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Safety, Performance, And Interoperability Requirements Document For Airborne Spacing - Flight Deck Interval Management (ASPA-FIM)

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TABLE OF CONTENTS

1 INTRODUCTION 1

1.1 Purpose of the document 2
1.1.1 ASPA-FIM System 2
1.1.2 Use of document for approvals 2
1.2 Scope of the Document 3
1.2.1 ASPA-FIM Context 3
1.2.2 Assumed Airborne and Ground Generic Surveillance Functional Architecture 5
1.3 Definition of Terms 7
1.4 Structure of Document 15
1.5 References 16
1.5.1 ICAO 16
1.5.2 EUROCONTROL 16
1.5.3 FAA 16
1.5.4 EUROCAE/RTCA 17
1.5.5 Other 19

2 APPROACH AND METHODOLOGY 21

2.1.1 Document development process 21
2.2 Methodology 21
2.2.1 Operational Services and Environment Definition (OSED) 21
2.2.2 Safety and Performance Requirements (SPR) 21
2.2.3 Interoperability Requirements (INTEROP) 22
2.3 Key Terms 23
2.3.1 Uses of Requirements and Recommendations and Key Words 23
2.3.2 Assumptions 23
2.3.3 Mitigation Means 23
2.3.4 Requirements 24
2.3.5 Recommendations 25

3 SAFETY AND PERFORMANCE REQUIREMENTS (SPR) 27

3.1 Background/Introduction 27
3.2 Scope of Safety and Performance Requirements 27
3.2.1 OSED Process 28
3.2.2 OPA process 29
3.2.3 OSA process 30
3.2.4 SPR Process 33
3.3 Assumptions 36
3.3.1 General Assumptions 36
3.3.2 Environmental Assumptions 37
3.3.3 Modeling Assumptions 38
3.3.4 Receive Aircraft Domain Assumptions 40
3.3.5 Transmit Aircraft Domain Assumptions 42
3.3.6 Ground Domain Assumptions 43

3.4 Operational Requirements 45
3.4.1 Pre-Initiation Activities 45
3.4.2 Initiation Phase 48
3.4.3 Execution Phase 52
3.4.4 Termination Phase 57
3.5 FIM Equipment Requirements 58
3.5.1 Functional Requirements for FIM Equipment 58
3.5.2 Safety and Performance Requirements for FIM Equipment 71
3.6 ASPA-FIM Data Requirements 74
3.7 Design Considerations for Instrument Arrival and Approach Procedures use of ASPA- 75
3.7.1 IM-Related Objectives 76
3.7.2 Speed Profile 77
3.7.3 Altitude Profile 80
3.7.4 Energy Management 80
3.7.5 Lateral Considerations 82
3.7.6 Other Concerns 82
3.7.7 Quantifying Errors 84
3.8 Further Analyses for Overall IM System Performance 87
3.8.1 Use of Intended Flight Path Information 87
3.8.2 Use of IM Operations with Optimized Profile Descent (OPD) Trajectories 88
3.8.3 Means to Communicate Final Approach Speed 89
3.8.4 Interoperability of Different FIM Equipment Implementations 89

4 INTEROPERABILITY REQUIREMENTS 91

4.1 Purpose of Interoperability Requirements 91
4.2 Scope of Interoperability Requirements 91
4.2.1 Uses of Requirements and Recommendations and Key Words 92
4.2.2 ASPA-FIM Domains 92
4.3 ASPA-FIM Interoperability Requirements 96
4.3.1 Target Aircraft Surveillance Information Requirements 96
4.3.2 Identity 97
4.3.3 Horizontal Position 97
4.3.4 Vertical Position 98
4.3.5 Horizontal Velocity 99
4.3.6 Vertical Rate 100
4.3.7 Surveillance quality indicators 100
4.3.8 Additional Surveillance Information 100
4.4 Communication Requirements for IM Clearances 101
4.4.1 Scope of Communication Requirements 101
4.4.2 ASPA-FIM Communication Domains 102
4.4.3 IM Clearance Information 103
4.4.4 Forecast Winds and Temperatures 107
4.4.5 Requirements for CPDLC Downlink 107

5. MEMBERSHIP 107

ANNEX A - OPERATIONAL SERVICES AND ENVIRONMENT DEFINITION A-1

A.1 Introduction A-1
A.2 Objective A-2
A.3 IM Operational Description A-3
A.3.1 Operational Examples A-4
A.3.2 Ground Infrastructure A-6
A.3.3 Pre-initiation Activities A-9
A.3.4 Initiation Phase A-40
A.3.5 Execution Phase A-48
A.3.6 Termination Phase A-60
A.4 Interval Management Scenarios A-62
A.4.1 General Use Scenarios A-63
A.4.2 Arrival and Approach Scenarios A-71
A.5 Airspace Characteristics, Supporting Systems and Operational Environment A-87
A.5.1 Airspace System A-87
A.5.2 Ground Equipment A-89
A.5.3 Communication Means A-90
A.5.4 Equipage A-90
A.6 General Application Context A-91
A.6.1 Scope A-91
A.6.2 Roles and Responsibilities A-92
A.7 Procedural Flow A-93
A.8 Phase Diagrams A-95
A.9 Phase Table A-104
A.10 Abnormal Events A-130
A.11 Summary of assumptions and Operational Requirements A-132
A.11.1 Assumptions A-132
A.11.2 Operational Requirements A-140

ANNEX B - OPERATIONAL PERFORMANCE ASSESSMENT B-1

B.1 Introduction B-1
B.1.1 Purpose B-1
B.1.2 The CNS/ATM system B-1
B.1.3 Objectives B-3
B.1.4 Scope B-3
B.1.5 Approach B-4
B.1.6 OPA Definitions B-4
B.2 Required Information for the ASPA-FIM SYSTEM B-6
B.2.1 Information Made Available to the FIM Equipment B-6
B.2.2 Information provided to the Flight Crew by FIM Equipment B-8
B.2.3 IM Aircraft Data via Interface B2 ..... B-9
B.2.4 Target Aircraft Data via Interface D B-10
B.3 Functional Requirements on the FIM Equipment B-10
B.3.1 Functional Requirements Supporting Data Availability to the FIM Equipment B-11
B.3.2 Functional Requirements Supporting Display Items B-22
B.4 Performance Requirements on the FIM Equipment B-31
B.4.1 Performance Requirements Supporting the FIM Equipment Tolerance B-31

B.4.2 Performance Requirements and Assumptions for IM Aircraft and Target Aircraft State Data….. .....B-34
B.4.3 Performance Requirements and Assumptions on Measured Spacing Interval Approximation Error B-45
B.4.4 Performance Requirements and Assumptions on Trajectory Generation for the IM Control Algorithm.....B-46
B.4.5 IM Speed Performance in the Assumed Operating Environment.....B-47
B.4.6 IM Performance Considerations for Differing Airspace Requirements.....B-49
B.5 Summary of Assumptions and Performance Requirements.....B-50
B.5.1 Assumptions.....B-50
B.5.2 Performance Requirements.....B-55

APPENDIX B-1 DETERMINATION OF IM OPERATIONAL TOLERANCES FOR SELECTED OPERATIONAL SCENARIOS.....B-71

B-1.1 IM Operational Tolerance Methodology B-71
B-1.1.1 Operationally-Required Tolerances.....B-71
B-1.1.2 Nominal Spacing Bounds B-72
B-1.1.3 Controller Intervention Threshold B-73
B-1.1.4 Reconciliation of the ORTs B-74
B-1.2 IM SCENARIO A.....B-74
B-1.2.1 Description of the IM Scenario.....B-74
B-1.2.2 Operational Goal.....B-74
B-1.2.3 Methodology for Deriving the IM Operational Tolerance.....B-74
B-1.2.4 Result B-75
B-1.2.5 Variations on IM Scenario A B-77
B-1.3 IM Scenario B.....B-77
B-1.3.1 Description of the IM Scenario.....B-77
B-1.3.2 Operational Goal.....B-77
B-1.3.3 Methodology for Deriving the IM Operational Tolerance.....B-78
B-1.3.4 Result B-78
B-1.3.5 Variations on IM Scenario B B-79
B-1.4 IM Scenario C.....B-80
B-1.4.1 Description of the IM Scenario.....B-80
B-1.4.2 Operational Goal.....B-80
B-1.4.3 Methodology for Deriving the IM Operational Tolerance.....B-80
B-1.4.4 Result B-81
B-1.5 IM Scenario D.....B-85
B-1.5.1 Description of the IM Scenario.....B-85
B-1.5.2 Operational Goal.....B-85
B-1.5.3 Methodology for Deriving the IM Operational Tolerance.....B-85
B-1.5.4 Result B-86
B-1.6 IM Scenario E B-92
B-1.6.1 Description of the IM Scenario.....B-92
B-1.6.2 Result B-92
B-1.7 Summary.....B-93

