states "(a) Initial, transition, and upgrade ground training for pilots and flight engineers must include instruction in at least the following as applicable to their assigned duties: ...(iii) Enough meteorology to insure practical knowledge of weather phenomena, including the principles of frontal systems, icing, fog, thunderstorms, and high altitude weather situations;". FAR 135.345 (a) (3) has only one difference in the text, it speaks to high altitude weather "if appropriate." Recurrent training requirements are less specific. FAR 121.427 (b) (2) and FAR 135.351 (b) (2) both state that "Recurrent ground training for crewmembers must include at least the following: ... (2) Instruction as necessary in the subjects required for initial ground training...". The key words here are "as necessary." This would give the carriers some latitude in the depth to which they go in presenting the basics of weather in recurrent training.

As with other findings in this study, there is diversity in the training aspect. The program of note is that of one of the regional carriers, (K). All crewmembers receive one full day of weather training semiannually. One half of the day is spent in review of the basics of meteorology. The other half is spent in applying the basics to operational considerations, and in discussion of the "hot" topics of the day, such as microburst, wind shear, etc. This training is in addition to the training given in initial and upgrade training, and supplants the training that would normally be given at the time of recurrent. While they do not meet the letter of the regulation, this training would seem to prepare their pilots better for dealing with weather than those of most other carriers studied, including the major carriers. To require strict adherence to the regulation might disrupt what gives all appearances of being an outstanding program, meeting far more than the intent of the regulation.

Another notable program is that of one of the smaller regionals studied, (P). They initiated wind shear training and recovery techniques long before the subject became widely covered and highly publicized. Still another regional, (O), does a thorough job of training in a low tech manner. They use mostly stand-up training with instructor-student interaction, charts, and some videos. One of these videos is a taped PBS program on wind shear and microburst.

To get a clearer view of what training is accomplished among the various airlines studied, refer to Table 4-1, "TRAINING METHODS AND MATERIALS." Of the majors, (A) uses all means available, save computer-assisted training, and charts, to teach all

