# TABLE OF CONTENTS

1.0 EXECUTIVE SUMMARY ..... 1-1
1.1 OVERVIEW ..... 1-1
1.2 INTRODUCTION ..... 1-1
1.3 SYSTEMS EVALUATED ..... 1-2
1.4 FTIHWG STRUCTURE ..... 1-2
1.5 SCOPE AND ASSUMPTIONS ..... 1-2
1.6 TECHNICAL EVALUATIONS ..... 1-4
1.7 TECHNICAL LIMITATIONS ..... 1-5
1.8 BENEFITS ..... 1-5
1.9 HAZARDS ..... 1-8
1.10 COST-BENEFIT ANALYSIS ..... 1-9
1.11 OVERALL CONCLUSION ..... 1-9
1.12 RECOMMENDATIONS ..... 1-10
2.0 INTRODUCTION ..... 2-1
2.1 BACKGROUND ..... 2-1
2.1.1 Scope ..... 2-1
2.1.2 Tasking Statement ..... 2-1
2.1.3 Charter ..... 2-4
2.2 WORKING GROUP DEVELOPMENT ..... 2-4
2.2.1 Organization ..... 2-4
2.2.2 Task Team Charters and Deliverables ..... 2-5
2.2.3 Schedule ..... 2-8
2.3 STANDARDS ..... 2-9
2.3.1 Assumptions ..... 2-9
2.3.2 Ground Rules ..... 2-9
3.0 SERVICE HISTORY ..... 3-1
3.1 METHODOLOGY ..... 3-1
3.2 ANALYSIS ..... 3-1
3.2.1 Analysis of Previous Tank Explosions ..... 3-2
3.2.2 Postcrash Fuel Tank Fires ..... 3-2
3.3 CONCLUSIONS ..... 3-3
4.0 SAFETY ASSESSMENT ..... 4-1
4.1 METHODOLOGY ..... 4-1
4.2 FLAMMABILITY ..... 4-1
4.2.1 Inerting ..... 4-2
4.2.2 Flammability Exposure Analysis ..... 4-2
4.2.3 GBI Analysis ..... 4-4
4.2.4 OBGI Analysis ..... 4-4
4.2.5 OBIGGS Analysis ..... 4-4
4.3 FUNCTIONAL HAZARD ANALYSIS ..... 4-5
4.4 PERSONNEL HAZARDS ..... 4-5
4.4.1 General ..... 4-5
4.4.2 Confined Spaces ..... 4-5

4.4.3 Gaseous Nitrogen ..... 4-6
4.4.4 Liquid Nitrogen ..... 4-6
4.4.5 Gaseous Oxygen ..... 4-7
4.5 SAFETY BENEFIT ANALYSIS ..... 4-7
4.6 SAFETY ASSESSMENT SUMMARY AND CONCLUSIONS ..... 4-10
5.0 GROUND-BASED INERTING ..... 5-1
5.1 CONCEPT DESCRIPTION ..... 5-1
5.1.1 Auxiliary Tanks ..... 5-3
5.2 APPLICABILITY TO STUDY-CATEGORY AIRPLANES ..... 5-5
5.3 AIRPORT RESOURCES SYSTEM REQUIRED ..... 5-5
5.4 AIRPORT OPERATIONS AND MAINTENANCE IMPACT ..... 5-5
5.4.1 Modification ..... 5-5
5.4.2 Scheduled Maintenance ..... 5-6
5.4.3 Unscheduled Maintenance ..... 5-7
5.4.4 Flight Operations ..... 5-8
5.4.5 Ground Operations ..... 5-9
5.5 SAFETY ASSESSMENT ..... 5-11
5.5.1 Flammability Exposure Analysis of GBI ..... 5-11
5.5.2 Safety Assessment of GBI ..... 5-13
5.6 COST-BENEFIT ANALYSIS ..... 5-14
5.7 PROS AND CONS ..... 5-19
5.8 TECHNICAL FEASIBILITY ..... 5-19
5.8.1 New Designs ..... 5-19
5.8.2 In-Production Airplane Designs ..... 5-19
5.8.3 In-Service Airplane Retrofit ..... 5-19
5.9 MAJOR ISUES AND RESOLUTIONS ..... 5-20
5.10 CONCLUSIONS ..... 5-20
6.0 AIRPORT FACILITIES ..... 6-1
6.1 CONCEPT DESCRIPTION ..... 6-1
6.1.1 Ullage Washing ..... 6-1
6.1.2 Fuel Scrubbing ..... 6-4
6.1.3 Fuel Cooling ..... 6-8
6.1.4 Carbon Dioxide Fuel Saturation ..... 6-8
6.2 AIRPORT FACILITIES ..... 6-9
6.2.1 Methodology ..... 6-9
6.2.2 Airport Evaluations ..... 6-9
6.3 IMPACT ON AIRPORTS ..... 6-10
6.4 ENVIRONMENTAL EVALUATION ..... 6-10
6.5 COST-BENEFIT ANALYSIS ..... 6-11
6.6 TECHNICAL LIMITATIONS ..... 6-15
6.7 POTENTIAL IMPACT ON FUEL PERFORMANCE ..... 6-15
7.0 ONBOARD GROUND INERTING ..... 7-1
7.1 SYSTEM REQUIREMENTS ..... 7-1
7.2 CONCEPT DESCRIPTION ..... 7-1
7.2.1 Air Source ..... 7-2
7.2.2 Pressure Ratio: Match APU Pressure ..... 7-2
7.2.3 Air Separator ..... 7-2
7.2.4 Time for Inerting ..... 7-3
7.2.5 Flammability Exposure ..... 7-3

