"OVERVIEW OF FAA'S AIRCRAFT ICING PROGRAM"

Loni Czekalski

The Aircraft Icing Accident Summary (Figure 1) shows statistics which were taken from National Transportation Safety Board (NTSB) records and the FAA's Accident Incident Data (AID) system. If you look at the number of accidents over about the last five and one-half years, from January 1978 to June 1983, you will find that there were 280 accidents which resulted in 364 fatalities and 171 injuries. The accident injury-to-fatality ratio is about 2 to 1. It is said that if you are involved in an icing accident, you probably will not walk away from it. It is a very serious accident in which to be involved.

1978 THROUGH JUNE 1983:

	FATALITIES	INJURIES	ACCIDENTS	INCIDENTS
TRANSPORT (121)	99	5	6	10
COMMUTER (135)	19	23	30	11
GENERAL AVIATION (91)	184	95	181	63
ROTOR	(1)	(5)	(8)	(1)
OTHER/UNKNOWN	62	48	63	2
TOTALS:	364	171	280	86
AVERAGE PER YEAR:	66	31	51	16

Figure 1. Aircraft Icing Accident Summary

In a breakdown of the statistics (Figure 2), we find that 35 accidents occurred in super-cooled clouds; 31 in freezing rain and drizzle; and 39 in snow. When the FAA regulates that you must be certified for flight in known icing conditions, this certification actually certifies only for flight in super-cooled clouds. This information tells us that we have almost as many accidents in freezing rain and drizzle as in super-cooled clouds, with even a larger amount of accidents in snow.

BY WEATHER:

CLIMB/CRUISE/DESCENT/APPROACH PHASES ONLY

WEATHER BRIEFING:	ADEQUATE	116
	INADEQUATE	55
	NONE	4
	UNREPORTED	7
SUPER-COOLED CLOUD		35
FREEZING RAIN/DRIZZLE		31
SNOW		39
OTHER/UNKNOWN		77

Figure 2. Weather Statistics of Aircraft Icing Accident Summary

Although we do not set a criteria, our regulations tell you that you must be able to fly in both falling and blowing snow. Figure 3 outlines the current regulations relative to the certification of both small and large aircraft for ice protection. Both FAR 23 and 25 reference the FAR 25 Appendix C; but only FAR 25, which is for the large transport category aircraft, references the falling and blowing snow.

In talking to the aviation community, we have learned some very interesting things (Figure 4). As your initial operating costs have increased, the buying of aircraft has become more expensive. The operating costs to maintain that fleet, because of the increase in labor and fuel costs, have created more and more concern about fleet productivity.

SMALL AIRCRAFT:

23.1093 INDUCTION SYSTEM ICING PROTECTION

23.1419 ICE PROTECTION
RE: FAR 25 APPENDIX C

TRANSPORT AIRCRAFT:

25.1093 INDUCTION SYSTEM DE-ICING & ANTI-ICING PROVISION
RE: FAR 25 APPENDIX C
RE: SNOW BOTH FALLING & BLOWING

25.1403 WING ICING DETECTION LIGHTS

25.1416 PNEUMATIC DE-ICER BOOT SYSTEM

25.1419 ICE PROTECTION
RE: FAR 25 APPENDIX C

Figure 3. Current Airworthiness Standards

- FLEET PRODUCTIVITY
  ALL-WEATHER OR NEAR ALL-WEATHER OPERATIONS
- CERTIFICATION PROCESS
  LENGTH & COST
- ROTORCRAFT CERTIFICATION
  S-76
  PUMA/SUPER PUMA
  412/214ST
- GA AIRCRAFT
  LOW-COST, LIGHTWEIGHT ICE PROTECTION SYSTEMS
- FAR 25 APPENDIX C

Figure 4. Aviation Community Concerns

People in the avition community have told us they want all-weather or near all-weather operating conditions. The manufacturers have told us they are concerned that the length and the cost of the FAA certification process is too great.

To date, unfortunately, we have not certified any helicopters for flight in known icing conditions. The French have certified the Puma. The manufacturer for the Puma Aerospeciale has come to the United States and asked us for certification for both the Puma and the Super Puma. Bell Helicopter has started flight testing for the 412 and 214ST and intends to get an icing certification for it, as does Sakorsky for the S76. General aviation aircraft is by far the largest and most rapidly growing segment of the aviation community. They have informed us that they need low-cost, lightweight, easy-to-maintain, low-power systems for their aircraft in order for them to fly efficiently. Manufacturers have also told us some interesting things about FAR 25 Appendix C. This is a very stringent requirement. They would like to see if we could possibly relax that and give them a little relief. These are the aviation community needs. The flip side of this coin is what the FAA needs.