APPENDIX B-2 EFFECT OF MEASUREMENT ERRORS ON THE FIM EQUIPMENT OBJECTIVE REGION.....B-94

APPENDIX B-3 ANALYSIS OF IM AIRCRAFT AND TARGET AIRCRAFT STATE DATA QUALITY B-98

B-3.1 Target and IM Aircraft Horizontal Position Accuracy Analysis B-99
B-3.2 IM Aircraft Horizontal Velocity Accuracy, Latency, and Update rate Analysis.....B-103
B-3.2.1 Compensated Latency – IM Aircraft B-103
B-3.2.2 Uncompensated Latency – IM Aircraft (Differential Latency) B-105
B-3.3 Target Aircraft Horizontal Velocity Accuracy, Latency, and Update Rate ANALYSIS B-106
B-3.3.1 Compensated Latency – Target Aircraft.....B-106
B-3.3.2 Uncompensated Latency – Target Aircraft (Differential Latency).....B-123
B-3.4 Model Inputs and Example Calculation for Determining Measured Spacing Interval Uncertainty B-123
B-3.5 Summary Analysis of the State Data Requirements and Assumptions that Affect the Measured Spacing Interval B-126
B-3.6 Vertical Position Accuracy Analysis B-132
B-3.7 Vertical Rate Accuracy Analysis.....B-134

APPENDIX B-4 MEASURED SPACING INTERVAL APPROXIMATION ERROR ANALYSIS…….B-136

B-4.1 Path Construction Errors.....B-136
B-4.2 Along-path Position Calculation.....B-138
B-4.3 Along-path Distance Calculation.....B-139
B-4.4 Approximation Errors from Interpolation.....B-139
B-4.5 Position Alignment Errors B-141
B-4.6 Allocation for errors.....B-141

APPENDIX B-5 DERIVATION OF IM SPEED PERFORMANCE REQUIREMENT TO SUPPORT GOOD STRING PERFORMANCE.....B-143

B-5.1 Overview of the Performance Analysis B-143
B-5.2 Aircraft Model Used for the Analysis.....B-143
B-5.2.1 Longitudinal Aircraft Model.....B-143
B-5.2.2 Selection of the Aircraft Performance Gain.....B-144
B-5.3 Achieve Stage Control Law.....B-149
B-5.3.1 Description of the Achieve Stage Control Law B-149
B-5.3.2 Time-to-Go Control Law for Time-Based Assigned Spacing Goals B-149
B-5.3.3 String Dynamics for the Time-to-Go Control Law (for Time-based Assigned Spacing Goals)…… B-150
B-5.3.4 Time-to-Go Control Law for Distance-Based Assigned Spacing Goals……B-151
B-5.3.5 String Dynamics for the Time-to-Go Control Law (for Distance-based Assigned Spacing Goals) B-152
B-5.4 Maintain Stage Control Law.....B-153
B-5.4.1 Description of the Maintain Stage Control Laws.....B-153
B-5.4.2 Station-keeping Control Law.....B-153

B-5.4.3 String Dynamics for the Station-keeping Control Law....B-154
B-5.4.4 Time-history Control Law....B-155
B-5.4.5 String Dynamics for the Time-history Control Law....B-155
B-5.4.6 Proof of Equivalence....B-156
B-5.4.7 Frequency Response of Error-Propagation Transfer Functions....B-157
B-5.5 Requirements on Closed-Loop Response to IM Speeds....B-159
B-5.5.1 Gain Tuning for Acceptable String Behavior....B-159
B-5.5.2 Gain Tuning for Acceptable Correction of Spacing Errors....B-164
B-5.6 Derivation of General Performance Requirement....B-165

APPENDIX B-6 VALIDATION THAT FIM EQUIPMENT TOLERANCE AND OTHER KEY PERFORMANCE REQUIREMENTS ARE SUFFICIENT TO MEET THE IM OPERATIONAL TOLERANCE....B-166

B-6.1 Introduction....B-166
B-6.2 IM Sample Algorithms....B-166
B-6.2.1 Reference Horizontal Path and Airspeed Profile....B-166
B-6.2.2 Achieve Stage Algorithm....B-167
B-6.2.3 IM Turn Algorithm....B-174
B-6.2.4 Maintain Stage Algorithm....B-178
B-6.3 Requirement for a Predictive Algorithm in the Achieve Stage....B-180
B-6.4 Fast-Time Simulation Environment....B-184
B-6.4.1 Aircraft Model....B-185
B-6.5 Experimental Overview....B-189
B-6.5.1 Assumptions....B-189
B-6.5.2 Scenarios....B-223
B-6.6 Performance Metrics....B-232
B-6.6.1 Achieve Stage Metrics....B-233
B-6.6.2 Maintain Stage Metrics....B-233
B-6.6.3 Capture Metrics....B-234
B-6.7 Interpretation of Results....B-235
B-6.8 Results....B-235
B-6.8.1 Same Runway Terminal Merge with Achieve-by Point at FAF....B-235
B-6.8.2 Same Runway Terminal Merge with Achieve-by Point at Merge Point....B-247
B-6.8.3 Capture then Maintain on Arrival Procedures....B-249
B-6.8.4 Dependent Parallel Runway Operations....B-252
B-6.8.5 Dependent Crossing and Converging Runway Operations....B-254
B-6.8.6 Paired Approach....B-255
B-6.8.7 Final Approach Spacing....B-258
B-6.8.8 IM Turn....B-259
B-6.9 Summary of Results....B-266

APPENDIX B-7 FLIGHT CREW TASK ANALYSIS....B-270

APPENDIX B-8 SPACING PRECISION DEMONSTRATED BY PAST RESEARCH EFFORTS……...B-282

APPENDIX B-9 DERIVATION OF NEAR-PARALLEL ROUTE REQUIREMENT B-289

B-9.1 Determination of Near-Parallel B-289
B-9.1.1 Speed Authority B-289
B-9.1.2 Path Length Differences Based on an Orthogonal Projection B-291
B-9.1.3 Steady-State Error B-293
B-9.3 Examples of Near-Parallel Routes B-298

APPENDIX B-10 DERIVATION OF ADS-B RANGE NEEDED TO SUPPORT ASPA-FIM B-301

B-10.1 ADS-B Range Analysis based on Operational Objectives B-301
B-10.2 Update Interval Required for ADS-B Data B-303

ANNEX C OPERATIONAL SAFETY ASSESSMENT C-1

C.1 Introduction C-1
C.1.1 OSA Objective C-1
C.1.2 OSA Purpose and Scope C-1
C.1.3 Definition of terms used in the OSA C-2
C.2 Operational Safety Assessment Approach C-4
C.2.1 OHA Process C-5
C.2.2 ASOR Process C-10
C.3 ASPA-FIM OSA Results Summary C-14
C.3.1 Operational Hazard Identification C-14
C.3.2 Operational Effects Assessment C-15
C.3.3 Safety Objectives C-21
C.4 Detailed Safety Analysis per OH C-31
C.4.1 OH1: Incorrect Initiation of IM Operation C-32
C.4.2 OH2: Incorrect or Inappropriate Execution of IM Operation C-125
C.4.3 OH3: Incorrect or Abnormal Termination of IM Operation C-220
C.4.4 OH4: Incorrect or Inappropriate Sequencing of Partial and Active IM Clearances C-223

APPENDIX C-1 ED-78A/DO-264 BASED HAZARD CLASSIFICATION MATRIX C-249

APPENDIX C-2 EVALUATING HUMAN ERROR RATE C-251

APPENDIX C-3 PERFORMANCE ENVELOPE OF AN AIRCRAFT C-258

APPENDIX C-4 OSA IMPACT ASSESSMENT OF OPERATIONAL SCENARIOS C-259

APPENDIX C-5 EXAMPLE TO CALCULATING THE IC DISTRIBUTIONS C-333

ANNEX D – FIM SPACING ERROR ANALYSIS FOR SINGLE RUNWAY OPERATIONS D-1

D.1 Introduction D-1
D.2 FIM Operational Spacing Error Analysis D-1
D.2.1 Spacing Error Analysis Modelling D-2
D.2.2 Determination of FIM NIC / SIL Requirements D-10
D.3 ADS-B Data Quality Indicator Coasting D-13

ANNEX E – FIM SPACING ERROR ANALYSIS FOR DEPENDENT RUNWAY OPERATIONS……E-1

E.1 Introduction And Summary of Key REquirements E-1
E.2 Operational Input Parameters E-1
E.2.1 Targeted Spacing at the Planned Termination Point E-2
E.2.2 Horizontal Position Performance Targets E-5
E.2.3 Exposure Time at Targeted Spacing E-14
E.2.4 Rate of IM Operations E-14
E.2.5 Likelihood That Horizontal Position Integrity Failure Is in a Critical Direction E-14
E.3 Results E-14
E.4 Considerations for Airspace without a NIC = 7 ADS-B Out Integrity Mandate E-18