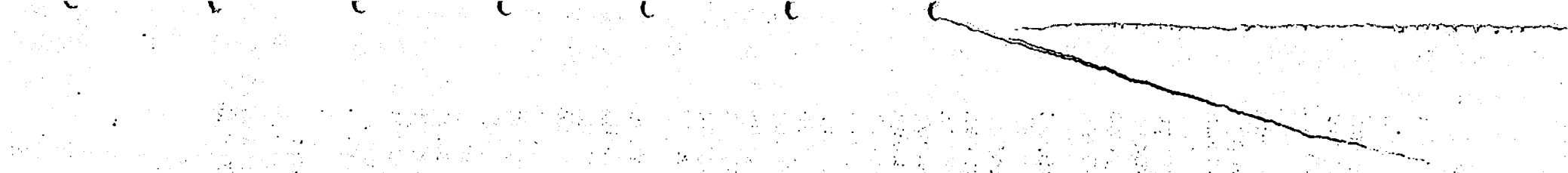

TABLE 4-1. TRAINING METHODS AND MATERIALS

NOTE: I = INITIAL TRAINING, R = RECURRENT TRAINING, U = UPGRADE TRAINING

MAJORS

	A			B			C			D			E			F			G		
	I	R	U	I	R	U	I	R	U	I	R	U	I	R	U	I	R	U	I	R	U
METHODS AND MATERIALS																					
STAND-UP	X	X	X				X									X	X				
CHARTS																					
SLIDES	X	X	X													X	X				
TRANSPARENCIES	X	X	X																		
VIDEOTAPES	X	X	X	X	X			X	X	X			X	X	X	X	X	X		X	
FAA/BOEING VIDEO	X	X	X																		
COMPUTER-ASSISTED TRAINING																			X	X	X
OPERATIONS BULLETINS		X			X	X					X						X			X	
TIME ALLOTTED																					
1/2 HOUR OR LESS							X	X													
1/2 TO ONE HOUR														X	X						
ONE TO TWO HOURS			X	X					X	X						X					
OVER TWO HOURS	X	X											X								
VARIES WITH STUDENT OR PROGRAM					X	X					X						X	X	X	X	X
SUBJECTS COVERED																					
THEORY OF METEOROLOGY	X	X	X	X				X		X	X		X	X	X	X			X	X	X
WEATHER REPORT INTERPRETATION	X	X	X	X					X				X	X	X				X	X	X
GRAPHIC CHART INTERPRETATION	X	X	X	X									X	X	X				X	X	X
WIND SHEAR	X	X	X	X	X	X		X	X		X		X	X	X	X	X		X	X	X
SUMMER/WINTER DIFFERENCES	X	X	X	X	X	X					X		X	X	X		X		X	X	X
MOUNTAIN WAVES	X	X	X										X	X	X	X					
CLEAR AIR TURBULENCE	X	X	X	X									X	X	X	X			X	X	X
JET STREAM	X	X	X	X							X		X	X	X	X			X	X	X
HIGH-LEVEL WIND SHEAR	X	X	X	X									X	X	X	X			X	X	X
AIRBORNE WEATHER RADAR USE	X	X	X	X					X		X		X	X	X	X			X	X	X
THUNDERSTORM AVOIDANCE	X	X	X	X					X		X		X	X	X	X	X		X	X	X
CAT II OR CAT III	X	X	X										X	X	X						
OPERATIONAL CONSIDERATIONS	X	X	X	X	X		X			X	X		X	X	X	X	X	X	X	X	X
TESTING																					
GIVEN (YES OR NO)	YES	YES	YES	YES	YES	YES	NO	NO	NO	NO	YES		YES	YES	YES	YES	NO	NO	YES	YES	YES
WRITTEN (YES OR NO)	YES	YES	YES	NO	NO	NO	NO	NO	NO	NO	YES		YES	YES	YES	YES	NO	NO	NO	YES	NO

REGIONALS

	H			I			J			K			L			M			N			O			P			Q		
	I	R	U	I	R	U	I	R	U	I	R	U	I	R	U	I	R	U	I	R	U	I	R	U	I	R	U	I	R	U
METHODS AND MATERIALS																														
STAND-UP	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	?	?	?	X	X	X	X	X	X	X	X	X
CHARTS											X		X	X	X	X		X	?	?	?	X	X	X	X	X	X	X	X	
SLIDES	X	X	X										X	X	X	X	X	X	?	?	?									
TRANSPARENCIES	X	X	X													X		X												
VIDEOTAPES	X	X	X				X	X	X				X	X	X	X	X	X				X	X	X				X	X	
FAA/BOEING VIDEO						X										X	X	X												
COMPUTER-ASSISTED TRAINING																														
OPERATIONS BULLETINS														X												X				
TIME ALLOTTED																														
1/2 HOUR OR LESS					X																									
1/2 TO ONE HOUR				X		X				X		X																		
ONE TO TWO HOURS		X					X										X		?	?	?		X	X	X					
OVER TWO HOURS	X		X								X		X	X		X		X				X						X	X	
VARIES WITH STUDENT OR PROGRAM								X	X						X											X	X			X
SUBJECTS COVERED																														
THEORY OF METEOROLOGY	X	X	X	X	X	X				X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	
WEATHER REPORT INTERPRETATION	X	X	X										X			X	X	X				X						X	X	
GRAPHIC CHART INTERPRETATION	X	X	X										X			X	X	X										X	X	
WIND SHEAR	X	X	X			X	X	X	X		X		X	X	X	X	X	X				X	X	X	X	X	X	X	X	
SUMMER/WINTER DIFFERENCES	X	X	X				X	X	X		X		X	X	X	X	X	X				X	X	X	X	X	X	X	X	
MOUNTAIN WAVES	X	X	X								X					X	X	X				X	X	X				X	X	
CLEAR AIR TURBULENCE	X	X	X								X		X			X	X	X				X	X	X						
JET STREAM			X										X			X	X	X												
HIGH-LEVEL WIND SHEAR			X										X			X	X	X												
AIRBORNE WEATHER RADAR USE	X	X	X				X	X	X		X		X		X	X	X	X				X	X	X				X	X	
THUNDERSTORM AVOIDANCE	X	X	X								X		X	X	X	X	X	X	X	X	X	X	X	X				X	X	
CAT II OR CAT III																														
OPERATIONAL CONSIDERATIONS	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
TESTING																														
GIVEN (YES OR NO)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	YES	NO	YES	YES	YES	YES	YES	YES	?	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	NO
WRITTEN (YES OR NO)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	YES	NO	YES	YES	YES	YES	YES	YES	?	YES	YES	YES	YES	YES	NO	NO	NO	YES	YES	NO