As noted in Figure 5, the FAA needs several different things in order to do its job efficiently. One of the things we need to do is characterize the icing atmosphere, as well as to learn things about aircraft performance in known icing conditions. As a special interest, we also want to take into consideration rotocraft needs. We would like to learn things about the use of thick fluids for deicing as is currently being done in Europe. Our program will also consider analytic methods to be applied in certain circumstances for certification. We also say that you can use simulation; but we really don't set any guidelines, standards, or procedures for you to follow which are acceptable to us. After we have done all these things, we need to update our standards, procedures and FARs for all of the above; i.e., rotocraft, turbine engines, and aircraft with fixed wings.

- CHARACTERIZATIONS
  - ATMOSPHERE
  - AIRCRAFT PERFORMANCE WITH SNOW/ICE ACCUMULATIONS
  - ROTORCRAFT PERFORMANCE WITH ICE ACCUMULATIONS
  - EFFECTS OF UNDER-WING FROST
  - AIRFOIL PARAMETERS SENSITIVE TO SURFACE ROUGHNESS
  - HIGHLY VISCOUS DE-ICING FLUIDS
- ANALYTICAL METHODS
  - DESIGN AND COMPLIANCE DEMONSTRATION
- SIMULATION
  - ADEQUACY OF ICE TEST FACILITIES
  - USE OF SIMULATION TECHNOLOGY
- UPDATED CERTIFICATION CRITERIA INCLUDING STANDARDS AND TEST PROCEDURES FOR:
  - ROTORCRAFT
  - TURBINE ENGINES
  - AIRCRAFT

Figure 5. Federal Aviation Administration Needs

Figure 6 summarizes the recent history of the FAA Aircraft Icing Program.

2-3-83	FAA ADMINISTRATOR BRIEFING ON ATMOSPHERIC CHARACTERIZATION & LONG-RANGE PLAN.
4-21-83	AVIATION STANDARDS & REGIONAL CERTIFICATION DIRECTORATES MEETING TO REVIEW PROGRAM PLAN.
7-28-83	FAA ADMINISTRATOR BRIEFED ON ACTIVITIES CURRENTLY GOING ON IN GOVERNMENT-RELATED AIRCRAFT ICING PLAN.
9-20/22-83	NATIONAL ICING RESOURCE SPECIALISTS AND REGIONAL CERTIFICATION DIRECTORATES REVIEW REQUIREMENTS AND PRIORITIES FOR PROGRAM PLAN.
SCHEDULED 11-3-83	FAA ADMINISTRATOR, NASA ADMINISTRATOR, CHAIRMAN FEDERAL COMMITTEE FOR METEOROLOGICAL SERVICES & SUPPORTING RESEARCH, UNDER SECRETARY OF DEFENSE FOR RESEARCH & ENGINEERING WILL BE BRIEFED.

Figure 6. Aircraft Icing Program

On February 3, 1983, the FAA Administrator asked us to present him with a briefing on why we were doing atmospheric characterization. In that briefing, we also gave him the long-range plan which the FAA had developed. At that same time, the Administrator asked us to return in one year to discuss all developments which had been made within the Government dealing with aircraft icing. Within about two months, we had the Aviation Standards people and the Regional Certification Directorates at a meeting to review the program plan. We did go back in July of this year to brief the Administrator on all of the information we had (and we had researched this thoroughly) concerning all aircraft icing research and developments. In September 1983, we had a meeting of the National Resource Specialists and the Regional Certification Directorates to review the plan and set the priorities within the program plan itself. We have also scheduled a meeting between the FAA Administrator, the NASA Administrator, the Chairman for the Federal Meteorological Services and Supporting Research, and the Under Secretary of Defense, at which time they will be briefed on the same subject.

Figure 7 will show you a little about how we have organized the Aircraft Icing Program for the FAA. We have sections on Atmospheric Criteria, Procedures and Technology, and Simulation. Those three things are R & D functions which will lead to a technology base to ultimately be used in the FAA regulatory base. We intend to work very closely within the government, with all the cognizant agencies, with the academic community, and with industry, itself, to see that the program really meets your needs, as well as meeting the needs of the FAA. We also intend for the program to put forth information, guidance material, etc., as information becomes available to us. We do not want to wait five years to have it all nice and tidy for you. That would not be very good for the people in the community.