ANNEX F – ACRONYMS F-1

TABLE OF TABLES

Table 3.1 OSA Operational Hazards 31
Table 3.2 Pre-Initiation Activities Operational Requirements 46
Table 3.3 Initiation Phase Operational Requirements 49
Table 3.4 Execution Phase Operational Requirements 53
Table 3.5 Termination Phase Operational Requirements 57
Table 3.6 Functional Requirements for FIM Equipment 59
Table 3.7 System Integrity Requirements 72
Table 3.8 ASPA-FIM System Timing Requirements 73
Table 3.9 ASPA-FIM Data Quality Requirements 74
Table 3.10 Steady-State Errors for Different Track-Angle Offsets 85
Table 4.1 Data for Short-Period Interrogation 107
Table A1 IM Application Information required for the Achieve-by then Maintain Clearance Type 14
Table A.2 IM Application Information required for the Capture then Maintain Clearance Type 17
Table A.3 IM Application Information required for the Maintain Current Spacing Clearance Type 20
Table A.4 IM Application Information required for the IM Turn Clearance Type 23
Table A.5 IM Application Information required for the Final Approach Spacing Clearance Type 25
Table A.6 Summary of IM Clearance Information elements for each IM Clearance Type 26
Table A.7 IM Clearance Type and corresponding recommended text on the flight crew interface 28
Table A.8 Expected Behavior after Resume during an IM Turn procedure 51
Table A.9 Mapping of IM Clearance Types to Operational Geometries 62
Table A.10 Phase Table: ASPA-FIM Initiation, Execution, Execution – Suspend/Resume, and Termination 104
Table A.11 Abnormal Events and Responses 130
Table A.12 Summary of OSED Assumptions 132
Table A.13 ASPA-FIM Operational Requirements 140
Table B.1 Allocations of the IM Operational Tolerances for the IM Operational Tolerances 32
Table B.2 FIM Equipment Tolerance for Different Horizontal Accuracies 50
Table B.3 Expected IM Performance for Different Horizontal Accuracies 50
Table B.4 OPA Assumptions 51
Table B.5 ASPA-FIM Performance Requirements 55
Table B.6 Final Approach Speeds by Wake Category 81
Table B.7 Distance-based Wake-Vortex Minimum Separation Standards (NM) 82
Table B.8 Time-based Wake-Vortex Minimum Separation Standards (seconds) 82
Table B.9 Wake Probabilities (percent) 83
Table B.10 Distance-based Minimum Separation Standards from FAA JO 7110.308C (NM) 86
Table B.11 Time-based Minimum Separation Standards from FAA JO 7110.308C (seconds) 86

Table B.12 Probability of Wake Category Pairs (percent) 88
Table B.13 Distance-based Separation Standard for Dependent Converging and Crossing Runways……..... 91
Table B.14 Time-based Separation Standard for Dependent Converging and Crossing Runways 91
Table B.15 Wake Category Pairing Probabilities for Runways 18C and 23 at KCLT (percent)..... 91
Table B.16 IM Operational Tolerances for the Sample Analyses. 93
Table B.17 Measured Spacing Interval Uncertainty (95%) due to either Target Aircraft or IM Aircraft Horizontal Position Accuracy 100
Table B.18 Measured Spacing Interval Uncertainty (95%) due to Target and IM Aircraft each having the same Horizontal Position Accuracy 102
Table B.19 Measured Spacing Interval Uncertainty (95%) due to IM Aircraft Latency Compensation [Assuming 3 seconds (95%) latency compensation]..... 105
Table B.20 Measured Spacing Interval Uncertainty (95%) due to 3.0 Second Velocity Compensation (Assuming no acceleration)..... 109
Table B.21 Measured Spacing Interval Uncertainty (95%) due to 3.0 Second Velocity Compensation (with 0.1g acceleration/deceleration) 109
Table B.22 Measured Spacing Interval Uncertainty (95%) due to 5 Sec. Update Interval as a function of Velocity Accuracy and Speed (no acceleration) 112
Table B.23 Measured Spacing Interval Uncertainty (95%) due to 10 Sec. Update Interval as a function of Velocity Accuracy and Speed (no acceleration) 113
Table B.24 Measured Spacing Interval Uncertainty (95%) due to 15 sec. Update Interval as a function of Velocity Accuracy and Speed (no acceleration) 114
Table B.25 Measured Spacing Interval Uncertainty (95%) due to 20 Sec. Update Interval as a function of Velocity Accuracy and Speed (no acceleration) 115
Table B.26 Measured Spacing Interval Uncertainty (95%) due to 25 Sec. Update Interval as a function of Velocity Accuracy and Speed (no acceleration) 116
Table B.27 Measured Spacing Interval Uncertainty (95%) due to 5 Sec. Update Interval as a function of Velocity Accuracy (Assuming: 0.1g acceleration/deceleration)..... 117
Table B.28 Measured Spacing Interval Uncertainty (95%) due to 10 Sec. Update Interval as a function of Velocity Accuracy (Assuming: 0.1g acceleration/deceleration)..... 118
Table B.29 Measured Spacing Interval Uncertainty (95%) due to 15 sec. Update Interval as a function of Velocity Accuracy (Assuming: 0.1g acceleration/deceleration)..... 119
Table B.30 Measured Spacing Interval Uncertainty (95%) due to 20 Sec. Update Interval as a function of Velocity Accuracy (Assuming: 0.1g acceleration/deceleration)..... 120
Table B.31 Measured Spacing Interval Uncertainty (95%) due to 25 Sec. Update Interval as a function of Velocity Accuracy (Assuming: 0.1g acceleration/deceleration)..... 121
Table B.32 Measured Spacing Interval Uncertainty (95%) due to Latency Compensation for ADS-B Target Aircraft..... 122
Table B.33 Measured Spacing Interval Uncertainty (95%) due to Latency Compensation for ADS-R Target Aircraft..... 123
Table B.34 Reference for Error Source Values 125
Table B.35 Measured Spacing Interval Uncertainty in Time (95%) due to State Data Quality (Speeds: 100 to 350 knots)..... 127
Table B.36 Measured Spacing Interval Uncertainty in Time (95%) due to State Data Quality (Speeds: 400 to 600 knots)..... 128

Table B.37 Measured Spacing Interval Uncertainty in Distance (95%) due to State Data Quality (Speeds: 100, 150, 250, 400, and 600 knots) 129
Table B.38 Example Calculation of the Measured Spacing Interval Uncertainty at 250 knots with ADS-B Version 2 as the Target Aircraft Surveillance Source 130
Table B.39 Nomenclature and Definitions for Time-to-Go Control Algorithm. 167
Table B.40 IM Speed Discretization Schedule for Uncoupled FIM Equipment Systems 173
Table B.41 IM Speed Discretization Schedule for Coupled FIM Equipment Systems 174
Table B.42 IM Speed Discretization Schedule 180
Table B.43 Comparison of Spacing Performance when using Non-predictive and Predictive Achieve Stage Algorithms 181
Table B.44 Altitude and Speed Constraints at KPHX Waypoints 192
Table B.45 Altitude and Speed Constraints at KDEN Waypoints 197
Table B.46 Sequence of Routes for Merging Routes at KDEN 201
Table B.47 Altitude and Speed Constraints at KLAS Waypoints 203
Table B.48 Altitude and Speed Constraints at KCLT Airport 207
Table B.49 Waypoint Speed and Altitude Constraints at KEWR 210
Table B.50 Waypoint Speed and Altitude Constraints at KPHL 212
Table B.51 Waypoint Speed and Altitude Constraints at KBOS 216
Table B.52 Waypoint Speed and Altitude Constraints at KSFO 218
Table B.53 Waypoint Speed and Altitude Constraints at KSEA 221
Table B.54 Scenarios used to Verify that Spacing Performance meets FIM Equipment Tolerances 223
Table B.55 Notional “Schedule” for Modeling Effects of Delay 226
Table B.56 Final Approach Spacing Scenario Summary 230
Table B.57 Spacing Performance for Terminal Merging Scenario (Time-based Assigned Spacing Goals and Uncoupled FIM Equipment Systems) 236
Table B.58 Number of Wind Conditions where FIM Equipment Tolerance is Met for Terminal Merging Scenario (Time-based Assigned Spacing Goals and Uncoupled FIM Equipment Systems) 237
Table B.59 Spacing Performance for Terminal Merging Scenario (Time-based Assigned Spacing Goals and Coupled FIM Equipment Systems) 238
Table B.60 Number of Wind Conditions where FIM Equipment Tolerance is Met for Terminal Merging Scenario (Time-based Assigned Spacing Goals and Coupled FIM Equipment Systems) 238
Table B.61 Spacing Performance for Terminal Merge Scenario (Achieve at FAF, Distance-based Assigned Spacing Goals, and Uncoupled FIM Equipment Systems) 240
Table B.62 Number of Wind Conditions where FIM Equipment Tolerance is Met for Terminal Merging Scenario (Distance-based Assigned Spacing Goals and Coupled FIM Equipment Systems) 241
Table B.63 Nominal and Reduced Speeds at Specified Waypoints for Generating Delayed Trajectories 241
Table B.64 Spacing Performance for Terminal Merging Scenario (Time-based Assigned Spacing Goals, Uncoupled FIM Equipment Systems, and Delayed Trajectories) 246

