Crew Interface With Windshear Systems

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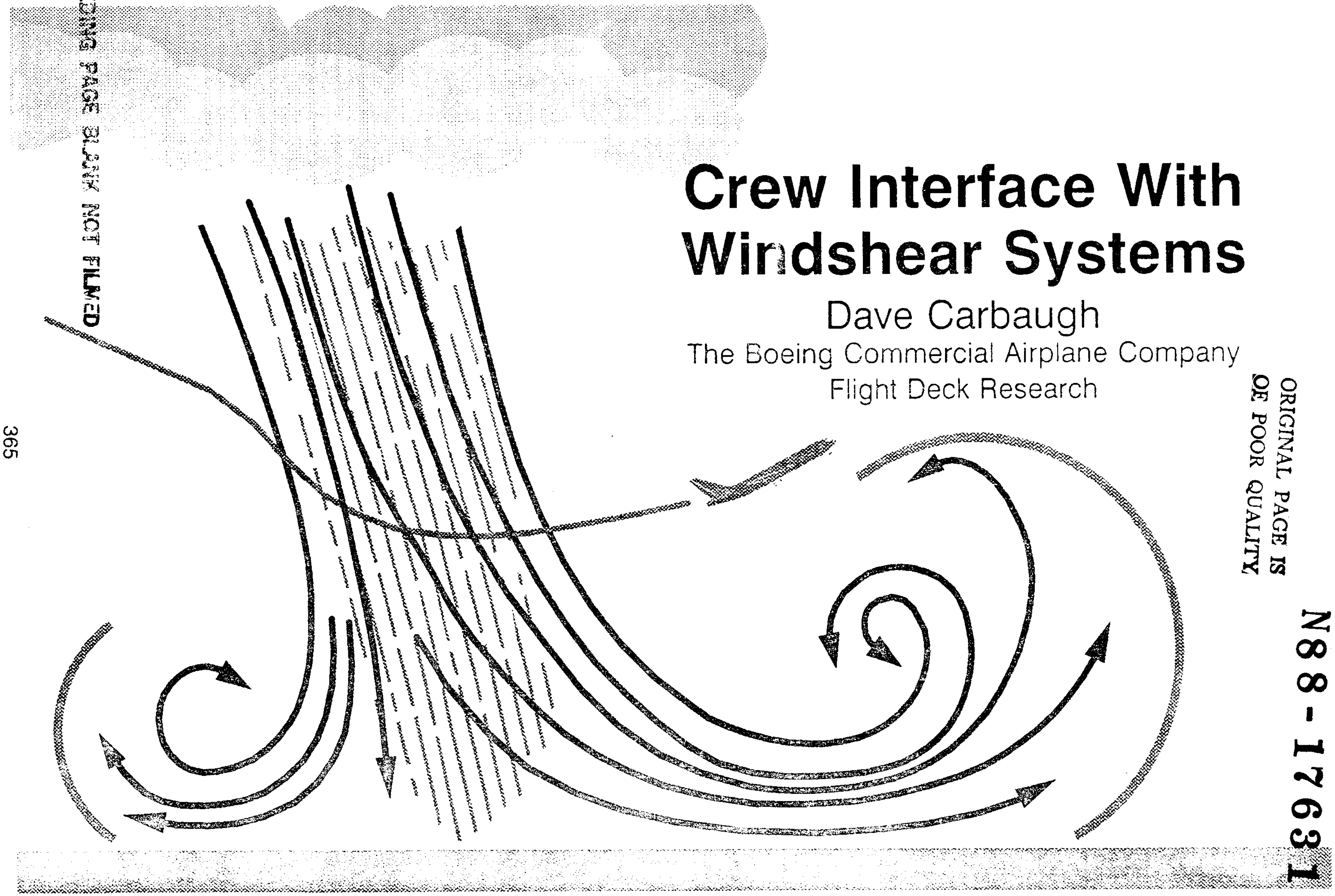

Slide 1
Crew Interface with Windshear Systems

Dave Carbaugh is one of the investigators involved with Boeing Commercial Airplane Company's contract with NASA to conduct windshear studies. The Flight Deck Research Group is primarily a human factors group focusing on advanced commercial transport projects. Dave Carbaugh has a degree from the United States Air Force Academy in engineering mechanics and a masters in aviation management with a human factors emphasis from Arizona State University. In addition, he has over 5000 hours jet time and 2000 hours instructor time in various aircraft from the F-15 to 4-engine heavy jets.