training - initial, recurrent, and upgrade. Another major carrier, (G), uses computer-assisted training for the majority of their training. Rather than teaching weather on a classroom basis, students use the computer training individually and can pace themselves as desired. Also included in this are questions which, if answered incorrectly, return the student for more study prior to further quizzing. With another of the majors, carrier (D), the subject of weather is not addressed in upgrade training. The regionals, on the other hand, address weather training in some form or another in all training - initial, recurrent, and upgrade. One regional, (M), sends their pilots, upgrading to Captain, back through training with a new hire class, for a complete review of weather training. They see this not as demeaning, but rather as providing the sharpening of skills needed for upgrading.

Table Five also shows that the range of subjects covered in training varies considerably among the carriers studied. For example, of the majors, (A), (E), and (G) cover a wide range of subjects in initial, recurrent, and upgrade training. They all teach theory of meteorology, weather report interpretation, graphic chart interpretation, wind shear, summer/winter differences, clear air turbulence, jet stream, high-level wind shear, airborne weather radar use, thunderstorm avoidance, and operational considerations. Carriers (A) and (E) also train in Cat II and III approach procedures, and mountain waves. Carriers (B) and (F) cover nearly the same in initial training, but the number of subjects covered in recurrent and upgrade training is far less. Among the regionals, carriers (H) and (M) provide training in a wide range of subjects in initial, recurrent, and upgrade training. (M) covers the same subjects as (A), (E) and (G), but does not teach Cat II or Cat III approach procedures, because they are not qualified to make that type of approach. Carrier (H) covers the same range of subjects, but only teaches jet stream and high-level wind shear when a pilot is upgrading to their jet equipment. Carrier (Q) covers the same subjects in initial and recurrent training, but doesn't address them in upgrade training. Many of the regionals cover the theory of meteorology only in relation to the performance of the aircraft, and not from the standpoint of what variable weather might be encountered in daily operations. Some of the major carriers are very skimpy on weather-related training of all kinds. One carrier, (D), uses occasional operations bulletins, and videotapes copied from training films they were using 25 years ago, that were old at that time. Another major carrier, (C), stated that they gave slight training, "no more, no less, than any other carrier." The results of the study showed that they gave considerably less training than many of the airlines, including the regionals.

The subject of training in weather-related subjects is covered clearly in the regulations regarding initial, transition, and upgrade training. The regulations on recurrent, as mentioned before, are not quite as specific, for either Part 121 or Part 135 carriers. The study determined that compliance with the regulations is not uniform, and, in some cases, is nonexistent. Carrier (D), as an example, provides brief instruction on theory of meteorology and operational considerations in initial training. They give no weather training at all at the time of upgrade. Carrier (C) teaches less than one-half hour of operational considerations in initial training. In recurrent they spend one half-hour, or less, instructing in theory of meteorology, and wind shear. Yet, carrier (M), a regional, teaches a full spectrum of subjects and spends much more time teaching them. This data, and the remainder of the data shown in Table Five, indicates again that there is little relationship between the size of the airline and the product that they produce. In the case of training, some of the regionals provide much more than some of the majors. The lack of training in some cases shows a departure from the regulations that should be addressed.

5. RESULTS OF ALPA SURVEY

The survey of pilots, undertaken by ALPA, provides a somewhat different view than the study conducted with the airlines. About 140 questionnaires were sent out to Central Air Safety committee chairmen, Local Air Safety committee chairmen, and members of interested committees. Twenty-eight were returned. While 52 percent of the returns were not identifiable by airline, some respondents mentioned the name of the airline, and some of the returns were identifiable in other ways. Of the identifiable returns, most could be identified as working for a major carrier. Although the response sampling is small, the attitudes displayed could be considered representative of the industry, since they are from regionals, major carriers, freight, and passenger carriers.

The responses confirmed a condition mentioned earlier in the report, dealing with FAR 121.601 (c), which mandates that the dispatcher must inform a flight of any significant weather changes along the route of flight. As was pointed out in Section 3.3, this FAR is not closely followed. The ALPA survey results indicated that although some airlines do require close adherence to this policy, with the majority, compliance was either lacking in large part, or missing altogether.

