Handbook for Preparing
DOT/FAA Formal Technical Reports

2009-2010

National Institute for Aviation Research
Wichita State University
Wichita, Kansas
GENERAL INSTRUCTIONS FOR PREPARING
DOT/FAA TECHNICAL REPORTS

This sample document has been prepared to show the standard formatting for DOT/FAA formal
technical reports, including title page, documentation page, table of contents, lists of tables and
figures, text, headings, figure and table captions, equations, references, and appendices.
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|          | **Half-inch** bottom margin for footer page numbers, including those in appendices.  
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|          | **Arabic numerals**, centered at bottom of page, for text that begins with the first page of the main body of the report through the references (i.e., 1, 2, 3, etc.).  
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Period after major-level heading number only.
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Underlining of all numbers and words in headings, but not the ending period.
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#. MAJOR-LEVEL HEADING.
#.# FIRST-LEVEL HEADING.
#.#.# Second-Level Heading Showing Hanging Indent with More than One Line.
#.#.#.# Third-Level Heading.

TABLE OF CONTENTS

Left-margin placement of major-level headings.
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All capital letters in major-level headings.
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#.# First-Level Heading Showing Hanging Indent with More than One Line

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Captions that describe the figure or table concisely. Avoid lengthy titles.  
Keep detailed descriptions of the figure or table within the text.  
**Title case and Arabic numerals** in figure and table captions throughout text (i.e., Table 1, Figure 1, etc.).  
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**16. Abstract**

Short summary of report here:

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## APPENDICES

A—Calibration Procedure for KGR-Type Device

B—Paste Adhesive Mixing Procedure

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*HEADINGS IN TABLE OF CONTENTS*

(M) = #. MAJOR-LEVEL HEADING

(1st) = #.# First-Level Heading

(2nd) = #.#.# Second-Level Heading

(3rd) = #.#.#.# Third-Level Heading
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EXECUTIVE SUMMARY

When American air carriers operate outside the United States, they may encounter reduced airport lighting system requirements that have been proposed by the European Joint Aviation Authority (JAA). These reduced requirements would be used during low-visibility takeoff and landing operations, and would differ from the lighting requirements that are used in the U.S. The JAA proposals mainly involve a reduction in the number of runway or approach lights as compared to the Federal Aviation Administration (FAA) standard systems for given weather conditions.

This report describes an evaluation to determine the adequacy of the JAA proposed lighting system requirements in supporting low-visibility operations. The evaluation was conducted using the FAA B-727 flight simulator with enhanced visual presentations and employed the services of experienced air carrier pilots as volunteer subjects.

This report presents data results of the evaluation, which will be used by the FAA to establish the degree to which U.S. air carriers serving European destinations will be permitted to operate in accordance with JAA operational procedures.
1. INTRODUCTION.

This evaluation effort has been undertaken in response to a memorandum request from the Director, Flight Standards Service, AFS-1, dated March 2, 1994. The memorandum requested that the Airport Technology Research and Development Branch, AAR-410, at the Federal Aviation Administration (FAA) Technical Center perform the testing and evaluation necessary to support FAA efforts to harmonize lighting requirements with the Joint Aviation Authority (JAA).

1.2 BACKGROUND.

When American air carriers operate outside the U.S., they may encounter reduced airport lighting system requirements that have been proposed by the European Joint Aviation Authority (JAA). These reduced requirements would be used during low-visibility takeoff and landing operations and would differ from the lighting requirements that are used in the U.S. The JAA proposals mainly involve a reduction in the number of runway or approach lights as compared to the FAA standard systems for the given weather conditions.

1.3 RELATED ACTIVITIES/DOCUMENTS.

The following documents relate directly to the issues addressed herein and define the nature of the lighting system differences studied in this evaluation:

a. JAA document No. JAR-OPS1 (Draft), “Joint Airworthiness Requirements,” contains air and ground equipment (to include lighting systems) required to support instrument operations in the European community.


c. FAA Order No. 8260.3B, “U.S. Standard for Terminal Instrument Procedures (TERPS).”


In addition to the above listed documents, there are on file at the FAA Technical Center, Atlantic City International Airport, New Jersey, a number of early (1960 – 1970) technical reports dealing with U.S. development of approach lighting to support instrument operations. These are particularly interesting in that they document actual weather testing of experimental approach lighting systems. These reports are not available on order, since only single copies are on file in most instances, but visitors with prior authorization may inspect them.
2. DISCUSSION.