Crew Interface With Windshear Systems

- NASA contract
- Flight deck research efforts
- Nuisance and alerts
- Research issues document

Slide 2
Crew Interface with Windshear Systems

The topics to be presented at the First Combined Manufacturers' and Technology Airborne Wind Shear Review Meeting include:

1. A review is given of the areas within Boeing that are presently working on the NASA contract to conduct windshear studies.

2. A synopsis is given of the work in particular that Boeing Flight Deck Research is conducting.

3. A short review of nuisance and alerts is given in light of upcoming forward-look technology.

4. Finally, an explanation is given of the research issues document that was distributed to the meeting attendants.

NASA/FAA Airborne Windshear Program Elements

- Hazard characterization
  - Windshear physics/modeling
  - Heavy rain aerodynamics
  - Impact on flight characteristics
- Sensor technology
  - INSITU
  - Airborne Doppler radar/lidar
  - Sensor fusion
- Flight management systems
  - System performance requirements
  - Guidance/display concepts
  - Pilot factor/procedures

Slide 3
NASA/FAA Airborne Windshear Program Elements

Boeing is working in three areas on the present NASA windshear contract. These areas include hazard characterization, sensor technology, and flight management systems. These areas mirror areas of the NASA/FAA Airborne windshear program. In the area of hazard characterization, Boeing is studying windshear physics modeling and improvements to windshear models presently used. Future work will look at heavy rain aerodynamics and the impact of microbursts on flight characteristics. In another area, Boeing will assist NASA in the evaluation of windshear advanced technology to include forward-look sensors and sensor fusion. The last area is in flight management systems which is handle by the Flight Deck Research group. We will look at system performance requirements, guidance and display concepts, and pilot factors and procedures.

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Slide 4
Goal

The long term goal of the Flight Deck Research groups' effort is to provide industry with a data base of crew information requirements, crew performance requirements, and display design guidelines for use in development and manufacturing of certifiable airborne windshear systems.

Goal

To provide industry with a data base of crew information requirements, crew performance requirements, and display design guidelines for use in development and manufacturing of certifiable airborne windshear systems.

Slide 5
Objectives

The way we are going to meet this goal is to accomplish these objectives:

1. We will establish the information requirements needed by flightcrews in order to avoid hazardous windshear conditions.

2. We will develop candidate formats of how the information needed by the crews will be displayed on flight deck.

3. We will develop operational and functional requirements for integration of reactive and forward-looking windshear sensor information as received by the flightcrew.

4. We will develop the procedures and criteria necessary to demonstrate that flightcrews are performing correctly to the windshear information displayed to them.

