

RTCA, Inc.
1828 L Street, NW, Suite 805
Washington, DC 20036-5133 USA

**Operational Services and
Environmental Definition (OSED)
for Unmanned Aircraft Systems (UAS)**

RTCA DO-320
June 10, 2010

Prepared by: SC-203
© 2010 RTCA, Inc.

Copies of this document may be obtained from

RTCA, Inc.

Telephone: 202-833-0339

Facsimile: 202-833-9434

Internet: www.rtca.org

Please visit the RTCA Online Store for document pricing and ordering information.

FOREWORD

This document was prepared by “Special Committee 203 (SC-203) and approved by the RTCA Program Management Committee (PMC) on June 10, 2010.

RTCA, Incorporated is a not-for-profit corporation formed to advance the art and science of aviation and aviation electronic systems for the benefit of the public. The organization functions as a Federal Advisory Committee and develops consensus based recommendations on contemporary aviation issues. RTCA objectives include, but are not limited to:

- Coalescing aviation system user and provider technical requirements in a manner that helps government and industry meet their mutual objectives and responsibilities;
- Analyzing and recommending solutions to the system technical issues that aviation faces as it continues to pursue increased safety, system capacity and efficiency;
- Developing consensus on the application of pertinent technology to fulfill user and provider requirements, including development of Minimum Operational Performance Standards (MOPS) for electronic systems and equipment that support aviation; and
- Assisting in developing the appropriate technical material upon which positions for the International Civil Aviation Organization (ICAO) and the International Telecommunication Union (ITU) and other appropriate international organizations can be based.

The recommendations of RTCA are often used as the basis for government and private sector decisions as well as the foundation for many Federal Aviation Administration Technical Standard Orders (TSO).

Since RTCA is not an official agency of the United States Government, its recommendations may not be regarded as statements of official government policy unless so enunciated by the United States Government organization or agency having statutory jurisdiction over any matters to which the recommendations relate.

This Page Intentionally Left Blank

Table of Contents

1	Introduction	1
1.1	Purpose	1
1.2	Scope	2
1.3	Relationship to Process	2
1.4	Document Organization	3
2	Overview of Unmanned Aircraft Systems and Types	
2.1	UAS Definition	3
2.2	UAS Element	4
2.2.1	Aircraft Segment	4
2.2.2	Control Segment	5
2.2.3	Communications Segment	5
2.3	Support Element	5
2.4	System Architectures	5
2.5	UAS Types	5
3	Stakeholder Description	6
4	Operational Concepts	7
4.1	Interface Depictions	7
4.2	Primary Operational Functions	7
4.3	Surface Environment	8
4.3.1	ATC Participating Airborne	8
4.3.2	Non-ATC Participating Support	9
4.3.3	Non-ATC Participating Surface	10
4.4	Airborne Environment	11
4.4.1	ATC Participating Airborne	12
4.4.2	Non-ATC Participation Airborne:	13
4.5	Cross-Comparison of Operational Concept Views	13
5	Flight Profiles	15
5.1.1	Point-to-Point	15
5.1.2	Planned Aerial Work	15
5.1.3	Unplanned Aerial Work	16
6	UAS Market Assessment	17
6.1	Market Demand and Trends	17
6.2	General Assumptions	18

6.3	Basis of Estimates	18
6.4	UAS Categories	19
6.5	UAS Market Segments	20
6.5.1	Military UAS Market	21
6.5.1.1	Current and Future Military Applications	21
6.5.1.2	Military Market Drivers and Impediments	21
6.5.1.3	Estimated Quantities and Growth Rates for Military UA	22
6.5.2	Civil Government UAS Market	26
6.5.2.1	Current and Future Civil Government Applications	26
6.5.2.2	Civil Government Market Drivers and Impediments	26
6.5.2.3	Estimated Quantities and Growth Rates for Civil Government UA	27
6.5.3	Commercial UAS Market	31
6.5.3.1	Current and Future Commercial Applications	31
6.5.3.2	Commercial Market Drivers and Impediments	31
6.5.3.3	Estimated Quantities and Growth Rates for Commercial UA	32
6.5.4	Summary of Military, Civil Government, and Commercial Markets	36
7	Operational Characterization	37
7.1	Defining Characteristics and Categories	37
7.1.1	Conversion of Manned Aircraft	38
7.1.2	Data Sources	38
7.1.3	Presentation of Data	38
7.1.4	Time References	40
7.2	Performance and Airspace Usage Descriptions	40
7.2.1	Category 1: Turbojet Fixed-Wing Aircraft	40
7.2.1.1	Representative Types	40
7.2.1.2	Applications and Flight Profile Breakdown	41
7.2.1.3	Estimated Numbers and Growth Rates	41
7.2.1.4	Representative Models and Airspace Usage	44
7.2.2	Category 2: Turboprop Fixed-wing Aircraft	46
7.2.2.1	Representative Types	46
7.2.2.2	Applications and Flight Profile Breakdown	46
7.2.2.3	Estimated Numbers and Growth Rates	46
7.2.2.4	Representative Models and Airspace Usage	48
7.2.3	Category 3: Reciprocating/Electric Fixed-wing Prop Aircraft	51