Evaluation tasks accomplished within the framework of this effort included the evaluation of JAA proposed differences to runway and approach lighting requirements to determine whether they will safely support takeoff and landing operations under reduced visibility conditions.

Proposed JAA differences in required lighting that were evaluated included the following:

- Requirement for high-intensity runway edge lighting (HIRL) only to support takeoff operations in 850-foot runway visual range (RVR) conditions.

- Requirement for HIRL and runway centerline lighting to support takeoff operations in 500-foot RVR conditions.

- Requirement for 100-foot (rather than 50-foot) spacing of runway centerline lights to support landing operations in 500-foot RVR conditions.

- Requirement for ICAO Simple Single Source Centerline Approach Lighting System (ALS) (Configuration C—figure 1) to support Category I (200'DH/2400'RVR) landing operations.

- Requirement for ICAO Simple Barrette Centerline ALS (Configuration D—figure 2) to support Category I (200'DH/2400'RVR) landing operations.

- Requirement for standard MALSR (Configuration A—figure 3) without runway touch down zone (TDZ) and centerline lighting to support Category I (200'DH/1800'RVR) landing operations.

In each instance, the JAA requirements are less stringent than the equivalent FAA lighting requirements for the given weather condition.
Figure 1. Velocity and Distance of Typical Inconel Fragment Traveling Through Ullage

Figure 2. Velocity and Distance of Typical Inconel Fragment Traveling Through Liquid Fuel
3. EVALUATION APPROACH.

3.1 EVALUATION METHOD.

In view of the fact that all of the evaluations involved testing of major lighting system configuration effectiveness/adequacy under reduced visibility conditions (Category I, II, and III), it would have been very difficult to conduct actual flight tests under existing weather conditions using modified full-scale ALS systems. Therefore, all evaluations were accomplished using the FAA Boeing 727 Flight Simulator located at the FAA Aeronautical Center in Oklahoma City. The visual display component of the flight simulator had recently been upgraded and calibrated in such a manner as to significantly enhance the lighting system presentation and to better suite it to visual aid evaluations.

The simulator is equipped with an SP-1T texturized dusk/night visual display, with a full range of visual weather effects available. These include clouds (base and top selectable), scud, homogeneous fog, patchy fog, and selectable visibility and RVR. A modified RVR was also implemented for the test based on data contained in the January 1985 report by C.A. Douglas for Slant Range RVR under stable, homogeneous fog conditions.

Twelve industry B-727 type-rated pilots from various air carrier organizations (airlines, Airline Pilots Association (ALPA), and Air Transport Association (ATA)) comprised the majority of the evaluation subjects. Three rated FAA pilots also participated as subjects.

The evaluation involved fifteen subject pilots executing at least six takeoff and twelve approach/landing operations each. Scenario outlines, detailing weather and configurations tested, are provided as figure 4.

FAA RVRs and meteorological conversion tables are shown in tables 1 and 2.

Flight simulator sessions lasted approximately two hours, with the subject pilot participating as Captain (Pilot-in-Command). For those evaluations that were conducted under simulated Category I conditions, all segments of the approach, to a point at or near the decision height, were flown coupled with auto throttle engaged. The captain then decoupled and, at decision height, either completed the landing visually or conducted a missed approach maneuver, depending upon the adequacy of the visual system displayed. All Category III approaches were “Autoland,” with manual rollout and deceleration. A qualified FAA pilot occupied the right seat in the simulator and performed such duties as would normally be assigned to the First Officer.
Table 1. Metric Operational Equivalent Values
(double spacing between caption and table)

<table>
<thead>
<tr>
<th>Runway Visual Range</th>
<th>Feet</th>
<th>Meters</th>
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</thead>
<tbody>
<tr>
<td>300</td>
<td>90</td>
<td></td>
</tr>
<tr>
<td>400</td>
<td>120</td>
<td></td>
</tr>
<tr>
<td>500</td>
<td>150</td>
<td></td>
</tr>
<tr>
<td>600</td>
<td>175</td>
<td></td>
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<tr>
<td>700</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>1,000</td>
<td>300</td>
<td></td>
</tr>
<tr>
<td>1,200</td>
<td>350</td>
<td></td>
</tr>
<tr>
<td>1,600</td>
<td>500</td>
<td></td>
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<tr>
<td>1,800</td>
<td>550</td>
<td></td>
</tr>
<tr>
<td>2,000</td>
<td>600</td>
<td></td>
</tr>
<tr>
<td>2,100</td>
<td>630</td>
<td></td>
</tr>
<tr>
<td>2,400</td>
<td>720</td>
<td></td>
</tr>
<tr>
<td>4,000</td>
<td>1,200</td>
<td></td>
</tr>
<tr>
<td>4,500</td>
<td>1,400</td>
<td></td>
</tr>
<tr>
<td>5,000</td>
<td>1,500</td>
<td></td>
</tr>
<tr>
<td>6,000</td>
<td>1,800</td>
<td></td>
</tr>
</tbody>
</table>