5. We will evaluate candidate crew interface requirements to determine recommended guidelines.

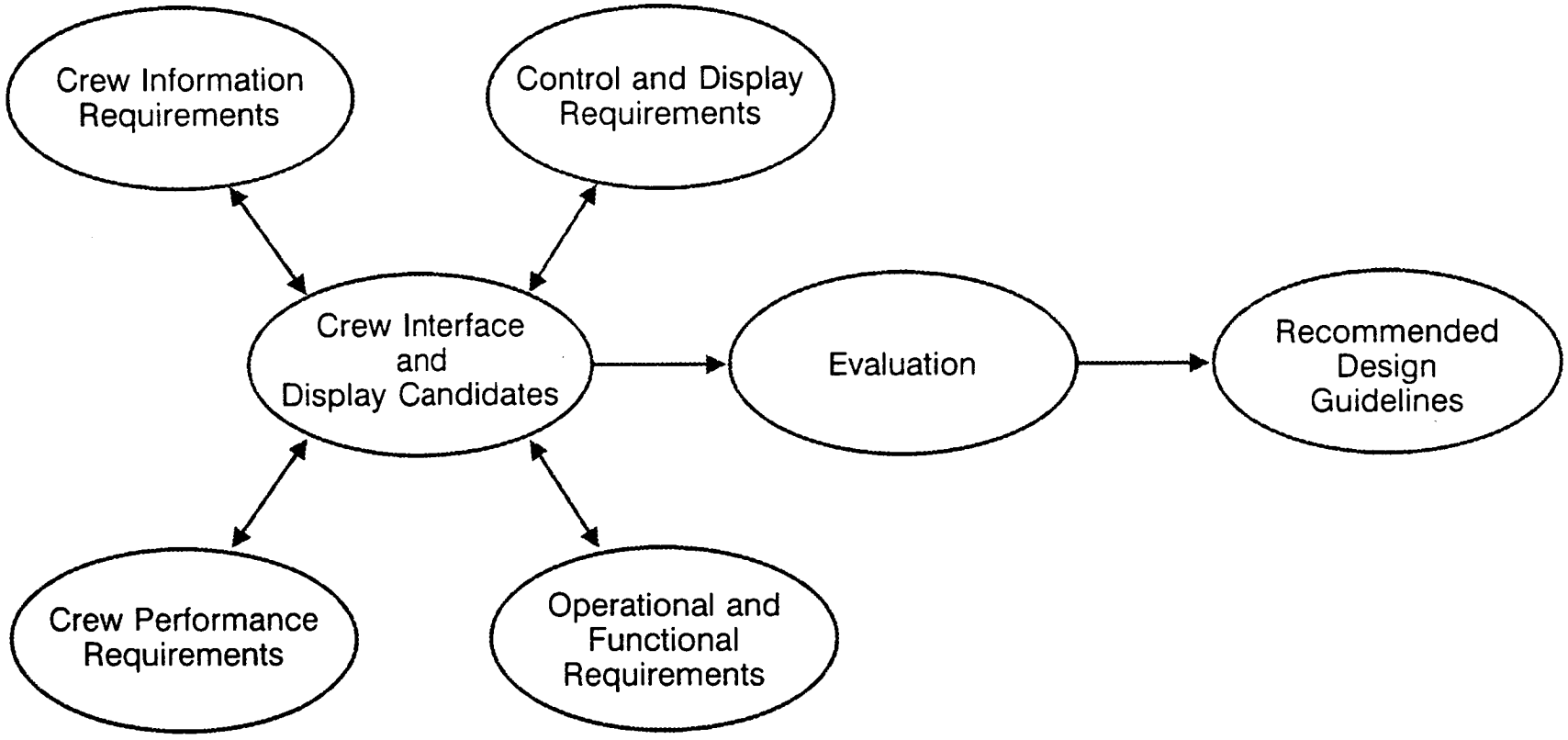
Objectives

- Establish information requirements needed by flightcrews to avoid hazardous windshear
- Develop candidate formats of how that information should be presented to the flightcrew
- Develop operational and functional requirements for integration of reactive and predictive sensor information
- Develop the procedures and criteria needed to demonstrate crew performance using windshear systems
- Evaluate candidate crew interface concepts

Slide 6
Crew Interface with Windshear Systems Program Approach

The crew interface with windshear systems program approach will be to take all four areas of interest(crew information requirements, crew performance requirements, operational and functional requirements, and control and display requirements) and develop candidate crew interfaces and displays. These candidates will then be evaluated in the laboratory, simulator, and in aircraft. The results of these evaluations will be used to recommend design guidelines for advanced windshear detection systems.

Crew Interface With Windshear Systems Program Approach



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Slide 7
Tasking of Present Contract - May 1988

This slide represents the tasking of Boeing Flight Deck Research efforts to complete the present NASA contract. The highlights of this tasking are the program plan, establishment of preliminary information requirements, and categorization of windshear alerts.