7.2.3.1	Representative Types	51
7.2.3.2	Applications and Flight Profile Breakdown	51
7.2.3.3	Estimated Numbers and Growth Rates	51
7.2.3.4	Representative Models and Airspace Usage	54
7.2.4	Category 4: VTOL	56
7.2.4.1	Representative Types	56
7.2.4.2	Applications and Flight Profile Breakdown	56
7.2.4.3	Estimated Numbers and Growth Rates	56
7.2.4.4	Representative Models and Airspace Usage	59
7.2.5	Category 5: Airship	62
7.2.5.1	Representative Types	62
7.2.5.2	Estimated Numbers and Growth Rates	62
7.2.5.3	Applications and Flight Profile Breakdown	63
7.2.5.4	Representative Models and Airspace Usage	64
7.3	Unique Attributes Within All Categories	65
7.3.1	High Altitude Long Endurance (HALE) UAS	65
7.3.1.1	Applications and Airspace Usage	65
7.3.1.2	Estimated Numbers and Growth Rates	67
7.3.2	Low Visual Signature (LVS) UA	67
7.3.2.1	Representative Models and Airspace Usage	67
7.3.2.2	Estimated Numbers and Growth Rates	69
8	Operational Architecture Framework	70
8.1	Purpose and Scope	70
8.2	Methodology	71
8.3	Operational View Descriptions	71
9	Representative Scenarios	73
9.1	Selection Criteria	73
9.2	Scenario Assumptions	73
9.3	Scenario Structure	74
9.4	Scenario Use Cases and Attributes	74
9.4.1	Flight Planning	74
9.4.2	Start and Taxi Operations	75
9.4.3	Launch/Takeoff and Departure	75
9.4.4	En route	76

9.4.5	Aerial Work	76
9.4.6	Descent and Landing/Recovery	76
9.4.7	Post Landing	77
9.5	Representative Scenarios	77
9.5.1	Scenario 1 – Law Enforcement – Small, Electrically-Powered Fixed Wing (Raven)	77
9.5.1.1	Flight Overview	77
9.5.1.2	UAS Description	78
9.5.1.3	Phase of Flight Descriptions	78
9.5.2	Scenario 2 – Marine Monitoring – Small, Fixed-Wing Reciprocating (ScanEagle)	80
9.5.2.1	Flight Overview	80
9.5.2.2	UAS Description	81
9.5.2.3	Phase of Flight Descriptions	81
9.5.3	Scenario 3: Environmental Sensing – Medium Fixed-Wing Reciprocating (Aerosonde)	83
9.5.3.1	Flight Overview	83
9.5.3.2	UAS Description	83
9.5.3.3	Phases of Flight	84
9.5.4	Scenario 4: Media and Traffic Reporting – Large, Turbine VTOL (Fire scout)	86
9.5.4.1	Flight Overview	86
9.5.4.2	UAS Description	86
9.5.4.3	Phase of Flight Descriptions	87
9.5.5	Scenario 5 – Cargo Delivery – Turboprop Conversion (Caravan)	89
9.5.5.1	Flight Overview	89
9.5.5.2	UAS Description	90
9.5.5.3	Phase of Flight Descriptions	90
9.5.6	Scenario 6 – Border Surveillance and Tracking – Turboprop (Predator B)	94
9.5.6.1	Flight Overview	94
9.5.6.2	UAS Description	94
9.5.6.3	Phase of Flight Descriptions	95
9.5.7	Scenario 7: Hurricane Research – Turbojet (Global Hawk)	97
9.5.7.1	Flight Overview	97
9.5.7.2	UAS Description	98
9.5.7.3	Phase of Flight Descriptions	98