Table B.65 Number of Wind Conditions where FIM Equipment Tolerance is Met for Terminal Merging Scenario (Time-based Assigned Spacing Goals, Uncoupled FIM Equipment Systems, and Delayed Trajectories) 247
Table B.66 Spacing Performance for Terminal Merging Scenario with Achieve-by Point at Merge Point (Time-based Assigned Spacing Goals and Uncoupled FIM Equipment Systems) ……..248
Table B.67 Percent of Maintain Stage where the Measured Spacing Interval is within the FIM Equipment Tolerance for Terminal Merging Scenario with Achieve-by Point at Merge Point (Time-based Assigned Spacing Goals and Uncoupled FIM Equipment Systems) ……248
Table B.68 Number of Wind Conditions with Measured Spacing Inteval within FIM Equipment Tolerance for 95% of Maintain Stage for Terminal Merging Scenario with Achieve-by Point at Merge Point (Time-based Assigned Spacing Goals and Uncoupled FIM Equipment Systems) 249
Table B.69 Percent of Maintain Stage where the Measured Spacing Interval is within the FIM Equipment Tolerance for Capture then Maintain on Arrival Procedures..... 251
Table B.70 Number of Wind Conditions where the Measured Spacing Inteval is within FIM Equipment Tolerance for 95% of Maintain Stage for Capture then Maintain on Arrival Procedures ……252
Table B.71 Spacing Performance for Dependent Parallel Runway Operations..... 252
Table B.72 Percent of Maintain Stage where the Measured Spacing Interval is within the FIM Equipment Tolerance for Terminal Merging Scenario with Achieve-by Point at Merge Point (Time-based Assigned Spacing Goals and Uncoupled FIM Equipment Systems) ……253
Table B.73 Number of Wind Conditions with Measured Spacing Inteval within FIM Equipment Tolerance for 95% of Maintain Stage for Terminal Merging Scenario with Achieve-by Point at Merge Point (Time-based Assigned Spacing Goals and Uncoupled FIM Equipment Systems) 253
Table B.74 Spacing Performance for Dependent Crossing and Convering Runway Scenario..... 255
Table B.75 Number of Wind Conditions where FIM Equipment Tolerance is Met for Dependent Crossing and Convering Runway Scenario..... 255
Table B.76 Percent of Maintain Stage where the Measured Spacing Interval is within the FIM Equipment Tolerance for Paired Approach..... 257
Table B.77 Number of Wind Conditions where the Measured Spacing Inteval is within FIM Equipment Tolerance for 95% of Maintain Stage Paired Approach. 258
Table B.78 Spacing Performance for the Final Approach Spacing Scenario with Time-based Assigned Spacing Goals..... 259
Table B.79 Spacing Performance for the Final Approach Spacing Scenario with Distance-based Assigned Spacing Goals..... 259
Table B.80 Number of Iterations for IM Turn Point to Converge to a Solution for Case 1 265
Table B.81 Number of Iterations for IM Turn Point to Converge to a Solution for Case 2 266
Table B.82 Performance Requirements Implicit in Fast-Time Simulation..... 267
Table B.83 Performance Requirements Implicit in Scenario Design 268
Table B.84 Related/Needed Information for each Flight Crew Task 274
Table B.85 Summary of Results from the Literature..... 283
Table B.86 Steady-State Errors for Different Track-Angle Offsets..... 298

Table B.87 Summary of Facility Corner-Post Distances 302
Table B.88 IM Required Update Interval at Range 303
Table C.1 Definition of Terms used in the OSA 2
Table C.2 Safety Targets from U.S. FAA SMS Approach 8
Table C.3 Safety Targets from European Approach 9
Table C.4 Gate Symbols 12
Table C.5 ASPA-FIM Operational Hazards 15
Table C.6 Environmental Conditions 16
Table C.7 Initial Conditions 17
Table C.8 External Mitigation Means 18
Table C.9 Internal Mitigation Means 21
Table C.10 ASPA-FIM Safety Requirements 22
Table C.11 OSA Assumptions 25
Table C.12 Safety Objectives per ASPA-FIM Hazard – FAA SMS 29
Table C.13 Safety Objectives per ASPA-FIM Hazard – European Safety Analysis 31
Table C.14 Safety Objectives for OH1.A Event Tree 37
Table C.15 Barriers for OH1.A Event Tree 38
Table C.16 Basic Causes/ Mitigations OH1.A Fault Tree without CPDLC 43
Table C.17 Basic Causes/ Mitigations OH1.A Fault Tree with CPDLC 48
Table C.18 U.S. FAA SMS Safety Objectives for OH1.B Event Tree 54
Table C.19 Barriers for OH1.B Event Tree for U.S. FAA SMS 55
Table C.20 Basic Causes/ Mitigations for OH1.B Fault Tree for U.S. FAA SMS without CPDLC 61
Table C.21 Basic Causes/ Mitigations for OH1.B Fault Tree for U.S. FAA SMS with CPDLC 66
Table C.22 Safety Objectives for OH1.B Event Tree for the European Safety Analysis 70
Table C.23 Barriers for OH1.B Event Tree for the European Safety Analysis 71
Table C.24 Basic Causes/ Mitigations for OH1.B Fault Tree for the European Safety Analysis without CPDLC 78
Table C.25 Basic Causes/ Mitigations for OH1.B Fault Tree for the European Safety Analysis with CPDLC 84
Table C.26 Safety Objectives for OH1.C Event Tree 90
Table C.27 Barriers for OH1.C Event Tree 91
Table C.28 Basic Causes/ Mitigations for OH1.C Fault Tree without CPDLC 100
Table C.29 Basic Causes/ Mitigations for OH1.C Fault Tree with CPDLC 105
Table C.30 Incorrect and Correct IM Clearance Types Combinations 108
Table C.31 Safety Objectives for OH1.D Event Tree 113
Table C.32 Barriers for OH1.D Event Tree 114
Table C.33 Basic Causes/ Mitigations for OH1.D Fault Tree without CPDLC 118
Table C.34 Basic Causes/ Mitigations for OH1.D Fault Tree with CPDLC 123
Table C.35 Safety Objectives for OH2.A Event Tree of FIM Equipment corrupting IM Speed(s) 130
Table C.36 Barriers for OH2.A Event Tree - FIM Equipment corrupting IM Speed(s) 131
Table C.37 Basic Causes/ Mitigations OH2.A FIM Equipment Fault Tree 136

Table C.38 IC.3 Error Distribution Sensitivity Analysis 137
Table C.39 Safety Objectives for OH2.B Event Tree – Over-Speed 142
Table C.40 Safety Objectives for OH2.B Event Tree – Under-Speed 142
Table C.41 Barriers for OH2.B Event Tree 143
Table C.42 Basic Causes/ Mitigations OH2.B Fault Tree 147
Table C.43 Safety Objectives for OH2.C Event Tree – Wrong IM Turn Point 152
Table C.44 Barriers for OH2.C Event Tree 153
Table C.45 Basic Causes/ Mitigations OH2.C Fault Tree 160
Table C.46 IC.5 Error Distribution Sensitivity Analysis 162
Table C.47 Safety Objectives for OH2.D Event Tree 167
Table C.48 Barriers for OH2.D Event Tree 168
Table C.49 Basic Causes/ Mitigations for OH2.D Fault Tree without CPDLC 176
Table C.50 Basic Causes/ Mitigations for OH2.D Fault Tree with CPDLC 181
Table C.51 Safety Objectives for OH2.E Event Tree 187
Table C.52 Barriers for OH2.E Event Tree 188
Table C.53 Basic Causes/ Mitigations for OH2.E Fault Tree 196
Table C.54 Safety Objectives for OH2.F Event Tree 202
Table C.55 Barriers for OH2.F Event Tree 203
Table C.56 Basic Causes/ Mitigations for OH2.F Fault Tree 207
Table C.57 Safety Objectives for OH2.G Event Tree 212
Table C.58 Barriers for OH2.G Event Tree 213
Table C.59 Basic Causes/ Mitigations for OH2.G Fault Tree 217
Table C.60 Safety Objectives for OH4.A Event Tree 228
Table C.61 Barriers for OH4.A Event Tree 229
Table C.62 Basic Causes/ Mitigations for OH4.A 234
Table C.63 Safety Objectives for OH4.B Event Tree 240
Table C.64 Barriers for OH4.A Event Tree 241
Table C.65 Basic Causes/ Mitigations for OH4.B Fault Tree 246
Table C.66 Generic Task Types Description 254
Table C.67 OH2.B Generic Performance Envelope Table 258
Table C.68 Impact Assessment Summary – Safety Requirement Value Determination 261
Table C.69 Scenario 1a Event Tree and Fault Tree Impacts 267
Table C.70 Scenario 1b Event Tree and Fault Tree Impacts 271
Table C.71 Scenario 1c Event Tree and Fault Tree Impacts 275
Table C.72 Scenario 2 Event Tree and Fault Tree Impacts 280
Table C.73 Scenario 3a Event Tree and Fault Tree Impacts 285
Table C.74 Scenario 3b Event Tree and Fault Tree Impacts 292
Table C.75 Scenario 3c Event Tree and Fault Tree Impacts 299
Table C.76 Scenario 4a Event Tree and Fault Tree Impacts 306
Table C.77 Scenario 4b Event Tree and Fault Tree Impacts 313
Table C.78 Scenario 5 Event Tree and Fault Tree Impacts 319

Table C.79 Scenario 6 Event Tree and Fault Tree Impacts 326
Table D.1 FIM Spacing Error Analysis – Safety Methodology Parameters Nomenclature..... 5
Table D.2 FIM Spacing Error Modelling – Measurement Integrity Modelling..... 8
Table E.1 Summary of Key Operational and Safety Input Parameters 2
Table E.2 FAA Safety Severity and Operational Effect for Paired Approach Front Spacing 7
Table E.3 European Safety Severity and Operational Effect for Paired Approach Front Spacing..... 8
Table E.4 FAA Safety Severity and Operational Effect for Paired Approach Rear Spacing 11
Table E.5 European Safety Severity and Operational Effect for Paired Approach Front Spacing.... 12
Table E.6 Horizontal Position Integrity Containment Radius Results..... 15