7.3 APPLICABILITY OF CONCEPT TO STUDY-CATEGORY AIRPLANES ..... 7-3
7.4 AIRPORT RESOURCES REQUIRED ..... 7-3
7.5 AIRLINE OPERATIONS AND MAINTENANCE IMPACT ..... 7-4
7.5.1 Modification ..... 7-4
7.5.2 Scheduled Maintenance ..... 7-5
7.5.3 Unscheduled Maintenance ..... 7-5
7.5.4 Flight Operations ..... 7-10
7.5.5 Ground Operations ..... 7-10
7.6 SAFETY ASSESSMENT ..... 7-11
7.7 COST-BENEFIT ANALYSIS ..... 7-12
7.8 PROS AND CONS ..... 7-17
7.9 MAJOR ISSUES AND RESOLUTIONS ..... 7-17
7.9.1 System Size ..... 7-17
7.9.2 Air Separator Modules ..... 7-18
7.9.3 Static Electricity ..... 7-18
7.10 CONCLUSIONS ..... 7-18
8.0 ONBOARD INERT GAS GENERATING ..... 8-1
8.1 SYSTEM REQUIREMENTS ..... 8-1
8.2 SYSTEM CONCEPT DESCRIPTION ..... 8-1
8.2.1 Air Source ..... 8-2
8.2.2 Pressure Ratio ..... 8-3
8.2.3 Air Separator ..... 8-3
8.2.4 Descent Rate ..... 8-3
8.2.5 Flammability Exposure ..... 8-3
8.3 APPLICABILITY OF CONCEPT TO STUDY-CATEGORY AIRPLANES ..... 8-3
8.4 AIRPORT RESOURCES REQUIRED ..... 8-3
8.5 AIRLINE OPERATIONS AND MAINTENANCE IMPACT ..... 8-4
8.5.1 Modification ..... 8-4
8.5.2 Scheduled Maintenance ..... 8-4
8.5.3 Unscheduled Maintenance ..... 8-5
8.5.4 Flight Operations ..... 8-14
8.5.5 Ground Operations ..... 8-15
8.6 SAFETY ASSESSMENT ..... 8-15
8.7 COST-BENEFIT ANALYSIS ..... 8-16
8.8 PROS AND CONS ..... 8-20
8.9 MAJOR ISSUES AND RESOLUTIONS ..... 8-21
8.9.1 System Size ..... 8-21
8.9.2 Air Separator Modules ..... 8-22
8.9.3 Static Electricity ..... 8-22
8.10 CONCLUSIONS ..... 8-22
9.0 HYBRID INERT GAS GENERATING SYSTEM ..... 9-1
9.1 SYSTEM REQUIREMENTS ..... 9-1
9.2 CONCEPT DESCRIPTION ..... 9-1
9.3 APPLICABILITY OF CONCEPT TO STUDY-CATEGORY AIRPLANES ..... 9-1
9.4 AIRPORT RESOURCES REQUIRED ..... 9-2
9.5 AIRLINE OPERATIONS AND MAINTENANCE IMPACT ..... 9-2
9.6 SAFETY ASSESSMENT ..... 9-2
9.7 COST-BENEFIT ANALYSIS ..... 9-6
9.8 PROS AND CONS OF SYSTEM DESIGN CONCEPT ..... 9-19