9.5.8	Scenario 8 – Mining Exploration – Conversion Airship (WDL 1B)	100
9.5.8.1	Flight Overview	100
9.5.8.2	UAS Description	102
9.5.8.3	Phase of Flight Descriptions	102
9.5.9	Scenario 9: Agricultural/environmental monitoring– High Altitude Long Endurance ((HALE) Global Observer UAS	103
9.5.9.1	Flight Overview	103
9.5.9.2	UAS Description	104
9.5.9.3	Phase of Flight Descriptions	105
10	Air Traffic Services Definition	108
10.1	AT Services	108
10.1.1	Flight Planning	108
10.1.1.1	Flight Plan Support	109
10.1.1.2	Flight Data Management	109
10.1.2	ATC-Separation Assurance	109
10.1.2.1	Aircraft to Aircraft Separation	110
10.1.2.2	Aircraft to Terrain/Obstacle Separation	110
10.1.2.3	Aircraft to Airspace Separation	110
10.1.2.4	Surface Separation	111
10.1.3	ATC Advisories	111
10.1.3.1	Weather Advisories	111
10.1.3.2	Traffic Advisories	111
10.1.3.3	NAS Status Advisories	111
10.1.4	Traffic Management Synchronization	111
10.1.4.1	Airborne Synchronization	111
10.1.4.2	Surface Synchronization	111
10.1.5	Strategic Flow Management	112
10.1.5.1	Long Term Planning	112
10.1.5.2	Flight Day Management	112
10.1.5.3	Performance Management	112
10.1.6	Emergency and Alerting	112
10.1.6.1	Emergency Assistance	112
10.1.6.2	Alerting Support	113
10.1.7	Navigation	113
10.1.7.1	Airborne Guidance	113

10.1.7.2	Surface Guidance	113
10.1.8	Airspace Management	113
10.1.8.1	Airspace Design	114
10.1.8.2	Airspace for Special Use	114
10.1.9	Infrastructure/Information Management	114
10.1.9.1	Monitoring and Maintenance	115
10.1.9.2	Spectrum Management	115
10.1.9.3	Government-Agency Support	115
10.1.9.4	Enabling Services Requirements	115
10.1.9.5	Automation	115
10.1.9.6	Communication	115
10.1.9.7	Security	116
10.1.10	Performance Requirements	116
10.1.11	Other Service Groups	116
10.2	AT Service Requirements	116
10.3	ATS Performance Expectations	116
10.4	ATC Operational and Equipage Requirements	116
10.4.1	Equipage by Class of Airspace	116
11	Operational Environment	118
11.1	Airspace Rules and Dimensions	118
11.1.1	Airspace Classes	119
11.1.2	Airspace Rules	120
11.1.2.1	Navigation Reference System (NRS)	122
11.1.3	Air Traffic Service (ATS) Routes	123
11.1.4	Required Navigation Performance (RNP)	123
11.1.5	Future Air Navigation System (FANS-1/A)	124
11.2	Air Traffic Service Units	124
11.2.1	Air Traffic System Command Center (ATCSCC)	124
11.2.2	Air Route Traffic Control Center	125
11.2.3	Terminal Radar Approach Control (TRACON)	125
11.2.4	Combined Center-Radar Approach Control (CERAP)	125
11.2.5	Control Tower	125
11.2.6	Flight Service Station	125
11.3	Air Traffic Systems	126