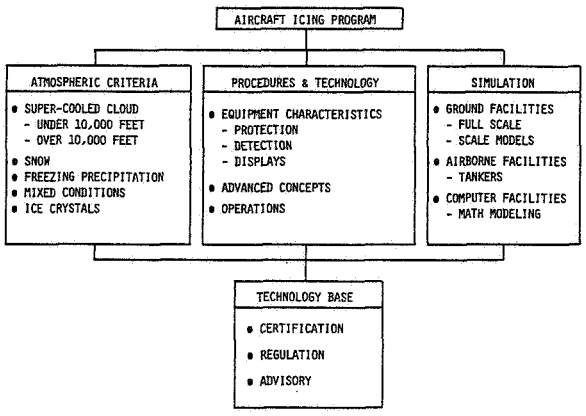

Figure 7. Aircraft Icing Research Program Functional Relationships

No program is a real program without adequate funding (Figure 8). Over the next five years, FY 84-88, the FAA plans to spend a total of $5.3 million in contracting funds to support this plan. It will also be supported with eight (8) senior specialists/scientists cognizant in their fields. As we see progress in this program, we will readjust the resources and the staffing.

FY		'83	'84	'85	'86	'87	'88
CONTRACT FUNDS	($K)	150	1500	1000	900	900	1000
STAFFING	(MY)	4	8	8	8	8	8

Figure 8. Five-Year Funding Plan

The FAA Program Plan outlined in Figure 9 shows that when we characterize the atmospheric environment for icing, we are talking about super-cooled clouds above 10,000 feet. We have already completed the first phase of atmospheric characterization; i.e., super-cooled clouds below 10,000 feet. We are also going to look at snow, freezing rain, drizzle, mixed conditions with super-cooled clouds and ice crystals; then we will look at ice crystals separately. The certification directorates have told us that it is most important for us to get not only CONUS data but world-wide data as well, because our aircraft fly world-wide, and we want the FARs to be able to cover all those conditions. Therefore, if we are going to relax the FAR 25, Appendix C, we would like to know that our

- SUPER-COOLED CLOUDS OVER 10,000 FEET
- SNOW
- FREEZING RAIN AND DRIZZLE
- MIXED CONDITIONS
- ICE CRYSTALS
- INSTRUMENTATION
  - TEST
  - EVALUATION
  - OPERATIONS
- INTERNATIONAL DATA BASE

Figure 9. FAA Program Plan

planes would not fall out of the sky if they were flying over Norway.

We are also developing something that is very important–an international data base. We are going to be asking the industry as well as the departments within the government to be contributing to this. There are many places with many different sources of data, such as the Bureau of Reclamation, DOD, and NASA. We would like to combine all of this information and start an international data base to characterize the atmosphere. As we evaluate and find holes in the data, we will initiate meteorological surveys in those areas in order to complete those characterizations.

Ice protection is a very important part of the program plan. Figure 10 defines the areas into which the FAA will be looking and keeping abreast of these areas as things develop. Rather than waiting for a request to certify to come into the FAA as the manufacturers develop these systems that will be used, we would like to stay abreast of them and issue guidance material. Therefore, when some-