9.9 MAJOR ISSUES AND RESOLUTIONS ASSOCIATED WITH CONCEPT ..... 9-20
9.10 CONCLUSIONS ..... 9-21
10.0 AIRPLANE OPERATIONS AND MAINTENANCE ..... 10-1
10.1 METHODOLOGY ..... 10-1
10.1.1 Modification ..... 10-3
10.1.2 MEL Relief ..... 10-5
10.1.3 Scheduled Maintenance ..... 10-7
10.1.4 Unscheduled Maintenance ..... 10-9
10.1.5 Flight Operations ..... 10-10
10.1.6 Ground Operations ..... 10-11
10.2 MAINTENANCE IMPACTS ..... 10-12
10.2.1 Modification and Retrofit ..... 10-12
10.2.2 MEL Relief ..... 10-12
10.2.3 Scheduled Maintenance ..... 10-12
10.2.4 Unscheduled Maintenance ..... 10-13
10.2.5 Maintenance Training ..... 10-14
10.3 OPERATIONAL IMPACT ..... 10-14
10.3.1 Flight Operations ..... 10-14
10.3.1.1 Schedule Impact ..... 10-14
10.3.1.2 MEL Relief ..... 10-15
10.3.1.3 Lost Revenue ..... 10-15
10.3.1.4 Flight Operations Safety ..... 10-15
10.3.1.5 Flight Operations Training ..... 10-16
10.3.2 Ground Operations ..... 10-16
10.3.2.1 Ground Operations Safety ..... 10-16
10.3.2.2 Ground Operations Training ..... 10-16
10.3.2.3 Ground Servicing ..... 10-17
11.0 ESTIMATING AND FORECASTING ..... 11-1
11.1 METHODOLOGY ..... 11-1
11.2 ECONOMIC MODEL FACTORS ..... 11-2
11.3 STUDY PERIOD ..... 11-4
11.4 IMPLEMENTATION ..... 11-4
11.5 COST SUMMARIES ..... 11-5
12.0 REGULATORY IMPACT ..... 12-1
12.1 TYPE CERTIFICATION ..... 12-1
12.2 MAINTENANCE AND AIRPLANE OPERATIONS ..... 12-3
12.3 AIRPORT FACILITIES ..... 12-6
12.4 ENVIRONMENTAL ..... 12-6
12.5 REGULATORY TEXT AND GUIDANCE MATERIAL ..... 12-6
12.5.1 Methodology ..... 12-7
12.5.2 Regulatory Text ..... 12-8
12.5.3 Intent of Proposed Guidance Material ..... 12-10
12.5.4 Guidance Material ..... 12-13
13.0 CONCLUSIONS AND RECOMMENDATIONS ..... 13-1
13.1 OVERALL CONCLUSIONS ..... 13-1
13.2 RECOMMENDATIONS ..... 13-3