The portion of the survey returns which dealt with training included some interesting points. One of the respondents, from an airline not studied, would like to exchange his company's stand-up training for computer-assisted training. He feels that it would provide him with more complete knowledge. In rebuttal were the responses from four pilots for a major airline which uses computer-assisted training, almost exclusively. The study included the airline with the computer-assisted training, and the airline demonstrated it proudly, and lauded its success. The pilot respondents in the ALPA survey, from that company, disagreed. They felt that a return to an instructor-student dialogue, with more detail being taught, would produce far better knowledge of weather and how to deal with it. One of these respondents mentioned the difference in his initial training of many years ago, and the present program. That initial training encompassed 6 months, and the weather training alone took 20 hours or more. The overall training time today is about 2 months, and the time spent on weather varies with the student, since they are using computer-assisted training. The average time spent on weather, under the current program, is less than 4 hours. The difference in time spent teaching weather, alone, cannot provide for a thorough knowledge of the subject, in his opinion. He felt that it is not possible to cram a 20-hour course into 4 hours, or less, and still present the material in such a way as to promote thorough understanding. He also felt that this reduction of knowledge, in recently hired pilots, contributed to a reduced ability to safely plan flights. He

attributed this change in training emphasis to deregulation, and its economic effect on the airlines. Other respondents agreed.

Other comments on training were indicative of the state of the industry, with regard to weather. One respondent, unidentifiable, was very pleased with most aspects of initial, recurrent, and upgrade training, but felt that more emphasis should be placed on training for severe weather. Another response, from the pilot of a major airline with a good industry reputation, which we did not study, was just the opposite. He told of no initial training in weather, no upgrade training in weather, and almost no recurrent training in the same subject. The majority of the responses fell somewhere between. Most felt that weather training, in general, was lacking in depth, and did not provide sufficient knowledge to deal with weather, either from a preflight ability to anticipate and plan around it, or from the inflight ability to deal with it. This feeling is supported, in part, by the tragic takeoff accident at Washington National Airport a few years ago, where a DC9 never achieved proper rotation speed, and crashed into the 14th Street bridge. One of the major factors in that was the lack of knowledge, on the part of the crew, of the effects of icing on a swept wing airplane, and the effects of icing on jet engines and their instrumentation. Many respondents felt the lack of knowledge was being perpetuated by inadequate training.

The ALPA survey also dealt with the weather information received by, and available to, crews. One comment echoed by half of the respondents was that they want more graphic depictions of weather available, and in all stations, not just the hubs. The lack of graphics, in general, is indicated by the data in Table Four - "ADDITIONAL SOURCES AVAILABLE PRIOR TO DEPARTURE," (see p. 27). Of the regionals, only (Q) has graphic charts available to their crews. All of the majors indicated that they had them available; however, by their own admission, this was normally only in the hubs. Almost all those responding to the ALPA survey stated that the weather information available in smaller, downline stations was far less than what was available at the hubs. Three indicated that they felt downline-station weather information was not adequate for proper flight planning.

Another comment voiced by a few was the desire to see plain language weather reports. This was also tied in with a desire to at least standardize reports so that international crews were not faced with shifting from U.S. formats, to ICAO formats, to the formats used by some of the other countries which might be serviced, in order to eliminate confusion and error.

One sector of the industry not examined for this study was the nonscheduled airlines. One of the respondents in the ALPA survey flies for a major, worldwide, cargo carrier. With this carrier he has been furloughed at times, for a total of about 16 years of

furlough time. During those periods he flew for the nonscheds. His comments indicate that the nonsched segment of the industry is one that should be more closely regulated; in this case, regarding weather information provided to their crews. He indicated that perhaps one or two companies provided decent weather support, but the great majority were lacking in this respect. And, that accurate weather information was almost impossible to get, in flights outside the coterminous U.S. He was not specific in what was lacking, but his comments indicated a definite lack of information with most of the nonscheds he worked for. He did mention the names of Tower, Arrow, Evergreen, Ryan, and Interstate as some who shared this problem.

Of the respondents, about half felt that access to real-time weather information, such as Kavouras' RADAC, or the Alden equivalent, would be more useful than some of the information they currently receive, such as general area forecasts. The lack of real-time information is decried by all.