TABLE OF FIGURES

Figure 1.1 Surveillance Functional Architecture 6
Figure 2.1 Traceability Scheme 25
Figure 3.1 Functional Architecture for ASPA-FIM 35
Figure 3.2 Upstream Speed Limit Carried Forward 79
Figure 3.3 IM Aircraft Lands on Nearer Runway 83
Figure 3.4 Target Aircraft lands on Nearer Runway 83
Figure 3.5 Spacing Error Distributions for Non-Offset and Offset Thresholds 86
Figure 3.6 Spacing Performance for a Range of Threshold Offsets 87
Figure A.1 Definition of Time-Based and Distance-Based Spacing 31
Figure A.2 Operational Objective to Drive the Spacing Interval in the IM Objective Region given an Assigned Spacing Goal in Time 31
Figure A.3 Operational Objective to Drive the Spacing Interval in the IM Objective Region given an Assigned Spacing Goal in Distance 32
Figure A.4 Traffic Reference Point as a Projection of the Achieve-by Point when the IM Aircraft and Target Aircraft are on Parallel or Near-Parallel Routes at or after the Achieve-by Point 34
Figure A.5 IM Turn 50
Figure A.6 IM Turn Suspend and Resume Cases 52
Figure A.7 Scenario 1a: Merge Behind 64
Figure A.8 Scenario 1b: Merge Behind with delayed Achieve-by Point 65
Figure A.9 Scenario 1c: Remain Behind 66
Figure A.10 S&M Merge Behind with Partial IM Clearance Sequencing 67
Figure A.11 Scenario 2: Follow Route then Turn 70
Figure A.12 Scenario 3a: Same Runway Arrival and Approach along OPD with High-Altitude Merge 73
Figure A.13 Scenario 3b: Same Runway Arrival and Approach along OPD with terminal area merge 74
Figure A.14 Scenario 3c: Same Runway Arrival and Approach along OPD to Final Approach Fix 76
Figure A.15 Dependent Parallel Runway Distance-Based Separation Standards 78
Figure A.16 Scenario 4a: IM Arrival and Approach to Dependent Parallel Runways using Achieve 79
Figure A.17 IM Paired Approach Application Overview (Before the PTP) 81
Figure A.18 Dependent Converging and Crossing Runway Separation Standards 83
Figure A.19 Scenario 5: IM Arrival and Approach to Dependent Converging and Crossing Runways 84
Figure A.20 Scenario 6: Final Approach Spacing 85
Figure A.21 Aligned with CF leg 89
Figure A.22 Phase Diagram: ASPA-FIM Pre-Initiation (1) 96
Figure A.23 Phase Diagram: ASPA-FIM Pre-Initiation (2) 97
Figure A.24 Phase Diagram: ASPA-FIM Initiation (1) 98
Figure A.25 Phase Diagram: ASPA-FIM Initiation (2) 99
Figure A.26 Phase Diagram: ASPA-FIM Execution (1) 100
Figure A.27 Phase Diagram: ASPA-FIM Execution (2) (On-Going Tasks) 101
Figure A.28 Phase Diagram: ASPA-FIM Execution – Suspend/Resume 102
Figure A.29 Phase Diagram: ASPA-FIM Termination 103

Figure B.1 Surveillance Functional Architecture for ASPA-FIM 2
Figure B.2 Operational Objective to Drive the Spacing Interval within the IM Operational Tolerance of the Assigned Spacing Goal 23
Figure B.3 Depiction of the FIM Equipment Tolerance Centered within the IM Operational Tolerance 24
Figure B.4 Depiction of an Aircraft String 48
Figure B.5 Depiction of the Operationally-Required Tolerances Comprised of the Nominal Spacing Bounds and the Controller Intervention Threshold 72
Figure B.6 Throughput at the Runway Threshold as a Function of Standard Deviation (IM Operation C) 84
Figure B.7 Illustration of Conflicting Separation Requirements 87
Figure B.8 Separation Standards for Lead Aircraft in Current Pair 89
Figure B.9 Separation Standards for Trail Aircraft in Current Pair 90
Figure B.10 IM Operational Tolerance at the Achieve-by Point 94
Figure B.11 FIM Equipment Objective Region with Zero Measurement Error 95
Figure B.12 FIM Equipment Objective Region with Non-zero Measurement Error in Target Aircraft Position 95
Figure B.13 FIM Equipment Objective Region with Non-zero Measurement Error in IM Aircraft Position 96
Figure B.14 FIM Equipment Objective Region with Zero Control Error and Non-zero Error in the IM Aircraft's Measured Position 97
Figure B.15 Difference Between Target and IM Aircraft's Horizontal Paths (figure adapted from reference [53]) 137
Figure B.16 Time-Based Measured Spacing Interval Error 138
Figure B.17 Depiction of Approximation error with Complete Target Aircraft History (Time-based spacing) 140
Figure B.18 Description of method to determine error induced from interpolating Target Aircraft position and time 140
Figure B.19 95% Bounds of the Approximation error introduced when interpolating based on known Target Aircraft positions and time (100,000 iterations) 141
Figure B.20 Response of Boeing 757-300 to 5-knot Speed Change (mass factor = 0.30) 145
Figure B.21 Response of Boeing 757-300 to 5-knot Speed Change (mass factor = 0.70) 145
Figure B.22 Response of Boeing 767-300 to 5-knot Speed Change (mass factor = 0.30) 146
Figure B.23 Response of Boeing 767-300 to 5-knot Speed Change (mass factor = 0.70) 146
Figure B.24 Response of Boeing 777-300 to 5-knot Speed Change (mass factor = 0.30) 147
Figure B.25 Response of Boeing 777-300 to 5-knot Speed Change (mass factor = 0.70) 147
Figure B.26 Response of A320 to 5-knot Speed Change (mass factor = 0.30) 148
Figure B.27 Response of A320 to 5-knot Speed Change (mass factor = 0.70) 148
Figure B.28 Frequency-Response Magnitudes for Different Control and Aircraft Performance Gains (for Time-to-Go control law) 158
Figure B.29 Frequency-Response Magnitudes for Different Control and Aircraft Performance Gains (for Station-keeping and Time-history control laws). 159
Figure B.30 Response of Ten-Aircraft String for the Time-to-Go control law (for □ = 0.6). 160
Figure B.31 Response of Ten-Aircraft String for the Time-to-Go control law (for □ = 2.0). 161
Figure B.32 Response of Ten-Aircraft String for the Time-to-Go control law (for □ = 4.0). 161
Figure B.33 Response of Ten-Aircraft String for the Time-History Control Law (for □ = 1.0). E-162
Figure B.34 Response of Ten-Aircraft String for the Time-History Control Law (for □ = 2.0) 163

Figure B.35 Response of Ten-Aircraft String for the Time-History Control Law (for □ = 4.0)…..
……..164
Figure B.36 Depiction of the Time-to-Go Control Law for time-based Assigned Spacing Goals. 168
Figure B.37 Depiction of the Time-to-Go Control Law for distance-based Assigned Spacing Goals. 170
Figure B.38 Error Thresholds for Time-to-Go control law and Time-based Assigned Spacing Goals..... 172
Figure B.39 Error Thresholds for Time-to-Go control law and Distance-based Assigned Spacing Goals..... 172
Figure B.40 IM Turn Ilustration..... 177
Figure B.41 Depiction of the Time-History Control Law (used for time-based Assigned Spacing Goals).
…….178
Figure B.42 Depiction of the Station-keeping Control Law (used for distance-based Assigned Spacing Goals). 179
Figure B.43 Evolution of Error Term for Wind Condition A. 182
Figure B.44 Evolution of Error Term for Wind Condition B..... 183
Figure B.45 Evolution of Error Term for Wind Condition C..... 183
Figure B.46 Evolution of Error Term for Wind Condition D. 184
Figure B.47 Simulation Modules in IM fast-time simulation environment, IMSim. 185
Figure B.48 Comparison of different options for generating vertical profiles in the presence of procedural altitude constraints. 187
Figure B.49 EAGUL5 and KOOLY4 Procedures at KPHX. 192
Figure B.50 KAILE1, TSHNR1, KIPPR4, and WAHUU1 Procedures at KDEN. 195
Figure B.51 View of KAILE1, TSHNR1, KIPPR4, and WAHHU1 Procedures Merging onto the Approach Procedure at KDEN. 195
Figure B.52 KIPPR4 and PEEKK3 Procedures at KDEN. 197
Figure B.53 View of KIPPR4 and PEEK3 Procedures to the Final Approaches for Runways 16L and 16R at KDEN. 197
Figure B.54 SUNST3 and KEPEC3 Procedures at KLAS. 202
Figure B.55 PARQR3 and CHSLY3 Procedures at KCLT with CHSLY3 Connecting to Final Approach for Runway 23..... 205
Figure B.56 PARQR3 and CHSLY3 Procedures at KCLT with CHSLY3 Connecting to the Final Approach for Runway 18L..... 206
Figure B.57 View of PARQR3 and CHSLY3 Procedures to the Final Approaches for Runways 18C and 18L. 207
Figure B.58 SHAFF7 Procedure at KEWR..... 210
Figure B.59 BOJID2 and PAATS2 Procedures at KPHL 212
Figure B.60 ROBUC3 Procedure at KBOS 215
Figure B.61 Final Approach Courses for Runways 04R and 04L at KBOS 216
Figure B.62 Final Approaches for Runways 28L and 28R at KSFO 218
Figure B.63 Final Approach Procedures to Runways 16C and 16L at KSEA 220
Figure B.64 Final Approach Procedures to Runways 16R and 16C at KSEA. 221
Figure B.65 Illustration of Extended Final Approach Spacing scenario for the case that Target Aircraft is on Extended Final Approach Course and IM Aircraft in on a Vector. 229
Figure B.66 Assumptions for Estimating Error in Merge Point Location from Extended Track of Aircraft on Vector to Final..... 231
Figure B.67 Cumulative Distribution Functions of Spacing Performance for Terminal Merge Scenario (Achieve at FAF, Time-based Assigned Spacing Goals, and Uncoupled FIM Equipment System)..... 236