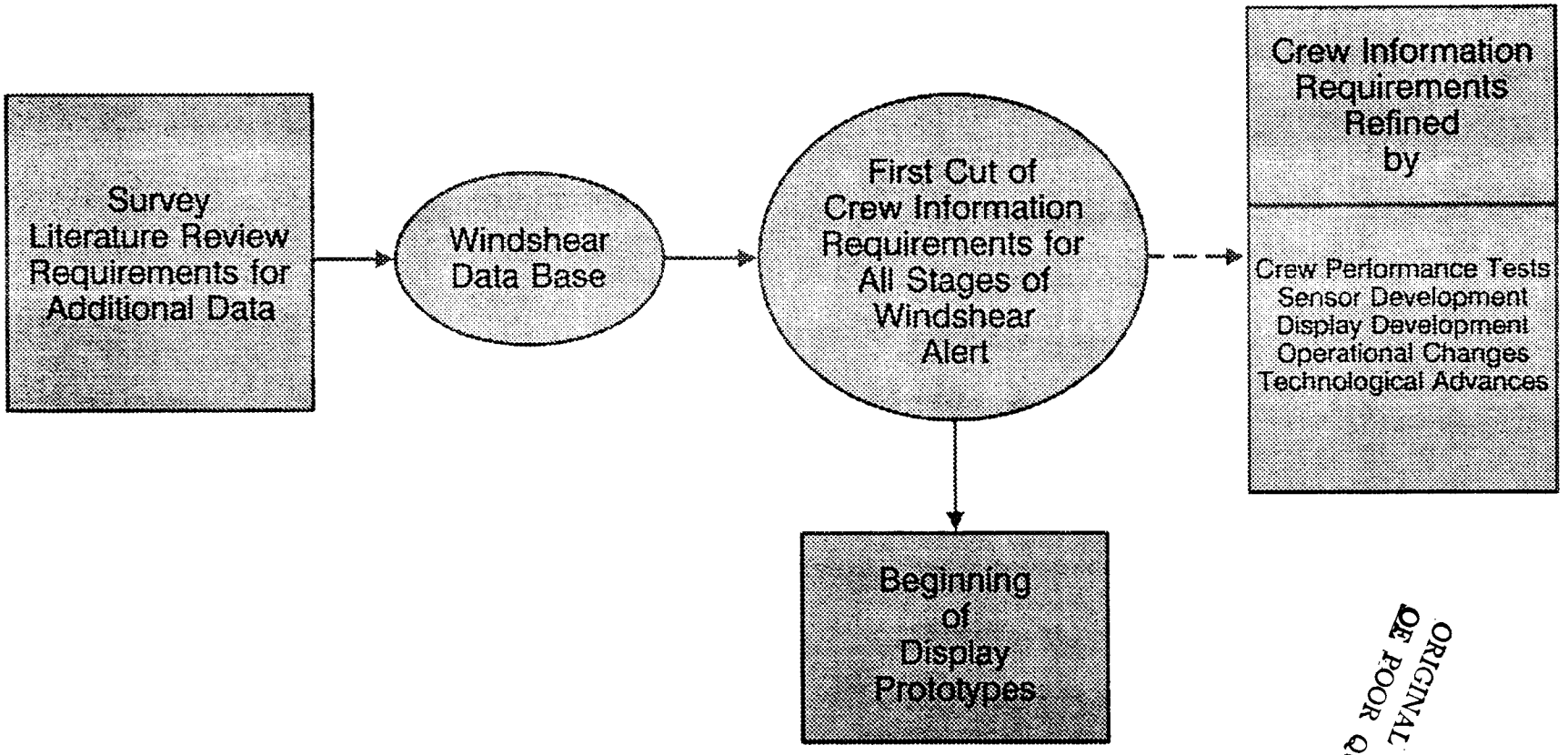
Tasking of Present Contract - May 1988

- Develop plan for defining crew interface with integrated windshear alerting system
  - First-year plan
  - Follow-on plan
- Perform a study to analyze pilot factor data
  - Survey
  - Review literature
  - Define requirements for additional data
  - Establish preliminary information requirements
  - Categorize windshear alerts
  - Review associated standards

Slide 8
Establish Preliminary Crew Information Requirements

This slide represents how our group intends to determine the crew information requirements. The use of a survey of crew information issues will help determine critical areas of understanding and required research. A literature review will be conducted and the requirements for additional data will be understood. The survey, literature review, and requirements for additional data will help establish a windshear data base from which a first cut of crew information requirements can be made. Display development can begin once this first cut of information requirements is performed. The crew information requirements will be refined by crew performance testing, sensor development, display development, operational changes, and technological advances.