Of particular interest in the responses to the ALPA survey were the comments on the general state of the industry, and some companies, in particular, as far as weather is concerned. Some of these comments follow, and are given as received.

> "I feel fortunate to fly for an airline that provides all the weather information the pilot needs and wants as opposed to the guys who rely on the back page of USA TODAY."
>
> "I would like the FAA to raise the standards of all carriers to a high level. This must be mandated. I know UAL and AAL will do an outstanding job. It's the peripheral carriers I worry about."
>
> "I'd like to see high standards required by FAA for all carriers. T----'s weather situation is excellent. But in 16 years of furloughs I've seen some pretty pathetic attempts to save money. The worst situation is flying out of the country for nonscheduled carriers. You're basically on your own out there."
>
> "Companies should be required to have their own meteorology departments with adequate staffing for personalized weather briefings."
>
> To improve weather information - "Put in a VCR and latest edition of PBS AM weather or put on the weather channel for viewing in Ops."

"It seems to me that the most authoritative source of weather info today is the weather channel on cable TV. Most pilots I speak with watch it if possible before a flight. Every dispatch office and pilot crew room ought to have a cable capable TV set tuned in to the weather channel."

"I would like to see a standard developed by the experts for use by all air carrier pilots. A package that is not overblown, but is comprehensive and tells us what we need to know for each leg."

All of these are valid comments and worthy of scrutiny. The fact that not all of them are in full accord only serves to point up the variant state of the industry. However, most of them indicate a belief that something is lacking in the weather training and information provided crews. Most of the respondents seem to feel that more training and information should be forthcoming to better enable proper flight planning, and enhance the safety of flight. Another belief expressed by most respondents is that the quality and amount of both training, and weather information provided, have diminished since deregulation.

6. RECOMMENDATIONS

During the course of this study many comments were received regarding standardization. These, and the conclusions of the study team, have led TSC to recommend that the FAA consider the following actions:

6.1 For overall stability in the industry, that the FAA establish a national standard, regarding weather information and training, for all POIs and FAA inspection teams to follow. The regional airlines studied had numerous comments concerning standardization, and some of the majors echoed them. The current method of local, or regional, autonomy produces many different answers to the same question, and is most apparent when an airline has a change of POI, or an inspection. The lack of standardization leads to confusion within the carriers - especially the regionals.

6.2 Apply any action forthcoming as a result of this report to the entire industry, including the nonscheds. Differences in operational requirements must be considered, but the need to provide current and complete weather information industry-wide must be met. A regional with a small route structure will not need some of the things required of a major with a world-wide route structure. Examples of this would be high-level winds aloft, an en route area forecast encompassing hundreds of miles, and tropopause data. However, the same need will be there for adequate, standardized training and sufficient weather information for proper prerelease briefing.

6.3 Resolve the ambiguity concerning the use of the weather vendor customized services. FAR 121.101 states, in part, "(b) Except as provided in paragraph (d) of this section, no domestic or flag air carrier may use any weather report to control flight unless - (1) For operations within the 48 contiguous States and the District of Columbia, it was prepared by the U.S. National Weather Service or a source approved by the U.S. National Weather Service; or (2) for operations conducted outside the 48 contiguous States and the District of Columbia, it was prepared by a source approved by the Administrator." FAR 135.213 states, in part, "(a) Whenever a person operating an aircraft under this part is required to use a weather report or forecast, that person shall use that of the U.S. National Weather Service, a source approved by the U.S. National Weather Service, or a source approved by the Administrator. However, for operations under VFR, the pilot in command may, if such a report is not available, use weather information based on that pilot's own observations or on those of other persons competent to supply appropriate observations." Some carriers, seeing these regulations, are concerned that if they use customized

services, such as tailored station forecasts, they will get in trouble with their POIs or be gigged by an inspection team. That has, in fact, happened. Some airlines use these customized services with impunity. Others have had trouble and are leery of using them, even though they could be beneficial operationally. This gray area should be clarified, and could be incorporated in the recommendation in 6.1.