## LIST OF FIGURES


1-1. Technical Summary of Inerting System Concepts ..... 1-4
1-2. Flammability Exposure—Generic In-Service and Current Production Airplanes ..... 1-6
1-3. Worldwide Forecast Cumulative Accidents ..... 1-7
1-4. Estimated Cumulative Worldwide Avoided Accidents, 2005 Through 2020 ..... 1-8
1-5. Cost-Benefit Analysis Results, Worldwide Fleet, 2005 Through 2020, Based on Present Value in Year 2005 $US ..... 1-9
4-1. Generic Tank Thermal Characteristics ..... 4-3
4-2. Personnel Hazards ..... 4-6
4-3. Worldwide Unexplained Fuel Tank Explosion Accident History and Forecast ..... 4-8
4-4. Average Number of People on Board Each Generic Airplane ..... 4-9
4-5. Worldwide Accidents Avoided by GBI and OBIGGS ..... 4-9
4-6. Summary of Lives Affected Worldwide by Inerting ..... 4-10
4-7. Accident Forecast Summary Information ..... 4-11
4-8. Fuel Tank Explosion Accident Rate Comparison ..... 4-11
5-1. Center Tank Installation Concept ..... 5-2
5-2. Center and Auxiliary Tank Installation Concept ..... 5-4
5-3. Modification Estimates for Ground-Based Inerting Systems ..... 5-6
5-4. GBI Additional Scheduled Maintenance Hours ..... 5-7
5-5. GBIS Reliability and Maintainability Analysis ..... 5-8
5-6. GBI System Cost to Carry ..... 5-8
5-7. Annual Labor Estimate for Ullage Washing ..... 5-10
5-8. Flammability Exposure Results, Ground-Based Inerting System ..... 5-12
5-9. U.S. Cumulative Accidents With Ground-Based Inerting ..... 5-13
5-10. Worldwide Cumulative Accidents With Ground-Based Inerting ..... 5-14
5-11. Scenario 11—Ground-Based Inerting, HCWT Only, All Transports (World) ..... 5-15
5-12. Scenario 12—Ground-Based Inerting, All Fuselage Tanks, All Transports (World) ..... 5-15
5-13. Scenario 11—Ground-Based Inerting, HCWT Only, All Transports (U.S.) ..... 5-16
5-14. Scenario 12—Ground-Based Inerting, All Fuselage Tanks, All Transports (U.S.) ..... 5-16
5-15. Scenario 11—Ground-Based Inerting, HCWT Only, All Transports (World, Passenger Only) .. 5-17
5-16. Scenario 12—Ground-Based Inerting, All Fuselage Tanks, All Transports (World, Passenger Only) ..... 5-17
5-17. Scenario 11—Ground-Based Inerting, HCWT Only, All Transports (U.S., Passenger Only) .... 5-18
5-18. Scenario 12—Ground-Based Inerting, All Fuselage Tanks, All Transports (U.S., Passenger Only) ..... 5-18
6-1. Membrane Gas Generator at Concourse for Ullage Washing ..... 6-2
6-2. Typical Metering Station, Nitrogen Flow, and Pressure Control ..... 6-2
6-3. Current Tank Farm Configuration ..... 6-6
6-4. Fuel-Farm Piping With Added Fuel Scrubbing Unit ..... 6-6
6-5. Complete Fuel Scrubbing Operation ..... 6-7
6-6. Airport Facility Survey Form for FAA Fuel Tank Inerting ..... 6-10
6-7. ARAC Facility Estimate—Fixed Ullage System ..... 6-12
6-8. ARAC Facility Estimate—Mobile Ullage System ..... 6-12
6-9. ARAC Facility Estimate—Fixed Scrubber System ..... 6-13
6-10. ARAC Facility Estimate—Mobile Scrubber System ..... 6-13
7-1. OBGIS Schematic ..... 7-2
7-2. Modification Estimates for the OBGIS ..... 7-4