Establish Preliminary Crew Information Requirements



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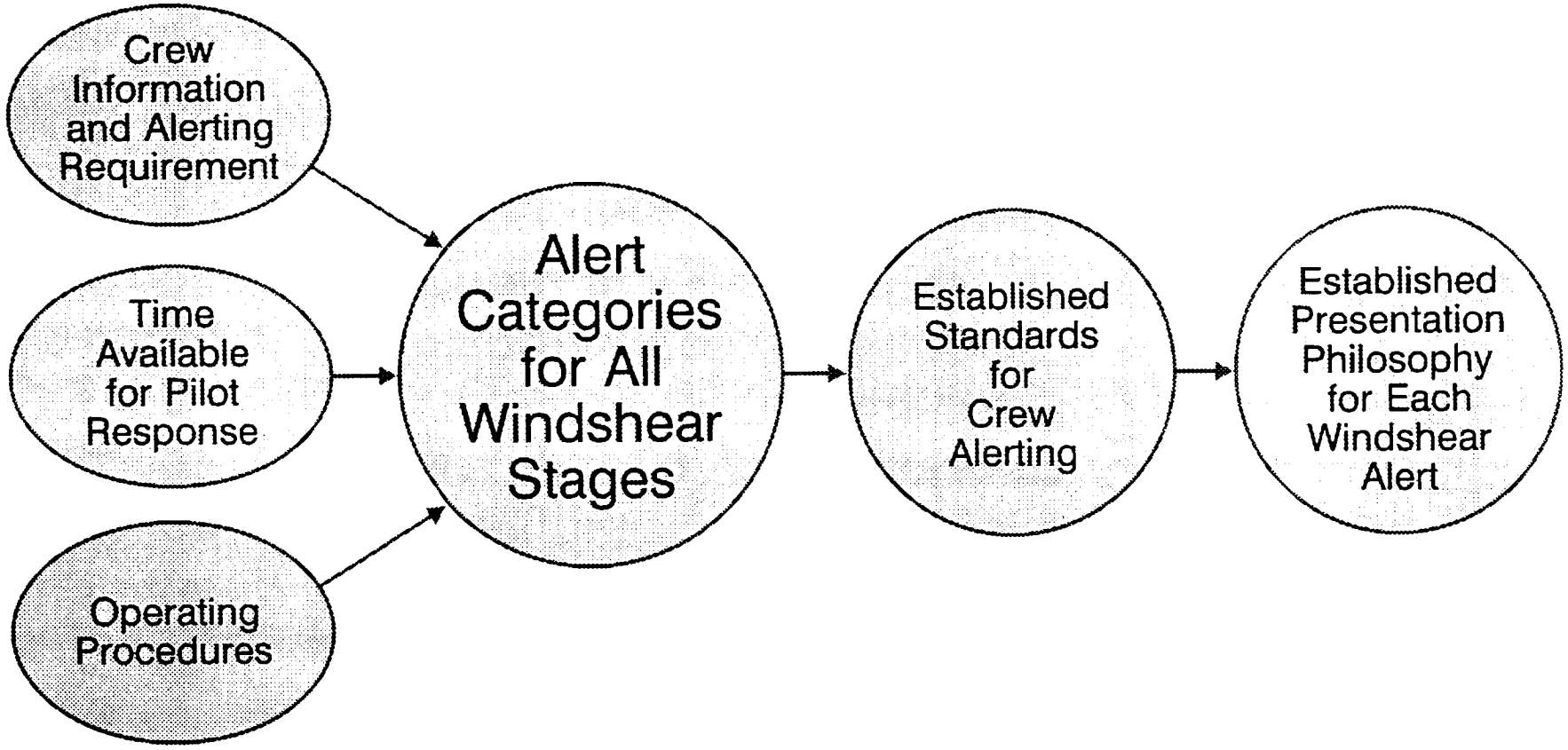
Slide 9
Categories of Windshear Alerts

This slide represents our groups method for determining the categorization of windshear alerts. Alert categories for all windshear stages will be determined by understanding crew information and alerting requirements, the time available for the pilot to respond, and crew operational procedures. Once alert categories are established then we will use the established standards for crew alerting and determine the established presentation philosophy for each of the windshear alerts. For example, if a windshear were detected at a range of 5 minutes then perhaps an alert category of advisory would be established. The established standards for crew alerting would then be used and the display would probably just be in a message form in the malfunction/message display area.