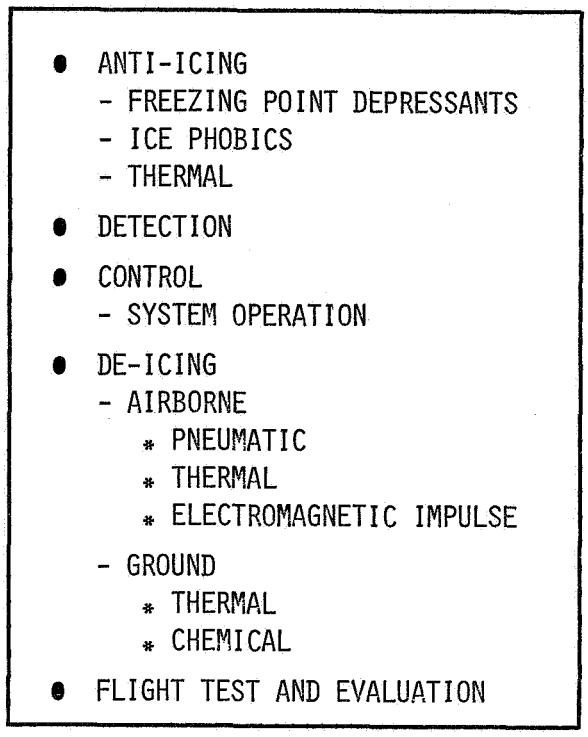

Figure 10. Ice Protection System Technology

one comes to us with a need for certification on a particular type of system, we will have done our homework in advance, eliminating a long wait to get a certification. Neither will we be confused as to the requirements for certification. We think we can cut the time down to certify an aircraft or rotorcraft if we do our homework first.

We will also be publishing the guidance material as we get it. However, the FAA will really not be advancing the ice protection system technology. We will be working with you as you develop the systems so that we can be aware and can be publishing our guidance material; however, we won't be trying to advance the state-of-the-art. We have stated that simulation can be used in order to meet some certification criteria. As shown in Figures 11 and 12, one of the things that we have to do now is to correlate the airborne facilities and the ground-based facilities with nature as we discover it through our atmospheric characterization studies. We will then be issuing guidelines, standards, and procedures which can be used in order to obtain an FAA certification. We are also going to validate that those ground-based and airborne facilities do, in fact, meet the guidance that has been set forth by FAA. In the analytic method, we will hope to be reducing the cost and length of