7-3. OBGI Additional Scheduled Maintenance Hours ..... 7-5
7-4. OBGIS Annual Use Rate ..... 7-5
7-5. Predicted OBGIS Annual Failure Rate ..... 7-6
7-6. Annual Unscheduled Maintenance Labor Estimate per Airplane ..... 7-7
7-7. OBGIS Availability ..... 7-8
7-8. MEL Dispatch Relief Effect ..... 7-9
7-9. Annual OBGIS Flight Delay Hours ..... 7-10
7-10. U.S. Cumulative Accidents With Onboard Ground Inerting ..... 7-11
7-11. Worldwide Cumulative Accidents With Onboard Ground Inerting ..... 7-12
7-12. Scenario 1—Onboard Ground Inerting, HCWT Only, Large, Medium, Small Transports, PSA/Membrane Systems (World) ..... 7-13
7-13. Scenario 2—Onboard Ground Inerting, All Fuselage Tanks, Large, Medium, Small Transports, PSA/Membrane Systems (World) ..... 7-13
7-14. Scenario 1—Onboard Ground Inerting, HCWT Only, Large, Medium, Small Transports, PSA/Membrane Systems (U.S.) ..... 7-14
7-15. Scenario 2—Onboard Ground Inerting, All Fuselage Tanks, Large, Medium, Small Transports, PSA/Membrane Systems (U.S.) ..... 7-14
7-16. Scenario 1—Onboard Ground Inerting, HCWT Only, Large, Medium, Small Transports, PSA/Membrane Systems (World, Passenger Only) ..... 7-15
7-17. Scenario 2—Onboard Ground Inerting, All Fuselage Tanks, Large, Medium, Small Transports, PSA/Membrane Systems (World, Passenger Only) ..... 7-15
7-18. Scenario 1—Onboard Ground Inerting, HCWT Only, Large, Medium, Small Transports, PSA/Membrane Systems (U.S., Passenger Only) ..... 7-16
7-19. Scenario 2—Onboard Ground Inerting, All Fuselage Tanks, Large, Medium, Small Transports, PSA/Membrane Systems (U.S., Passenger Only) ..... 7-16
7-20. OBGI Required Resources for All Tanks ..... 7-18
8-1. OBIGGS Schematic ..... 8-2
8-2. Modification Estimations for OBIGGS ..... 8-4
8-3. OBIGGS Additional Scheduled Maintenance Times—Cryogenic System ..... 8-5
8-4. OBIGGS Additional Scheduled Maintenance Times—Membrane System ..... 8-5
8-5. System Annual Utilization Rate ..... 8-6
8-6. System MTBUR ..... 8-7
8-7. System Annual Failure Rate ..... 8-8
8-8. Additional Annual Labor-Hours ..... 8-9
8-9. Additional Annual Labor Costs ..... 8-10
8-10. System Availability (10 Days' MMEL Relief) ..... 8-11
8-11. Delays per Year (Hours) ..... 8-12
8-12. OBIGGS Power Requirements (kVA) ..... 8-13
8-13. U.S. Cumulative Accidents With OBIGGS ..... 8-15
8-14. Worldwide Cumulative Accidents With OBIGGS ..... 8-16
8-15. Scenario 5—OBIGGS, All Tanks, Large and Medium Transports, Membrane Systems, and Small Transports, PSA/Membrane Systems (World) ..... 8-17
8-16. Scenario 13—OBIGGS, All Tanks, Large and Medium Transports, Cryogenic Systems, and Small Transports, PSA/Membrane Systems (World) ..... 8-17
8-17. Scenario 5—OBIGGS, All Tanks, Large and Medium Transports, Membrane Systems, and Small Transports, PSA/Membrane Systems (U.S.) ..... 8-18
8-18. Scenario 13—OBIGGS, All Tanks, Large and Medium Transports, Cryogenic Systems, and Small Transports, PSA/Membrane Systems (U.S.) ..... 8-18