6.4 Specify an irreducible core curriculum for initial training. This should present a minimum amount of data on all the weather phenomena that might be encountered in the daily operations of an air carrier. It is also recommended that there be a thorough review of that information, for all crewmembers, on an annual recurrent basis, and that any recent new information be included. Since disregard for the FARs regarding training is rampant, this should result in the upgrading of those airlines currently below standard, and yet would allow for innovation on the part of those airlines currently giving more than is required. This should obviate the need for additional review in a transition or upgrade situation. It will also assure that the material is being covered, and yet may avoid too much repetition and the resulting boredom and lack of interest. This should not be subject to modification or reduction by local POI review.

6.5 Insure that the amount of weather available in downline stations is the same as that available in the hubs. There are many trip sequences that lay over in small cities and originate there the following day. For them to have less weather information for flight planning for the day than the originators at the hubs doesn't make sense. The current means of providing weather in most smaller stations puts less importance on the flights originating at those points, and in so doing diminishes their optimum opportunity for safe flight planning.

6.6 Develop a very specific requirement for the minimum amount of weather to be issued for flight planning. This should include, but not be limited to, SAs, SPs (if applicable), and FTs for the areas of departure, takeoff alternate (if required), destination, and alternate; FDs for the filed route of flight and at least one alternate route; FAs for all areas within 100 miles of the projected route; SAs and FTs for most of the stations within 100 miles of the projected route of flight (this to give some indication of frontal movements and other trends); and SIGMETS, AIRMETS, and PIREPS for the route of flight. It is also recommended that some graphics be made available - the graphics most requested are radar summaries. Size of route structure would dictate scaling down some of the recommendations to fit the needs of the regionals. For them, as an example, a forecast

covering their route structure would suffice, rather than FAs for all areas within 100 miles of the projected route. Another consideration, with the regional carriers, is the sources of weather available to them in some of the very small stations they serve. In many cases, the only thing available is a phone call to a FSS or an AFSS. From comments made by many of the regionals studied, this ranges from less than satisfactory to unsatisfactory. If some means of restructuring the FSS/AFSS system is not available, perhaps it should become a requirement for a city desiring airline service to put in an AWOS, and the airline to certify its local personnel to operate a SAWRS. Although this would be a costly procedure, it would certainly be less costly than an accident caused by the lack of proper information for flight planning. Another suggestion made would be to have air carrier specialists in the FSS/AFSSs. This solution would also have to address the basic problem mentioned earlier of apparent lack of interest, or tolerance, on the part of FSS/AFSS personnel.

APPENDIX A

Questionnaires used for airline study and for ALPA survey

CARRIER QUESTIONNAIRE

CHECKLIST:

1. Which of the following sources of weather information do you utilize?
   - 1.1 WSI _____
   - 1.2 Kavouras _____
   - 1.3 ARINC _____
   - 1.4 Lockheed Met Plan _____
   - 1.5 Alden _____
   - 1.6 UPI _____
   - 1.7 TAFS _____
   - 1.8 METARS _____
   - 1.9 NWS _____
   - 1.10 Pan Am Weather Systems _____
   - 1.11 Others _____

2. Of the vendors you use, which services do you subscribe to?
   - 2.1 Hourly sequence reports _____
   - 2.2 Station forecasts _____
   - 2.2.1 Length of forecast _____
   - 2.3 Area forecasts _____
   - 2.3.1 Length of forecast _____
   - 2.4 DIFAX or NAFAX _____
   - 2.5 Winds aloft _____
   - 2.6 SIGMETS and AIRMETS _____
   - 2.7 Others _____

3. What is the cost for services utilized?

4. If money were not a constraint, would you utilize other or more services, and, if so, which ones and why?

5. Are the following provided to flight crews with flight departure papers as SOP?
   - 5.1 Route and area forecasts _____
   - 5.2 Hourly sequence reports for area of departure, destination, and alternate _____ OR
   - 5.3 Hourly sequence reports for only specific stations of departure, destination, and alternate _____

5.4 SIGMETS and AIRMETS _____
5.5 Radar plots _____

6. If these are not provided with the flight departure papers, how do the crews generate the necessary weather?

7. If the Captain wants amplification of the weather provided him, which of the following sources are available to him?
7.1 Direct phone to company meteorology department _____
7.2 Direct phone to dispatch _____
7.3 Radar plots _____
7.4 Other _____

8. Are all the services mentioned above available to crews at all stations, or just at hubs and crew bases?

9. Once a flight has departed, is the dispatcher responsible for tracking significant changes in en route and destination weather and relaying them to the Captain?
9.1 What is the dispatcher's source of weather?