Figure B.68 Cumulative Distribution Functions of Spacing Performance for Terminal Merge Scenario (Achieve at FAF, Time-based Assigned Spacing Goals, and Coupled FIM Equipment System). 237
Figure B.69 Equivalent Time-based Assigned Spacing Goals for Distance-based Assigned Spacing Goal Scenarios 239
Figure B.70 Cumulative Distribution Functions of Spacing Performance (Achieve at FAF, Distance-based Assigned Spacing Goals, and Uncoupled FIM Equipment Systems) 240
Figure B.71 Difference in Nominal Trajectory Time and Delayed Trajectory Time on the WAHUU1 (KDEN) Procedure. 243
Figure B.72 Difference in Nominal Trajectory Time and Delayed Trajectory Time on the SUNST3 (KLAS) Procedure 244
Figure B.73 Difference in Nominal Trajectory Time and Delayed Trajectory Time on the EAGUL5 (KPHX) Procedure. 245
Figure B.74 Cumulative Distribution Functions of Spacing Performance for Terminal Merge Scenario (Achieve at FAF, Time-based Assigned Spacing Goals, Uncoupled FIM Equipment System, and Delayed Trajectories). 246
Figure B.75 Cumulative Distribution Functions of Capture Rate for Capture then Maintain on Arrival Procedures. 250
Figure B.76 Cumulative Distribution Functions of Capture Time for Capture then Maintain on Arrival Procedures. 251
Figure B.77 Cumulative Distribution Functions of Spacing Performance for Dependent Crossing and Convering Runway Scenarios. 254
Figure B.78 Cumulative Distribution Function of Capture Rate for Paired Approach. 256
Figure B.79 Cumulative Distribution Function of Capture Times for Paired Approach. 257
Figure B.80 IM Turn Point for Case 1 at KDEN on KIPPR4. 260
Figure B.81 IM Turn Point for Case 1 at KLAS on SUNST3. 261
Figure B.82 IM Turn Point for Case 1 at KPHX on KOOLY4. 261
Figure B.83 IM Turn Point for Case 2 at KDEN on the KIPPR4 Arrival. 263
Figure B.84 IM Turn Point for Case 2 at KLAS on the SUNST3 Arrival. 264
Figure B.85 IM Turn Point for Case 2 at KPHX on the KOOLY4 Arrival. 265
Figure B.86 On-Going Flight Crew Tasks 270
Figure B.87 Initiation Phase Up To Clearance Loading 270
Figure B.88 Initiation Phase Clearance Loading for Voice Clearance 271
Figure B.89 Initiation Phase Clearance Loading for CPDLC Clearance 271
Figure B.90 Initiation Phase from Clearance Loading to Exectuion 272
Figure B.91 Execution Phase 272
Figure B.92 IM Clearance Suspension in Execution Phase 273
Figure B.93 Termination Phase 273
Figure B.94 Depiction of the difference between the true distance travelled by the Target Aircraft, D, and the apparent distance D*cos(Ø) as measured along the IM Aircraft's route. 290
Figure B.95 Plot showing how various offset angles will drive the IM Aircraft's IM Speed different percentages away from the planned groundspeed. 291
Figure B.96 Depiction of the angle and distance parameters to consider when comparing orthogonal projections of the Target Aircraft onto its own route and onto the IM Aircraft's route.. 292
Figure B.97 Path length difference and time-based spacing error (using 200 knot groundspeed) as a function of distance to go to the PTP for various offset angles 293
Figure B.98 Illustration of IM Aircraft and Target Aircraft on Near-Parallel Routes. 294
Figure B.99 Steady-state Value for the Control Law Error Term for Different Track Angle Differences and Target Aircraft Ground Speeds. 295
Figure B.100 Steady-state Errors for 3-degree Track Angle Difference 297
Figure B.101 Steady-state Errors for 20-degree Track Angle Difference 297

Figure B.102 Depiction of how routes with small turns may still be considered sufficiently parallel. 299
Figure B.103 Operational examples of approach paths to parallel runways. The left and center images show sufficiently parallel paths. The right image shows two paths that are not considered sufficiently parallel because the ground track for a segment portion of one path deviates by more than 10 degrees from the ground track of a segment portion of the other path (between TOCUB and ISACE). 300
Figure B.104 Adjacent and Oppostie Corner-Post Range Results for LAX 302

Figure C.1 OSA Process (Bowtie Model) Overview 5
Figure C.2 OHA Steps 6
Figure C.3 Probability "Pe" per Hazard-Effect Pair Scheme 8
Figure C.4 ASOR Steps 11
Figure C.5 Example of Fault Tree Structure 12
Figure C.6 OH1.A: TRL02 Flight Crew Selects Incorrect AC to Merge Behind 34
Figure C.7 OH1.A Event Tree 36
Figure C.8 OH1.A Fault Tree without CPDLC 42
Figure C.9 OH1.A Fault Tree with CPDLC 47
Figure C.10 OH1.B: Ownship Uses Incorrect Assigned Spacing Goal to Space off Aircraft A 51
Figure C.11 OH1.B Event Tree for U.S. FAA SMS 53
Figure C.12 OH1.B Fault Tree for U.S. FAA SMS without CPDLC 60
Figure C.13 OH1.B Fault Tree for U.S. FAA SMS with CPDLC 65
Figure C.14 OH1.B Event Tree for the European Safety Analysis 69
Figure C.15 OH1.B Fault Tree for the European Safety Analysis without CPDLC 77
Figure C.16 OH1.B Fault Tree for the European Safety Analysis with CPDLC 83
Figure C.17 OH1.C: Flight Crew of TRL02 Enters Incorrect Achieve-by Point 87
Figure C.18 OH1.C Event Tree 89
Figure C.19 OH1.C Fault Tree without CPDLC 99
Figure C.20 OH1.C Fault Tree with CPDLC 104
Figure C.21 OH1.D: Scenario for Incorrect IM Clearance Type 110
Figure C.22 OH1.D Event Tree 112
Figure C.23 OH1.D Fault Tree without CPDLC 117
Figure C.24 OH1.D Fault Tree with CPDLC 122
Figure C.25 OH2.A: FIM Equipment Corrupts the IM Speed 127
Figure C.26 OH2.A Event Tree of FIM Equipment Corrupting IM Speed(s) 129
Figure C.27 OH2.A Fault Tree of FIM Equipment corrupting IM Speed(s) 135
Figure C.28 OH2.B Event Tree 141
Figure C.29 OH2.B Fault Tree 146
Figure C.30 OH2.C: Wrong IM Turn Point 150
Figure C.31 OH2.C Event Tree – Wrong IM Turn Point 151
Figure C.32 OH2.C Fault Tree 159
Figure C.33 OH2.D: Incorrect Target Aircraft Intended Flight Path Information 164
Figure C.34 OH2.D Event Tree 166
Figure C.35 OH2.D Fault Tree without CPDLC 175

Figure C.36 OH2.D Fault Tree with CPDLC 180
Figure C.37 OH2.E: Incorrect IM Aircraft Intended Flight Path Information 184
Figure C.38 OH2.E Event Tree 186
Figure C.39 OH2.E Fault Tree 195
Figure C.40 OH2.F Event Tree 201
Figure C.41 OH2.F Fault Tree 206
Figure C.42 OH2.G Event Tree 211
Figure C.43 OH2.G Fault Tree 216
Figure C.44 OH3.A: Insertion of non-IM Aircraft between IMAC and TAC 221
Figure C.45 OH3.B: Premature Termination 223
Figure C.46 Initial Setup for the Stressing Scenario for OH4.A 225
Figure C.47 Failure to Transition to Partial IM Clearance for the Stressing Scenario for OH4.A 225
Figure C.48 OH4.A Event Tree 227
Figure C.49 OH4.A Fault Tree 233
Figure C.50 OH4.B: Ownship Fails to Amend to the Active IM Clearance 238
Figure C.51 OH4.B Event Tree 239
Figure C.52 OH4.B Fault Tree 245
Figure C.53 CARA Process 252
Figure C.54 Estimates of Human Performance Error Rates 257
Figure C.55 Event Tree for OH1.C where IC.2 has a 100% large IM Special Point Error 334
Figure C.56 Safety Objectives for OH1.C where IC.2 has a 100% large IM Special Point Error 335
Figure C.57 Event Tree for OH1.C where IC.2 only has a large IM Special Point Error Likelihood derived that meets the applicable Safety Objectives 336
Figure C.58 Safety Objectives for OH1.C where IC.2 only has a large IM Special Point Error Likelihood derived that meets the applicable Safety Objectives 337
Figure C.59 Event Tree for OH1.C where IC.2 has large and medium IM Special Point Error Likelihoods 338
Figure C.60 Safety Objectives for OH1.C where IC.2 has large and medium IM Special Point Error Likelihoods 339
Figure C.61 Event Tree for OH1.C where IC.2 has large and medium IM Special Point Error Likelihoods derived that meet the applicable Safety Objectives 340
Figure C.62 Safety Objectives for OH1.C where IC.2 has large and medium IM Special Point Error Likelihoods derived that meet the applicable Safety Objectives 341
Figure C.63 Event Tree for OH1.C where the final IC.2 meets the Safety Objectives 342
Figure C.64 Safety Objectives for OH1.C where the final IC.2 meets the Safety Objectives 343