8-19. Scenario 5—OBIGGS, All Tanks, Large and Medium Transports, Membrane Systems, and Small Transports, PSA/Membrane Systems (World, Passenger Only) ..... 8-19
8-20. Scenario 5—OBIGGS, All Tanks, Large and Medium Transports, Membrane Systems, and Small Transports, PSA/Membrane Systems (U.S., Passenger Only) ..... 8-19
8-21. Scenario 13—OBIGGS, All Tanks, Large and Medium Transports, Cryogenic Systems, and Small Transports, PSA/Membrane Systems (U.S., Passenger Only) ..... 8-20
8-22. OBIGGS System Size Issues ..... 8-21
9-1. U.S. Cumulative Accidents With Hybrid OBIGGS ..... 9-3
9-2. Worldwide Cumulative Accidents With Hybrid OBIGGS ..... 9-4
9-3. U.S. Forecast Cumulative Accidents With Hybrid OBGIS ..... 9-5
9-4. World Forecast Cumulative Accidents With Hybrid OBGIS ..... 9-6
9-5. Scenario 3—Hybrid OBGI, Heated CWT Only, Large, Medium, Small Transports, PSA/Membrane Systems (World) ..... 9-7
9-6. Scenario 4—Hybrid OBGI, All Fuselage Tanks, Large, Medium, Small Transports, PSA/Membrane Systems (World) ..... 9-7
9-7. Scenario 7—Hybrid OBIGGS, Heated CWT Only, Large and Medium Transports, Membrane Systems, and Small Transports, PSA/Membrane Systems (World) ..... 9-8
9-8. Scenario 9—Hybrid OBIGGS, All Tanks, Large and Medium Transports, Membrane Systems, and Small Transports, PSA/Membrane Systems (World) ..... 9-8
9-9. Scenario 14—Hybrid OBIGGS, Heated CWT Only, Large and Medium Transports, Cryogenic Systems, and Small Transports, PSA/Membrane Systems (World) ..... 9-9
9-10. Scenario 15—Hybrid OBIGGS, All Tanks, Large and Medium Transports, Cryogenic Systems, and Small Transports, PSA/Membrane Systems (World) ..... 9-9
9-11. Scenario 3—Hybrid OBGI, Heated CWT Only, Large, Medium, and Small Transports, PSA/Membrane Systems (U.S.) ..... 9-10
9-12. Scenario 4—Hybrid OBGI, All Fuselage Tanks, Large, Medium, and Small Transports, PSA/Membrane Systems (U.S.) ..... 9-10
9-13. Scenario 7—Hybrid OBIGGS, Heated CWT Only, Large and Medium Transports, Membrane Systems, and Small Transports, PSA/Membrane Systems (U.S.) ..... 9-11
9-14. Scenario 9—Hybrid OBIGGS, All Tanks, Large and Medium Transports, Membrane Systems, and Small Transports, PSA/Membrane Systems (U.S.) ..... 9-11
9-15. Scenario 14—Hybrid OBIGGS, Heated CWT Only, Large and Medium Transports, Cryogenic Systems, and Small Transports, PSA/Membrane Systems (U.S.) ..... 9-12
9-16. Scenario 15—Hybrid OBIGGS, All Tanks, Large and Medium Transports, Cryogenic Systems, and Small Transports, PSA/Membrane Systems (U.S.) ..... 9-12
9-17. Scenario 3—Hybrid OBGI, Heated CWT Only, Large, Medium, and Small Transports, PSA/Membrane Systems (World, Passenger Only) ..... 9-13
9-18. Scenario 4—Hybrid OBGI, All Fuselage Tanks, Large, Medium, and Small Transports, PSA/Membrane Systems (World, Passenger Only) ..... 9-13
9-19. Scenario 7—Hybrid OBIGGS, Heated CWT Only, Large and Medium Transports, Membrane Systems, and Small Transports, PSA/Membrane Systems (World, Passenger Only) ..... 9-14
9-20. Scenario 9—Hybrid OBIGGS, All Tanks, Large and Medium Transports, Membrane Systems, and Small Transports, PSA/Membrane Systems (World, Passenger Only) ..... 9-14
9-21. Scenario 13—OBIGGS, All Tanks, Large and Medium Transports, Cryogenic Systems, and Small Transports, PSA/Membrane Systems (World, Passenger Only) ..... 9-15
9-22. Scenario 14—Hybrid OBIGGS, Heated CWT Only, Large and Medium Transports, Cryogenic Systems, and Small Transports, PSA/Membrane Systems (World, Passenger Only) ..... 9-15
9-23. Scenario 15—Hybrid OBIGGS, All Tanks, Large and Medium Transports, Cryogenic Systems, and Small Transports, PSA/Membrane Systems (World, Passenger Only) ..... 9-16