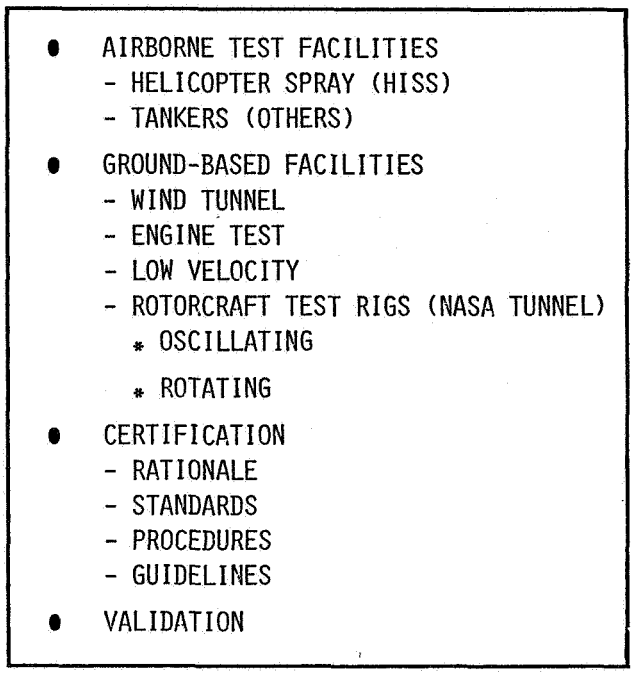

Figure 11. Correlation of Airborne and Ground-Based Facilities

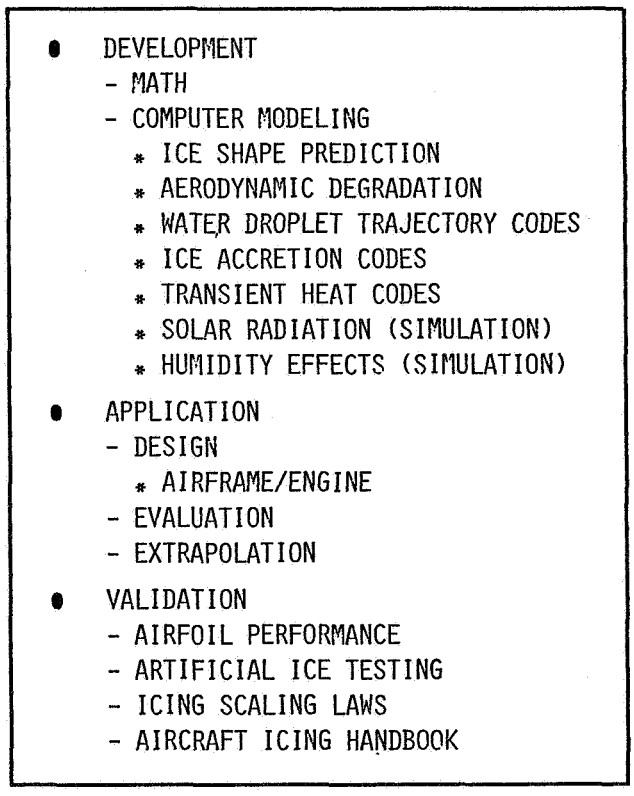

Figure 12. Analytic Methods in the Certification Process

the certification process by using more of the analytic methods as we come to know more about them. NASA is the leader in this, as well as the academic community. They are the people who will help us learn more about analytic methods. We will also be updating things like the ADS-4, which is about 20 years old and really in need of updating. Figure 13 shows our schedule, drawing things together and putting them into perspective. The atmospheric characterizations that are seen here did not really begin until 1983. The supercooled cloud and the snow did; however, the freezing rain, drizzle, ice crystals, mixed conditions will all begin in 1984. It is planned for them to go all the way through 1988 in order for us to obtain both CONUS and world-wide data. The procedures and the technology for the ground de-icing will be updating AC 20-117 to include things like thick fluids. The initial update of the Aircraft Icing Handbook will not be a reprint but an updating of the newest, latest technology that we can find, and that ought to be out within two years.

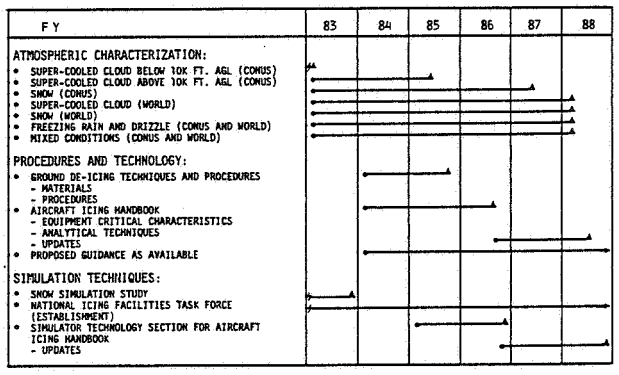

Figure 13. Aircraft Icing Program Planning Schedule

The FAA will proceed on a bi-annual update plan henceforth. We will be doing the same thing with simulation technology. We are trying to put all the information into one spot, so an internally consistent document is available.

As noted in Figure 14, the specific products with which we have promised to come forward are: 1) atmospheric characterization for supercooled clouds over 10,000 feet by June 1985 (only CONUS) 2) an update to AC 20-117 by September 1985; 3) an update of the Aircraft Icing Handbook by June 1986; 4) a simulator technology section of the handbook by September 1986.

This morning we have looked at some of the statistics that prompted the FAA to put together an icing program. We have looked at some of the history from user needs; and now we have gone into detail through the program. Please feel free to contact me with any comments or criticisms or suggestions.

• ATMOSPHERIC CHARACTERIZATIONS - SUPER-COOLED CLOUD ABOVE/BELOW 10,000 FT.	REPORT	JUNE 1985
• GROUND DE-ICING TECHNOLOGY REVIEW UPDATE AC20-117	REPORT	SEPTEMBER 1985
• AIRCRAFT ICING HANDBOOK		
• SIMULATOR TECHNOLOGY AIRCRAFT ICING HANDBOOK	ENGINEERING SUMMARY	JUNE 1986
• ATMOSPHERIC CHARACTERIZATION - SNOW	ENGINEERING SUMMARY	SEPTEMBER 1986
• ATMOSPHERIC CHARACTERIZATIONS - FREEZING RAIN - MIXED CONDITIONS - WORLDWIDE	REPORT	DECEMBER 1986

Figure 14. FAA Product Developments for FY 85/86

"OVERVIEW OF NASA'S PROGRAMS"

A. Richard Tobiason

I will try to give a general overview of NASA's programs and be as brief as possible. It is germane to the scope of what you will be looking at for the next few days. The good news is that we have 17 NASA representatives here from aeronautics programs within all the centers who can help you through the next few days, and they are strategically placed on all of the committees. So, if you need any follow-up on what I'm going to discuss, they are here. I will identify them as I go through the presentation this morning.

There is an aeronautics side of NASA as well as a "space" side. We are involved in things like improving planes for both the civil and military communities in areas of speed, safety, world leadership, and what the problems of flight are and how they can be fixed. That is where we start; that's why we have a charter. Our meteorology work is carried out in the Aeronautical Systems Division under the Subsonic Office. The meteorology work is really a subset of our safety program. I'm the Safety Manager with about $6 million of R & D