Figure D.1 Quantitative Spacing Loss Severities 3
Figure D.2 Allowable Spacing Loss Rate (based on both FAA and European Safety Mappings) 4
Figure D.3 Example Integrity Monitoring Analysis Snapshot 8
Figure D.4 Analysis Results for a Single Assigned Spacing Goal 11
Figure D.5 Determination of FIM NIC Requirement 12
Figure D.6 Conditional FIM Rc Bounds 14

Figure E.1 Top View of Paired Approach Operation…….....3

Figure E.2 Spacing Distances for Paired Approach Expansion Scenario with FAA Safety Targets for Front Spacing 4

Figure E.3 Spacing Distances for Paired Approach Compression Scenario with FAA Safety Targets for Rear Spacing..... 5

Figure E.4 Spacing Distances for Paired Approach Expansion Scenario with European Safety Targets for Front Spacing..... 10

Figure E.5 Spacing Distances for Paired Approach Compression Scenario with European Safety Targets for Rear Spacing..... 13

Figure E.6 Horizontal Position Integrity Containment Radius for Front Spacing Hazard for US Operations 16

Figure E.7 Horizontal Position Integrity Containment Radius for Front Spacing Hazard for European Operations 16

Figure E.8 Horizontal Position Integrity Containment Radius for Rear Spacing Hazard for US Operations 17

Figure E.9 Horizontal Position Integrity Containment Radius for Rear Spacing Hazard for European Operations 17

Figure E.10 Spacing to Meet 0.6 NM Containment Radius for an Operational Rate of 1/1.5 Flight Hours for Rear Spacing Hazard for US Operations..... 19

1 INTRODUCTION

This document provides the minimum operational, Safety and Performance Requirements (SPR) and Interoperability Requirements (INTEROP) to implement Airborne Spacing (ASPA) - Flight Deck Interval Management (FIM) in support of an identified set of IM Operations. ASPA-FIM is defined as the flight deck component of the Interval Management (IM) System. The IM System includes the ground domain's tools to generate IM Clearance information for the controller to provide to IM equipped aircraft. Then, based upon the IM Clearance provided by the controller and surveillance information received on the aircraft against which the relative spacing is desired (referred to as the Target Aircraft), ASPA-FIM generates guidance for the flight crew to successfully and safely comply with the IM Clearance.

All material in this document was developed jointly by EUROCAE Working Group 51 (WG-51) and RTCA Special Committee 186 (SC-186).

This document was developed based on the criteria for the SPR and INTEROP documents set forth in RTCA DO-264/EUROCAE ED-78A, "Guidelines for Approval of the Provision and Use of Air Traffic Services Supported by Data Communications" [12]. This SPR provides the set of minimum requirements applied to any ASPA-FIM installation. Avionics that support and perform the functions that comprise the ASPA-FIM System are referred to as "FIM Equipment." The use of the ASPA-FIM System within a given operational environment is referred to as an "IM Application." An aircraft pair executing an IM Clearance in the context of an IM Application is referred to as performing an "IM Operation." The Operational Services and Environment Definition (OSED) includes sample scenarios depicting IM Operations that are representative of most near-term IM Applications. These depictions span the capabilities required by the IM Applications. This SPR defines the methodology that is to be applied to IM Applications to determine appropriate operational objectives and associated safety and performance requirements for ASPA-FIM Systems. These requirements are not necessarily intended to be limited to the IM Scenarios defined in the OSED (Annex A.4); the overall SPR methodology may be applied, as appropriate, to support additional IM Scenarios not directly analyzed in this document.

The requirements in this document are necessary to provide adequate assurance that the appropriate aspects of the relevant Communications Navigation Surveillance/Air Traffic Management (CNS/ATM) system, when operating together, will perform their intended function for the IM Operations represented within the IM Scenarios and defined by the OSED (Annex A.4) acceptably, and in a safe manner.

Note: The requirements in this document are focused on the on-board requirements for the FIM Equipment and for the received Surveillance data (e.g., ADS-B) quality needed to provide guidance to the flight crew to perform the IM Operation. Also examined are the interactions between the ground domain (ATC) and the receive aircraft domain (IM Aircraft) and communication requirements that are needed to issue IM Clearances and the operational status of the resulting IM Operation.

While all detailed SPR-related assessments are found in the Annexes to this document, Chapter 3 presents the results of reconciling all of these assessment results into a single set of underlying Safety and Performance Requirements. This process retains the most stringent

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requirements for those attributes or parameters commonly applied by both the safety and performance assessments. Traceability of those requirements to the corresponding assessment(s) is provided within Chapter 3.

1.1 Purpose of the document

This document defines and allocates the set of minimum requirements for the end-to-end operational, safety, performance, and interoperability aspects for implementations of a set of IM Operations. The requirements and their initial application are also expected to form the basis for all future ASPA-FIM implementations. Allocation of these requirements is done by this SPR/INTEROP to the necessary domains of the CNS/ATM system, i.e., at aircraft and ground domain level.

Note: Requirements allocated to the ground domain are limited to operational and interoperability requirements. Safety and performance requirements on how the ground domain determines when to issue IM Clearances to help schedule and manage the traffic flow are out of scope of this document.

These requirements can be used as a component for approval processes including aircraft type design approval, aircraft operator operational approval, and Air Traffic Services (ATS) provider operational approval. However, this document cannot be a sole means for such approval processes. Rather, the minimum requirements specified and the methodologies defined within provide a path to those approvals for given IM Applications. This SPR/INTEROP document is also written to support the development of system-specific standards (e.g., Minimum Aviation System Performance Standard [MASPS], Minimum Operational Performance Standard [MOPS], Advisory Circulars [ACs], and Technical Standard Orders [TSOs]) that will define specific IM Applications and may be required for many airspace regulators.

1.1.1 ASPA-FIM System

Airborne Spacing - Flight Deck Interval Management (ASPA-FIM) describes a set of airborne (i.e., flight deck) capabilities designed to support a range of IM Operations whose goal is precise inter-aircraft spacing. IM is the overall system that improves spacing consistency between aircraft and traffic flows and includes the use of both ground and airborne components. The ground component of IM provides ATC with IM Clearance information, including the spacing goals for the IM pair, and the airborne component of IM provides pilots with speed commands to comply with the IM Clearance.

This document focuses on the airborne components of the larger IM System to define and analyze the required capabilities and level of performance needed by the FIM Equipment (i.e. avionics). The FIM Equipment provides the flight crew with safe and appropriate information to support execution of an IM Operation as described in the representative IM Scenarios depicted in the OSED (Annex A.4).

1.1.2 Use of document for approvals

This document is intended to support the approval of the aircraft components of the CNS/ATM system relating to ASPA-FIM.

The corresponding safety, performance and interoperability assessments are based on material in the OSED (Annex A) including the generic operational definition of ASPA-FIM and detailed operations represented within a set of defined IM Scenarios (Annex A.4). States or regions implementing operations different from those specified in the OSED must take into account those differences in the operations or environment in the supporting analyses and must analyze the impact of these differences on the requirements. The Operational Performance Assessment (OPA, Annex B) and Operational Safety Assessment (OSA, Annex C) provide the framework and methodologies to be used for any specific application of ASPA-FIM and the environment for which it is designed.

The assessments and specifications in this document are not intended to be the sole basis for type design, operational approval, and airworthiness approval. However, this material can be used as an important component for establishing minimum design and system performance standards for Air Navigation Service Provider (ANSP), aircraft operator and aircraft certification approvals of ASPA-FIM.

Aircraft modifiers, Original Equipment Manufacturers (OEMs), avionics system designers and operators should consider any additional specifications that may enhance the system supporting ASPA-FIM in view of other future applications so that systems designed for ASPA-FIM can easily accommodate more demanding operations enabled by Automatic Dependent Surveillance – Broadcast (ADS-B) in the future. To facilitate this, design considerations are discussed in both Chapter 3 and the OPA.

1.2 Scope of the Document

This document includes the definition of the services and the Environmental Conditions relevant to the implementation of the ASPA-FIM System and the operational, safety, performance and interoperability requirements for IM Applications.

Note: Requirements that provide protection against intentional behavior causing harm or sabotage are beyond the scope of this document.

Note: Requirements related to the recording of ADS-B data for accident or incident investigation purposes are beyond the scope of this document.