11.3.1	Communications Systems	126
11.3.1.1	Telecommunications	126
11.3.1.2	Mobile Communications	126
11.3.1.3	Network Communications	127
11.3.1.4	Voice Communications	127
11.3.2	Navigation Systems	128
11.3.2.1	Global Navigation Domain	129
11.3.2.2	En Route and Terminal Domain	129
11.3.2.3	Precision Approach Domain	130
11.3.3	Surveillance Systems	132
11.3.3.1	Automatic Dependent Surveillance-Broadcast	133
11.3.3.2	En route Surveillance	133
11.3.4	Terminal Surveillance	134
11.3.4.1	Surface Surveillance	134
11.3.5	Automation Systems	135
11.3.5.1	ERAM	135
11.3.5.2	En Route Automation Modernization System Release 1 (ERAM R1)	136
11.3.5.3	En Route Automation Modernization System Release 2 (ERAM R2)	137
11.3.5.4	En Route Automation Modernization Release 3 (ERAM R3)	137
11.3.5.5	Traffic Flow Management System (TFMS)	138
11.3.5.6	Terminal Data Distribution System (TDDS)	138
11.3.5.7	Tower Flight Data Manager Phase 1 (TFDM1)	138
11.3.5.8	Dynamic Ocean Tracking System	139
11.3.5.9	Advanced Technologies and Oceanic Procedures	139
11.3.5.10	Aeronautical Information Management	139
11.3.5.11	Security Integrated Toolset	140
11.4	Active Aircraft and Aggregate Traffic Density	143
11.4.1	Baseline Aircraft Numbers, Activity, and Altitude Distribution Data	143
11.4.1.1	Baseline Data Table Description	145
11.4.2	Aggregate Air Traffic Density Calculations	146
12	NextGen Considerations	150
12.1	Overview of NextGen	150
12.1.1	Guiding Documents	150

12.1.2	Key NextGen Capabilities	151
12.1.3	Key NextGen Technologies	151
12.2	NextGen Timeline	152
12.3	UAS and NextGen Perspectives and Considerations	152
12.4	Opportunities	153
12.4.1	Greater Coordination and Improved Situational Awareness	153
12.4.1.1	Precision Navigation and Flight Predictability	154
12.4.1.2	Flexible Use of Airspace	154
12.4.2	Distributed Decision Making	154
12.4.2.1	Improved Communications	155
12.5	Managing Change in the Standards Development Process	155
Appendix A	Definitions	A-1
Appendix B	Acronyms	B-1
Appendix C	Market Assessment Supplement	C-1
C.1	Technology Adoption Model Description	C-1
C.2	Input Assumptions	C-2
C.3	Model Results	C-2
C.4	Limitations in Forecasting	C-3
Appendix D	Stakeholders Descriptions	D-1
D.1	Primary Stakeholders: Those Involved in the Approval Process	D-1
D.1.1	Federal Aviation Administration (FAA)	D-1
D.1.2	Service Provider - Air Traffic Organization	D-1
D.1.3	Regulator - Associate Administrator for Aviation Safety (AVS)	D-1
D.1.4	Other Key FAA Stakeholders	D-2
D.1.5	Department of Defense (DoD)	D-2
D.1.6	Other Federal Government Agencies	D-2
D.1.7	Department of Justice	D-3
D.1.8	Department of Agriculture	D-3
D.1.9	NOAA/NASA	D-3
D.1.10	State and Local Government Entities	D-3
D.1.11	Civil Airworthiness Authorities of Other Countries	D-3
D.2	Secondary Stakeholders: Those Impacted by UAS Operations	D-3
D.2.1	Existing NAS Users	D-3
D.2.2	General Aviation Community	D-4

D.2.3	Air Carrier Industry	D-4
D.2.4	UAS Industry	D-4
D.3	Ancillary Stakeholders: Those Needing to Be Informed	D-5
D.3.1	Congress	D-5
D.3.2	Public	D-5
D.3.3	Media	D-6
Appendix E	Operational Characterization Data Sources	E-1
E.1	RTCA DO-304 Mission Scenarios	E-1
E.2	Additional Scenarios and Operating Concepts	E-1
E.3	Subject Matter Expert Assessment	E-1
E.4	Stakeholder Feedback	E-2
Appendix F	Physical Attributes and Performance Data	F-1
F.1	Turbojet fixed-wing	F-1
F.1.1	Global Hawk (RQ-4)	F-1
F.1.2	N-UCAS (X-47B)	F-2
F.1.3	Gulfstream 550	F-3
F.2	Turboprop fixed-wing	F-4
F.2.1	Predator B	F-4
F.2.2	King Air 200	F-5
F.2.3	Cessna Caravan	F-6
F.3	Reciprocating fixed-wing Propeller	F-7
F.3.1	Predator A	F-7
F.3.2	Shadow 200	F-8
F.3.3	Cessna 182	F-9
F.3.4	Aerosonde Mk47	F-10
F.3.5	ScanEagle	F-11
F.4	Vertical Takeoff and Landing (VTOL)	F-12
F.4.1	Firescout	F-12
F.4.2	Bell 206	F-13
F.4.3	Hummingbird A-160	F-14
F.4.4	RMAX TYPE II	F-15
F.4.5	Honeywell RQ-16A T-Hawk	F-16
F.5	Airships	F-17
F.5.1	SA 60 LAA	F-17