Categories of Windshear Alerts



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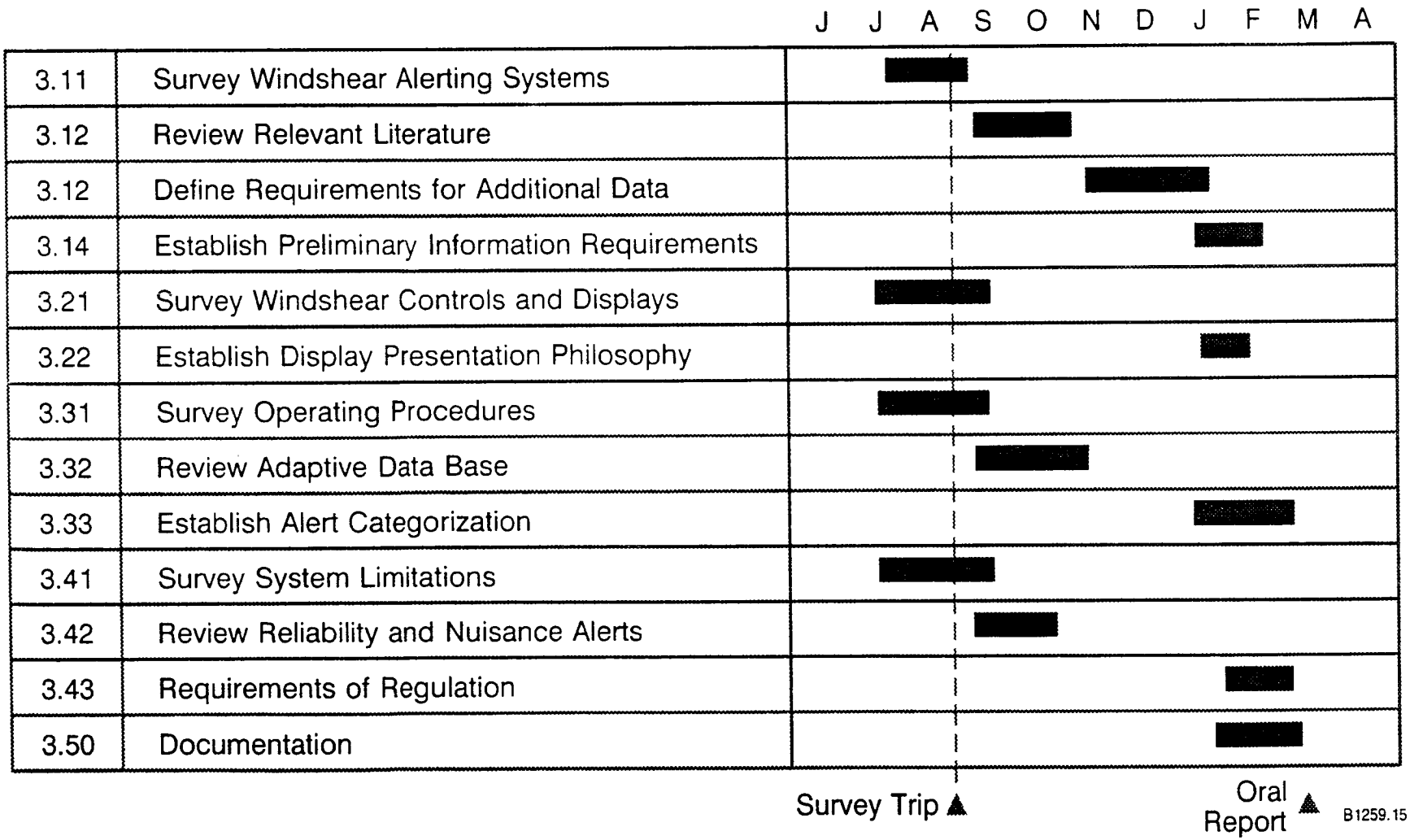
Slide 10
First-Year Program Schedule

This slide represents the timing of the events required to complete the first year of Flight Deck Research groups' present windshear contract with NASA. Highlights of this schedule include the preliminary information requirements in January of 1988 and the alert categorization in February of 1988.