10. If the Captain wants weather updates en route, which of the following sources does he have available?
10.1 Phone patch to dispatch _____
10.2 ACARS _____
10.3 ARINC _____
10.4 Others _____

11. Which of these sources do you recommend be used and is this basically on a cost consideration?

12. Is there a difference in SOP on weather gathering and dissemination between the International and Domestic Divisions? (If this division exists.)

13. Crew training ...
13.1 Do you assume a new hire pilot is well versed in the use of weather information, or do they go through the basics in initial training?
13.2 What review is given in recurrent training?

13.2.1 Subject matter? _____

_____

_____

_____

13.2.2 Time allotted? _____

13.2.3 Method of training? _____

_____

_____

13.2.4 What testing is given to determine competence?

_____

_____

13.3 What review is given in upgrade training?

13.3.1 Subject matter? _____

_____

_____

_____

13.3.2 Time allotted? _____

13.3.3 Method of training? _____

_____

_____

13.3.4 What testing is given to determine competence?

_____

_____

13.4 What sort of additional training, if any, is given to crews flying routes to;

13.4.1 West Coast:

13.4.1.1 Rocky Mountains _____

13.4.1.2 Sierra Nevadas _____

13.4.1.3 Anchorage _____

13.4.2 Caribbean _____

13.4.3 Europe _____

13.4.4 Pacific _____

13.4.5 Other _____

13.5 Is there a program of annual review of seasonal reminders for winter and summer?

13.5.1 What does it consist of? _____

_____

_____

13.6 Is training given in high altitude meteorology such as mountain wave, clear air turbulence, etc.?

13.6.1 What does it consist of? _____

_____

_____

13.7 Would it be possible to get copies of the syllabus and materials for training on weather and seasonal reviews?

CREW QUESTIONNAIRE

1. Weather Training...

1.1 In **initial** training, did you find that a reasonable percentage of the training dealt with the use of weather information?

1.1.1 What type of training was utilized?
- 1.1.1.1 Lecture? _____
- 1.1.1.2 Computer-assisted instructions? _____
- 1.1.1.3 Videotapes? _____
- 1.1.1.4 Home study? _____

1.1.2 How much time was spent on each area?
- 1.1.2.1 Lecture? _____
- 1.1.2.2 Computer-assisted instructions? _____
- 1.1.2.3 Videotapes? _____
- 1.1.2.4 Home study? _____

1.1.3 Did you feel it just repeated information previously learned, or did you feel it was worthwhile?

1.1.4 If it covered information new to you, did you feel that the coverage was sufficient?

1.1.5 Did the training cover frontal systems _____, hourly sequence report and station forecast interpretation ____, winds aloft ____, different weather formats that might be encountered in flying outside the Continental U.S. ____, others? _____ _____

1.1.6 What changes do you think should be made?
- 1.1.6.1 What should be reduced? _____
_____
- 1.1.6.2 What should be increased? _____
_____

1.2 In **recurrent** training, what sort of review of weather is included?

1.2.1 What type of training was utilized?
- 1.2.1.1 Lecture? _____
- 1.2.1.2 Computer-assisted instructions? _____

1.2.1.3 Videotapes? _____
1.2.1.4 Home study? _____

1.2.2 How much time was spent on each area?
1.2.2.1 Lecture? _____
1.2.2.2 Computer-assisted instructions? _____
1.2.2.3 Videotapes? _____
1.2.2.4 Home study? _____

1.2.3 Did you feel it just repeated information previously learned, or did you feel it was worthwhile?

1.2.4 If it covered information new to you, did you feel that the coverage was sufficient?

1.2.5 Did the training cover frontal systems _____, hourly sequence report and station forecast interpretation ____, winds aloft ____, different weather formats that might be encountered in flying outside the Continental U.S. ____, others? _____ _____

1.2.6 What changes do you think should be made?
1.2.6.1 What should be reduced? _____
_____

1.2.6.2 What should be increased? _____
_____

1.3 If you start flying, or the company acquires, new routes which have significant weather pattern differences from routes previously flown, do you receive differences training for the new areas flown?