1.2.1 ASPA-FIM Context

The IM System, employing ASPA-FIM with supporting ground capabilities, is the basis of a range of envisioned IM Applications based on an ADS-B “In” function that relies on airborne surveillance information (e.g., ADS-B “Out”) being available for the Target Aircraft. ADS-B Out is scheduled to be implemented throughout the United States (U.S.) National Airspace and Europe by similar rulemaking processes. To support IM Operations, this document places requirements on the quality of surveillance information, which has been developed to be consistent with the ADS-B Out rules wherever possible. While defined and assessed as a self-contained system, it is envisioned that ASPA-FIM will be implemented as part of a larger Aircraft Surveillance Application (ASA) System in which it is integrated with other ADS-B In capabilities. This standard, however, does not consider the interaction, interoperability and transition between ASPA-FIM and other ADS-B In applications and systems.

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IM is closely related to the Sequencing and Merging airborne spacing application originally defined in the first package of Ground and Airborne Surveillance Applications enabled by ADS-B and collectively called “Package 1” [5]. IM, with an enabling ASPA-FIM installation, is a superset of Operational Applications, under which Sequencing and Merging resides.

Package 1 is enabled by ADS-B given a sufficient level of equipage of aircraft broadcasting ADS-B information, ground stations, and other aircraft receiving and processing that same data.

Package 1 applications require harmonization of minimum system requirements to facilitate interoperability among applications. This has been accomplished through ED-194B/DO-317B [22], DO-282B [28] and ED-102A/DO-260B [31].

The envisioned applications in Package 1 fall into two categories:

ADS-B Package 1 Ground Surveillance Applications (GSA):

- ADS-B-NRA Enhanced ATS in non-radar areas using ADS-B surveillance
- ADS-B-RAD Enhanced ATS in radar areas using ADS-B surveillance
- ADS-B-APT Airport surface surveillance
- ADS-B-ADD Aircraft derived data for Air Traffic Control tools

ADS-B Package 1 Airborne Surveillance Applications (ASA):

- ATSA-VSA Enhanced visual separation on approach
- ATSA-ITP In-trail procedure in procedural airspace
- ATSA-AIRB Enhanced traffic situational awareness during flight operations
- ATSA-SURF Enhanced traffic situational awareness on the airport surface
- ASPA-FIM Flight Deck Interval Management

Note: ADS-B-RAD is a combination of the former ADS-B-ACC (Area Control Centre) and ADS-B-TMA (Terminal Control Area) which defined ATC services based on ADS-B in en-route and terminal areas, respectively in Package 1.

Note: ATSA-AIRB has been combined with the Package 1 definition of ATSA-S&A (“Enhanced Visual Acquisition for See-and-Avoid”).

Note: IM, with an enabling ASPA-FIM installation, is a set of functions and procedures defined to support a variety of airborne spacing operations, including the former ASPA-S&M (Sequencing and Merging) application.

Separate publication of the SPR/INTEROP documents for each application will allow States, ANSPs and airspace users to select those applications that are best suited to their operations and needs. However, to ensure seamless growth and global interoperability, any new installation of ADS-B should meet the full minimum requirements for the given data link as specified in the published ADS-B link MOPS.

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Since ADS-B Package 1, the SPR process has been applied to expand the capabilities of ASPA-FIM and the considerations in this document. Originally developed as "Advanced Interval Management" or "A-IM," the envisioned IM Applications include the following:

- Dependent Parallel Runway Operations
- Dependent Crossing or Converging Runway Operations
- Paired Approach – a specific, closely-spaced dependent parallel runway operation
- Generalized IM Operations on Non-Coincident Routes
- Operations enabled by data communications – specifically CPDLC and ATS Winds.
- Sequential IM Operations

These applications, and the analysis to support them, are described throughout the document. Scenarios illustrating specific IM Operations within the context of these applications are included in Section A.4. This list is not intended to be exhaustive, however, and additional IM Applications may be identified at a later time. Any additional IM Application must meet minimum equipment performance and safety requirements before resulting IM Operations can be conducted.

1.2.2 Assumed Airborne and Ground Generic Surveillance Functional Architecture

Figure 1.1 presents the generic surveillance functional architecture to support all Package 1 applications. The figure identifies the airborne domains and the ground domain associated with Ground and Airborne Surveillance Applications enabled by ADS-B. The airborne domain consists of the Transmit Aircraft Domain and the Receive Aircraft Domain. The Transmit Aircraft Domain represents the functions associated with providing the ADS-B Out capability needed to support ground-based or aircraft-based surveillance applications. The Receive Aircraft Domain provides the ADS-B In capability to host Airborne Surveillance Applications. The Ground Domain represents the capability to host ground-based surveillance applications in support of Air Traffic Services.

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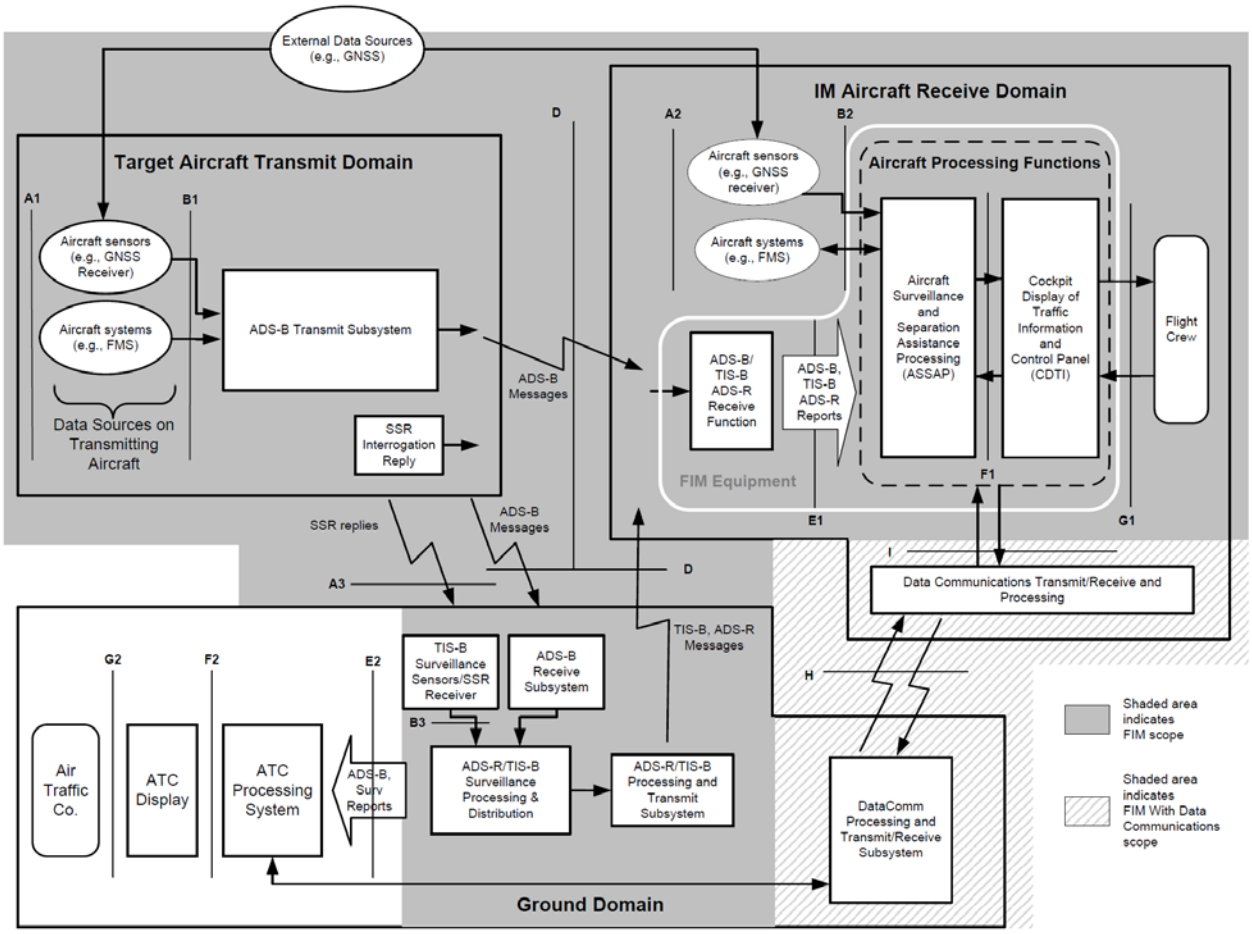


Figure 1.1 Surveillance Functional Architecture

Figure 1.1 also identifies the system functions and functional interfaces (small lines with associated letters and numbers, e.g., B1) associated with the aircraft domains and the ground domain. The figure identifies the functional interfaces (e.g., D, G1) to which the Safety and Performance Requirements are allocated. These interfaces are referenced throughout the document where requirements are provided.

General functional capabilities and key aspects of the architecture are specified below.

For the Receive Aircraft Domain:

- The minimum surveillance functional architecture includes:
  - reception of ADS-B messages (represented by the ADS-B Receive Function);
  - ownship sensor data processing;
  - surveillance data processing, and applications-specific processing (represented by the Airborne Surveillance and Separation Assurance Processing Function [ASSAP]); and
  - the provision of necessary information to the flight crew by the Traffic Display Function and its associated control interface.

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