Table 2. Meteorological Visibility Versus RVR
(double spacing between caption and table)

<p>| Meteorological Visibility When RVR is Not Available |
|---------------------------------|--------|--------|</p>
<table>
<thead>
<tr>
<th>Statute Miles</th>
<th>Meters</th>
<th>Nautical Miles</th>
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<tbody>
<tr>
<td>1/4</td>
<td>400</td>
<td>1/4</td>
</tr>
<tr>
<td>1/2</td>
<td>800</td>
<td>1/2</td>
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<tr>
<td>3/4</td>
<td>1,200</td>
<td>7/10</td>
</tr>
<tr>
<td>1</td>
<td>1,600</td>
<td>9/10</td>
</tr>
<tr>
<td>1 1/4</td>
<td>2,000</td>
<td>1 1/10</td>
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<td>1 1/2</td>
<td>2,400</td>
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<td>3,200</td>
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<td>3,600</td>
<td>2</td>
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<tr>
<td>2 1/2</td>
<td>4,000</td>
<td>2 1/5</td>
</tr>
<tr>
<td>2 3/4</td>
<td>4,400</td>
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</tr>
<tr>
<td>3</td>
<td>4,800</td>
<td>2 3/5</td>
</tr>
</tbody>
</table>
The complete evaluation program consisted of 15 pilots flying at least six takeoffs and twelve approach/landing operations each for a total of 270 runs. Subject pilots were B-727 type-rated, Category II qualified, and recruited from a number of different air carriers.

Every effort was made to automate the testing procedures and simulator setup as much as practicable to ensure repeatability and high quality data collection for future analysis and evaluation.

All tests were flown using the Oklahoma City (OKC) runway 35R visual model. Certain scenario parameters had been keyed to this runway, and using a different airport would have required changes to the programs. The necessary Category III features were available on this runway, and the high quality of this particular visual model greatly enhanced test validity.

Based on the proposed weather and failure requirements provided, there were approximately 25 test scenarios available. Selection of the desired scenario automatically repositioned the aircraft, provided pre-selected failures at the appropriate time, and set up the proper weather conditions for that test.

3.2 INITIAL CONDITIONS.

Initial simulated aircraft conditions, as set for takeoff, were as follows:

- Gross Weight: 172,000 lbs.
- Fuel Freeze: Set
- Visual Control: CRT
- Visibility: As required
- Ceiling: As required
- Turbulence: 8%

Initial simulated aircraft conditions, as set for approach and landing, were as follows:

- Gross Weight: 154,000 lbs.
- Fuel Freeze: Set
- Visual Control: CRT
- Visibility: As required
- Ceiling: As required
- Turbulence: 8%

3.2.1 Simulated Weather Conditions.

Based on the adopted test criteria, there were 10 different sets of weather conditions required. The correct set of weather conditions, with correlated visual effects, was automatically activated when a test scenario was selected.
3.2.2 Failure Conditions.

The takeoff failure condition that was used is described briefly below. The selected scenario at critical speeds determined during previous flight tests automatically triggered failures.

<table>
<thead>
<tr>
<th>FAILURE</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine Seizure</td>
<td>Represents internal destruction of the 2 turbine on the no. 3 engine. The engine seizes (1, 2 to zero) and all accessories logic is lost with the loss in power. In addition, an engine fire-warning bell was sounded concurrently as an additional pilot alert.</td>
</tr>
</tbody>
</table>

3.3 PILOT OPERATING PROCEDURE.

As previously discussed, the simulator test program was automated as much as possible to expedite test runs and ensure repeatability with different subject pilots.

The cockpit operator initiated each test from the pilot instructor’s station. When the scenario number was entered and activated, the aircraft was repositioned to either a takeoff position at the end of the runway or to a location within the approach area. Prior to flying the actual test scenarios each subject was given a practice session for simulator familiarization. This session typically included manually flown takeoffs, approaches, and landings and lasted approximately 15–20 minutes.