1.4 In upgrade training, is there a complete review of weather phenomena and the interpretation of weather information?

1.4.1 Do you feel this provides you with sufficient knowledge to properly plan and operate a flight?

1.4.2 If you don't feel that way, what would you like to see included in the training?

1.5 Is your knowledge of weather ever tested in a classroom situation, as opposed to an on-the-line situation?

2. Operational weather use...

2.1 To get weather for flight planning, do you:

2.1.1 Receive it with flight departure papers generated by station personnel?

2.1.2 Pull it up yourself from a computer?

2.1.3 Other? (Specify)_____
_____
_____

2.2 Which of the following do you receive with your flight departure papers:

2.2.1 Hourly sequence reports for the area of departure, destination(s) and alternate(s) ____, OR
for only the stations of departure, destination(s), and alternate(s)? _____

2.2.2 Terminal forecasts?

2.2.3 Area and route forecasts?

2.2.4 SIGMETS and AIRMETS?

2.2.5 Radar summary charts?

2.2.6 Domestic surface analysis charts?

2.2.7 Forecast charts?

2.2.8 Other graphic products?

2.2.9 TAFS or METARS (Int'l. Flts.)?

2.2.10 Others? _____
_____

2.3 Does this information differ for different stage lengths? (i.e., 150 - 300 NM, greater than 300 NM.) Please include a copy of weather packages for both short haul and long haul if you can.

2.4 If the above are not included in your departure papers package, is it because the company is trying to save money, or some other reason of which you are aware?

2.5 Of the above, do you utilize all of them in flight planning, and, if not, which ones do you not use, and why?

_____

_____

_____

2.6 Are there other things you would like to see included in the weather information that you receive with flight departure papers?

_____

_____

_____

2.7 If you want more information, which of the following sources are available:

2.7.1 Direct phone line to company weather department?

2.7.2 Direct phone line to dispatch?

2.7.3 More information available through the computer that you can pull up?

2.7.4 Phone to Flight Service Station?

2.7.5 Other (Specify)? _____

_____

2.8 If there are any significant changes in the route or destination weather while you are en route, does the company contact you?

2.8.1 If so, do they contact you in sufficient time to let you make a proper decision whether to press on or divert?

2.9 If you want weather updates en route, which of the following sources are available to you:

2.9.1 ARINC?____

2.9.2 Phone patch to dispatch? ____

2.9.3 Radio call to Flight Service Station? ____

2.9.4 Company radio network? ____

2.9.5 ACARS? ____

2.9.6 Other? _____
_____

3. What recommendations would you make to improve the weather information you receive for flight planning?

4. What recommendations would you make to improve the training you receive in the use of weather information?

GLOSSARY

ACARS	ARINC Communications Addressing and Reporting System
AFSS	Automated Flight Service Station
AIRMET	Airman's meteorological information; an in-flight advisory forecast of conditions possibly hazardous to light aircraft or inexperienced pilots
ALPA	Air Line Pilots Association
AMOS	Automatic Meteorological Observing Station
ARINC	Aeronautical Radio, Inc.
ATC	Air Traffic Control
AWOS	Automated Weather Observing Systems
CAT	Clear Air Turbulence
CWA	Center Weather Advisory
FA	Area Forecast
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulations
FBO	Fixed Base Operator
FD	Winds and temperatures aloft forecast
FSS	Flight Service Station
FT	Terminal Forecast
ICAO	International Civil Aviation Organization
LAWRS	Limited Aviation Weather Reporting Station - usually a control tower
METAR	Surface aviation weather report, in ICAO format, for other than U.S. stations
NMC	National Meteorological Center
NOTAM	Notice to Airmen
NWS	National Weather Service, National Oceanic and Atmospheric Administration, Department of Commerce

PATWAS	Pilots' Automatic Telephone Weather Answering Service, a self-briefing service
PIREP	Pilot report (also UA)
SA	Surface aviation weather report
SP	Surface aviation weather report at other than the normal time of observation, denoting a significant change in conditions
SAWRS	Supplemental Aviation Weather Reporting Station, usually an airline office at a terminal not having NWS or FAA facilities
SIGMET	Significant Meteorological Information; an in-flight advisory forecast of weather hazardous to all aircraft
TAF	Terminal aviation forecast in ICAO format
UA	Pilot report (also PIREP)