

# AEROSPACE

## SHORT COURSES

### **Aircraft Icing: Meteorology, Protective Systems, Instrumentation and Certification (AERO0060)**

**Instructors:** Wayne R. Sand, Steven L. Morris, Kara Greene

#### **Course Description**

This course covers meteorology and physics of aircraft icing: forecasting, finding and avoiding icing conditions, designing and evaluating ice protection systems; and certification of aircraft for flight into known icing conditions.

#### **Who Should Attend?**

Designed for aerospace engineers, flight test and design engineers, test pilots, line pilots, meteorologists, FAA engineers and Designated Engineering Representatives (DERs), and program managers.

#### **Course Highlights**

- Description of aircraft icing, severity, types and photos
- Atmospheric aerosols
- Cloud physics of icing and conceptual cloud modes
- Ground icing
- Skew-T, Log P adiabatic diagrams
- Assessment of icing potential
- Critical icing parameters, theory and measurements
- Meteorology of SLD icing
- Finding and avoiding icing conditions
- Discussion of sources and meaning of available forecast information
- Ice accretion characteristics
- Effects of ice on aircraft performance
- Anti-ice and de-ice systems
- Icing instrumentation and detection
- Effect of SLD on aircraft
- Engine icing considerations
- Ice-testing methods
- Certification and regulations
- Conceptual methods

## **Learning Objectives**

- Basic physics of aircraft icing
- Basic understanding of the meteorology of aircraft icing
- How to obtain icing forecast information to find or avoid icing conditions
- Background and discussion of key aircraft icing accidents
- An understanding of the icing problems associated with Supercooled Large Droplets (SLD)

## **Course Outline**

### **Day One**

- Icing hazard description
- Atmospheric aerosols
- Cloud physics of icing
- Ground icing, atmospheric cooling mechanisms
- Conceptual cloud modes: convective clouds, stratiform clouds
- Skew-T, Log P adiabatic diagrams

### **Day Two**

- Icing environment analysis using Skew-T, Log P
- Assessment of icing potential
- Critical icing parameters, theory and measurements
- Meteorology of supercooled large drops (SLD icing)
- Finding/avoiding icing conditions
- New and current icing research
- Internet resources

### **Day Three**

- Ice accretion characteristics
- Effects of ice on aircraft performance
- Anti-ice systems
- De-ice systems
- Icing instrumentation, icing environment
- Icing detection

### **Day Four**

- Effect of SLD on aircraft
- Engine icing considerations
- Ice-testing methods
- Certification and regulations
- Computational methods
- Review and discussion

## **Classroom hours / CEUs**

28.00 classroom hours

2.8 CEUs

## **Certificate Track**

Aerospace Compliance

Aircraft Maintenance and Safety

## **Course Fees**

Early registration course fee: \$2,295 if you register and pay by the early registration deadline (45 or more days prior to the class start date).

Regular registration course fee: \$2,495 if you register and pay after the early registration deadline.

## **Course Materials**

Course materials, including outlines, presentation copies, and supplementary materials, will be accessible through Canvas, KU's online learning system. Instructions to access Canvas will be provided upon completed registration. Students are required to bring a computer or other electronic device with PDF-viewing capabilities with them to class each day. If you require accommodation contact us at [professionalprograms@ku.edu](mailto:professionalprograms@ku.edu) and we will work with you on an accessible solution.

## **U.S. Federal Employee Discount**

This course is available to U.S. federal employees at 10% off the registration fee. To receive the federal employee discount, you must enter the code **FGVT116** during the checkout process. Please note that you must validate your eligibility to receive this discount by entering your U.S. government email address (ending in .gov or .mil) when creating your online registration profile. This discount is available for both the early registration and regular registration fees.

## **Canada Department of National Defence Discount**

This course is available to Canada DND employees at 10% off the registration fee. Please contact the DND Procurement Authority (DAP 2-3) for details. Please note that you cannot register using our online system when requesting this discount. This discount is available for both the early registration and regular registration fees.

## **Instructor Bios**

**Kara Greene** is a Mechanical/Aeronautical Engineer and a Senior Consultant for Engineering Systems Inc. (ESi) where she specializes in aircraft (airplane and helicopter) accident reconstruction and analysis. Using radar, GPS, ADS-B, aircraft system information, atmospheric data, and geographical surroundings, Dr. Greene evaluates aircraft performance and puts together a cohesive picture of an accident. She has analyzed dozens of airplane and helicopter accidents following the scientific and forensic engineering method. During her service in the Air

Force, Dr. Greene was an evaluator and instructor pilot in the C-17A (Boeing Globemaster), an instructor in the T-53 (Diamond DA-40), T-52 (Cirrus SR-20), and T-41 (Cessna172), and a pilot in the T-37 (Cessna Tweet) and T-1 (Beech Jayhawk) with a total of over 3,500 hours including combat and Night Vision Goggle (NVG) time. While at the Air Force Academy, she taught courses in aeronautics, experimental methods, a capstone mathematics course, and flight test techniques including data acquisition in the T-41. Dr. Greene received a B.S. in Mechanical Engineering from the University of Notre Dame, a M.S. in Mechanical Engineering from the University of Idaho, a M.A. in Leadership and Counseling from the University of Colorado, Colorado Springs, and a Ph.D. in Aerospace Engineering from the Air Force Institute of Technology.

**Wayne R. Sand** is an aviation weather consultant with expertise in aircraft icing tests, analysis of icing accidents and development of icing instrumentation. He also has extensive expertise in convective weather, winter weather and mountain weather. As former deputy director of the Research Applications Program at the National Center for Atmospheric Research, he developed aviation weather technology for the FAA. Previously, Sand was a member of the atmospheric science department at the University of Wyoming. He also conducted research on thunderstorms and convective icing while at the South Dakota School of Mines and Technology. Sand is co-holder of a patent on a technique for the remote detection of aircraft icing conditions. He holds a B.S. in mathematics and physical science from Montana State University, an M.S. in meteorology from the South Dakota School of Mines and Technology and a Ph.D. in atmospheric science from the University of Wyoming.

**Steven L. Morris** is a Principal and Manager of Colorado Operations for Engineering Systems Inc. (ESI), Colorado Springs, Colorado. Morris served as an officer and engineer in the U.S. Air Force for more than 24 years. His experience includes teaching, research and consulting in the areas of airplane design, stability and control, aerodynamics, flight simulation, aircraft icing and accident reconstruction. He is a co-author of Introduction to Aircraft Flight Mechanics: Performance, Static Stability, Dynamic Stability, and Classical Feedback Control. Morris is an Associate Fellow of AIAA and is a member and past Chair of the SAE Aircraft Icing Technology Committee. He received a B.S. in engineering sciences from the U.S. Air Force Academy, an M.S. in aeronautical engineering from the Air Force Institute of Technology and a Ph.D. in aerospace engineering from Texas A&M University.

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