First-Year Program Schedule



Slide 11
A Look at Alerting

It is very important to look at alerting and nuisance when considering forward-look technology windshear systems. These systems must be design with the special requirements of the crew, the decision making force, in mind. These systems may be executive or advisory in nature. Advisory systems are those systems that provide the crew with guidance which they follow only when, in the crew's judgment, they have some other reason to believe that they should carry out the indicated action. Executive systems are those systems that provide the crew with guidance that is mandatory unless, in the crew's judgment, they have reason to believe that they shouldn't carry out the indicated action.

A Look at Alerting

Advisory systems

Systems that provide the crew with guidance which they follow only when, in the crew's judgment, they have some other reason to believe that they should carry out the indicated action

Executive systems

Systems that provide the crew with guidance that is mandatory unless, in the crew's judgment they have reason to believe that they shouldn't carry out the indicated action.

Slide 12
Types of Alerts Crews Receive

There are four basic types of alerts crews can receive. Time critical alerts are those which the time to respond is extremely limited and the response to the alert is the most important action the crew can take at that specific time. A warning alert is an emergency operational or aircraft system condition that requires immediate corrective or compensatory action by the crew. A caution alert is an abnormal operational or aircraft system condition that requires immediate crew awareness and subsequent corrective or compensatory crew action. Lastly, an advisory alert is an operational or aircraft system condition that requires crew awareness and may require crew action.

Types of Alerts Crews Receive

- Time critical warning
- Warning alert
- Caution alert
- Advisory alert

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Slide 13
Looking at the "Nuisance" Problem

There are three types of alerts that generally fall under the "nuisance" problem category.

1. Missed Alerts - Alerts not given but threat to aircraft exists

Example - The aircraft enters a dangerous microburst with no warning. The missed alert rate should obviously be held very low.

2. False Alerts - An alert caused by false indication or system malfunction given when no threat exists

Example - The aircraft receives a windshear warning on a calm day when clearly no windshear exists. The false alert rate should be quite low so as to not destroy crew confidence.

3. Nuisance alert - Wind change or microburst is actually detected but does not develop or represent a threat

Example - The windshear alert is given for a microburst 3 miles removed from the intended flight path or for a microburst that exists 2 miles past the departure end of the runway when an aircraft is crossing the threshold for landing. This nuisance rate should be at a rate acceptable to the crews and is probably at a "to be determined" rate.

Looking at the "Nuisance" Problem

- Missed alert

  Alert not given but threat to aircraft exists

- False alert

  An alert caused by false indication or system malfunction given when no threat exists

- Nuisance alert

  Wind change or microburst actually detected but does not develop or represent a threat

Slide 14
Windshear Issues Document

All participants at the First Combined Manufacturers' and Technology Airborne Wind Shear Review Meeting should have received a windshear issues document. The purpose of this survey document is to help determine the priority of research on crew information issues involving advanced windshear detection equipment. The responses to this survey will help identify crew information issues and those issues of a critical nature that need to researched in the near term. The future use of this document will be the incorporation of the issues into an R-bases software data base for easy access by industry and government. This readily accessed data base will allow the information exchange necessary to help industry develop windshear systems with the crew's needs understood.

Windshear Issues Document

- Purpose
  - Priority of research
  - Identify issues
- Future
  - Provide ready-access
  - Information exchange

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Slide 15
Issues Document Limitations

The survey of crew information issues was developed with several limitations imposed. These limitations include: forward-look orientation, no involvement in FAA regulatory changes, not sensor specific, reactive devices are incorporated as part of an overall advanced windshear system, involvement to be centered around the man-machine interface, and the scope limited to airborne systems.

Issues Document Limitations

- Forward-look orientated
- No involvement in FAA regulatory changes
- Not sensor specific
- Reactive devices are incorporated as part of system
- Involve with man-machine interface
- Limit ground-based involvement

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Slide 16
Conclusion

This presentation stated how Boeing is involved in a NASA contract to conduct windshear studies, in particular the Flight Deck Research Groups' effort. A review was given of the importance of understanding nuisance and alerting when related to the development of forward-look technology. Finally, the crew information issues document was presented and the importance of identifying key issues stressed.