3.3.1 Takeoff Scenarios 1 through 4.

As soon as the simulator was stabilized at the takeoff position, the pilot initiated the takeoff run. Takeoffs were made at RVR’s between 500, 850, and 1,000 feet under weather conditions as described elsewhere in this report. The programmed fault was a no. 3 engine failure.

Appropriate weather conditions were introduced, to include crosswinds and fog.

If the pilot completed a successful takeoff, he continued climb-out on the runway heading, stabilized the aircraft, and leveled off at 500’ AGL to end the segment. This permitted the automatic test facilities to complete processing of the run and configured the aircraft for repositioning at the end of the runway for the next run.

3.3.2 Approach/Landing Scenarios 5 through 19.

After the simulator was stabilized and “frozen” at the approach position, approximately five nautical miles from the runway, the pilot was advised of the simulated weather conditions. When the subject indicated that he was ready to begin the scenario, the simulator was then “unfrozen” allowing the approach to commence.

Approaches and landings were made at RVR values of 500, 1800, and 2400 feet and with other weather conditions (wind, fog, etc.) as required by the scenario setup. No aircraft equipment failures were simulated during this approach and landing segment.
3.3.2.1 Motion of Hailstones.

The motion of hailstones in the air capture streamtube and the inlet (figure 1) is determined in an air flowfield that is established, as stated earlier, independently of the presence of hailstones. The hailstones are assumed to be subject to the following processes.

3.3.2.2 Describing Equations for Hail Motion.

The Lagrangian equations of motion for hailstone of mass \(m_h\) in the \(x, y, z\) coordinates in a given \(y, z\) plane are as follows:

\[
\dot{x} = k \frac{m_h}{m_h} (U_a - \dot{x}) \sqrt{(U_a - \dot{x})^2 + (V_a - \dot{y})^2} \tag{1}
\]

\[
\dot{y} = k \frac{m_h}{m_h} (V_a - \dot{y}) \sqrt{(U_a - \dot{x})^2 + (V_a - \dot{y})^2} - g \tag{2}
\]

where \(k = \frac{1}{2} \rho_a C_D A_p\), and \(A_p\) is the cross-sectional area of the hailstone. The following relation is used for \(C_D\) the draft coefficient [1]:

\[
C_D = \begin{cases} 
24 & \text{Re} < 1000 \\
\frac{24}{\text{Re}} + \frac{0.66}{6.0} & \text{otherwise}
\end{cases} \tag{3}
\]

The impact and rebound process for a hailstone striking a solid surface depends upon the relative normal velocity, radius of curvature of the impacting bodies, the Young’s moduli and Poisson’s ratio of the material of the bodies, the coefficient of friction static and kinetic, and the normal coefficient of restitution [2]. Here, the static friction force is the force required to move a body from rest, and the kinetic friction force is the force required to sustain sliding motion.
6. REFERENCES


APPENDIX A—CALIBRATION PROCEDURE FOR KGR-TYPE DEVICES

This appendix discusses the calibration procedure for KGR-type devices. An example of calibration curves for KGR-type devices is shown in figure A-1 . . . .

Figure A-1. Example of Calibration Curves for KGR-Type Devices

Calibration Factor

The calibration factor is derived as

\[ EQUATION WITHIN APPENDIX \] (A-1)

Table A-1 lists the correction factors in tabular form.

Table A-1. KGR-Type Device Correction Factors in Tabular Form

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This table shows that . . .
APPENDIX B—PASTE ADHESIVE MIXING PROCEDURE

As shown in table B-1, several adhesive-mixing ratios . . . The procedure used for mixing the past adhesives in this investigation is outlined below.

Table B-1. Adhesive-Mixing Ratios for All Three-Paste Adhesives Used in This Investigation

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Equipment:

- Triple beam balance or other measuring device.
- Mixing cups.
- Mixing utensils—wooden or plastic.

Procedure:

- Place empty mixing cup on balance and tare.
- Dispense approximate amount needed.
- Weigh and calculate amount of curing agent.
- Mix until a homogeneous appearance is achieved, and no swirls or contrasting colors or consistency are visible.

(each appendix numbered separately with capital letters and Arabic numerals,
SAMPLE APPENDICES

separated by a hyphen and centered at bottom of page)