9-24. Scenario 3—Hybrid OBGI, Heated CWT Only, Large, Medium, Small Transports, PSA/Membrane Systems (U.S., Passenger Only) ..... 9-16
9-25. Scenario 4—Hybrid OBGI, All Fuselage Tanks, Large, Medium, Small Transports, PSA/Membrane Systems (U.S., Passenger Only) ..... 9-17
9-26. Scenario 7—Hybrid OBIGGS, Heated CWT Only, Large and Medium Transports, Membrane Systems, and Small Transports, PSA/Membrane Systems (U.S., Passenger Only) ..... 9-17
9-27. Scenario 9—Hybrid OBIGGS, All Tanks, Large and Medium Transports, Membrane Systems, and Small Transports, PSA/Membrane Systems (U.S., Passenger Only) ..... 9-18
9-28. Scenario 14—Hybrid OBIGGS, Heated CWT Only, Large and Medium Transports, Cryogenic Systems, and Small Transports, PSA/Membrane Systems (U.S., Passenger Only) ..... 9-18
9-29. Scenario 15—Hybrid OBIGGS, All Tanks, Large and Medium Transports, Cryogenic Systems, and Small Transports, PSA/Membrane Systems (U.S., Passenger Only) ..... 9-19
9-30. Hybrid OBGIS Installation Issues ..... 9-20
9-31. Hybrid OBIGGS Installation Issues ..... 9-21
10-1. Flight Delay Assumptions ..... 10-7
10-2. Average Fleetwide Maintenance Intervals ..... 10-8
10-3. Airplane Use by Category ..... 10-10
11-1. Inerting Combinations Evaluated ..... 11-1
11-2. Cost Summary—Worldwide Fleet, All Transports ..... 11-5
11-3. Cost Summary—U.S. Fleet, All Transports ..... 11-5
11-4. Cost Summary—Worldwide Fleet, Passenger Planes Only ..... 11-6
11-5. Cost Summary—U.S. Fleet, Passenger Planes Only ..... 11-6

## GLOSSARY

| | |
|---|---|
| AC | advisory circular |
| AD | Airworthiness Directive |
| AEA | Association of European Airlines |
| AECMA | European Association of Aerospace Industries |
| AIA | Aerospace Industries Association |
| ALPA | Airline Pilots Association |
| API | American Petroleum Institute |
| APU | auxiliary power unit |
| ARAC | Aviation Rulemaking Advisory Committee |
| ASM | air separator module |
| ASTM D | an ASTM test designation |
| ASTM | American Society for Testing and Materials |
| ATA | Air Transport Association of America |
| ATB | air turnback |
| BITE | built-in test equipment |
| CBT | computer-based training |
| CFR | Code of Federal Regulations |
| CMR | certification maintenance requirement |
| CRC | Coordinating Research Council |
| CWT | center wing tank |
| DDG | dispatch deviation guide |
| DOT | Department of Transportation |
| EPA | Environmental Protection Agency |
| ER | extended range |
| ERA-7 | an additive for $CO_2$-enriched fuel |
| ETOPS | extended twin operations |
| FAR | Federal Aviation Regulation |
| FHA | functional hazard analysis |
| FTHWG | Fuel Tank Harmonization Working Group |
| FTIHWG | Fuel Tank Inerting Harmonization Working Group |
| GBI | ground-based inerting |
| GBIS | ground-based inerting system |
| $GN_2$ | gaseous nitrogen |
| GPM | gallons per minute |
| HCWT | heated center wing tank |
| HWG | Harmonization Working Group |
| IAMAW | International Association of Machinist Aerospace Workers |
| IATA | International Air Transport Association |
| JAA | Joint Airworthiness Authorities |
| JAR | Joint Aviation Requirements |

| | |
|---|---|
| LFL | lower flammability limit |
| MEL | minimum equipment list |
| MMEL | master minimum equipment list |
| MO | modification order |
| MSG-3 | Maintenance Steering Group—Version 3 |
| MTBF | mean time between failures |
| MTBMA | mean time between maintenance actions |
| MTBUR | mean time between unscheduled removal |
| NEA | nitrogen-enriched air |
| NIOSH | National Institute of Occupational Safety and Health |
| NPRM | Notice of Proposed Rulemaking |
| NSF | nitrogen-saturated fuel |
| NTSB | National Transportation Safety Board |
| OBGI | onboard ground inerting |
| OBGIS | onboard ground inerting system |
| OBI | onboard inerting |
| OBIGGS | onboard inert gas generating system |
| OEM | original equipment manufacturer |
| OSHA | Occupational Safety and Health Administration |
| p/m | parts per million |
| PRV | pressure-regulating valve |
| PSA | pressure-swing adsorption |
| SB | service bulletin |
| SCF | standard cubic feet |
| SCFM | standard cubic feet per minute |
| SFAR | Special Federal Aviation Regulation |
| TC | type certificate |
| TCAS | traffic collision avoidance system |
| UFL | upper flammability limit |
| VOC | volatile organic compound |

# 1.0
# Executive Summary