F.5.2	WLD 1B	F-18
F.6	Unique Attributes UAS - HALE	F-19
F.6.1	Global Observer	F-19
F.7	Unique Attributes UA – Low Visual Signature (LVS)	F-20
F.7.1	Raven	F-20
Appendix G	Scenario Operational, Environment and Services Matrix	G-1
Appendix H	Endnotes for Table 32 - Data on Aircraft Numbers, Utility, and Distribution by Altitude	H-1

List of Figures

Figure 1 DO-264 Process Flow	3
Figure 2 UAS Segments	4
Figure 3 ATC Participating Airport Operational, Environment and System Interfaces (OV-1A)	8
Figure 4 Non-ATC Participating Airport (OV-1B)	9
Figure 5 Non-ATC Participating Surface Operational, Environment and System Interfaces (OV-1C)	10
Figure 6 Airspace Classes	11
Figure 7 ATC Participating Airborne Operational, Environment and System Interfaces (OV-1D)	12
Figure 8 Non-ATC participating Airborne Operational, Environment and System Interfaces (OV-1E)	13
Figure 9 Point-to-Point	15
Figure 10 Planned Aerial Work	16
Figure 11 Unplanned Aerial Work Mission	16
Figure 12 Current and Potential UAS Military Applications	21
Figure 13 Estimated Military UA Growth Rates and Uncertainty Bounds to 2030	25
Figure 14 Current and potential Civil Government Applications	26
Figure 15 Estimated Civil Govt. Growth Rate and Uncertainty Bounds to 2035	30
Figure 16 Potential Commercial UA Applications	31
Figure 17 Estimated Commercial UA Growth Rate and Uncertainty Bounds to 2040	35
Figure 18 Forecast UAS Military Turbojet	42
Figure 19 Forecast UAS Civil Govt. Turbojet	42
Figure 20 Forecast UAS Commercial Turbojet	43
Figure 21 Forecast UAS Military Turboprop	47
Figure 22 Forecast UAS Civil Govt. Turboprop	47
Figure 23 Forecast UAS Commercial Turboprop	48
Figure 24 Forecast - UAS Military Reciprocating	52
Figure 25 Forecast - UAS Civil Govt. Reciprocating	52
Figure 26 Forecast - UAS Commercial Reciprocating	53
Figure 27 Forecast - UAS Military VTOL	57
Figure 28 Forecast - UAS Civil Govt. VTOL	57
Figure 29 Forecast - UAS Commercial VTOL	58
Figure 30 Forecast - UAS Military Airship	62
Figure 31 Forecast - UAS Civil Govt. Airship	63
Figure 32 Forecast - UAS Commercial Airship	63
Figure 33 Operational Architecture Process Development Flow	71
Figure 34 Raven - Route Flown	78
Figure 35: ScanEagle - Planned Route	80
Figure 36: Scan Eagle – Planned vs. Actual Route Flown	82

Figure 37 Aerosonde- Planned Route	84
Figure 38: Firescout- Planned Route	86
Figure 39 Firescout - Planned vs Actual Route Flown	88
Figure 40 Caravan - Planned Route	89
Figure 41 Caravan - Departure Area	92
Figure 42 Caravan - Arrival Area	93
Figure 43 Predator B - Planned Route	94
Figure 44 Predator B - Departure Area	96
Figure 45 Global Hawk - Planned Route	97
Figure 46: Scenario 8 – Global Hawk Departure Area	99
Figure 47 – Global Hawk – Aerial Work Area	100
Figure 48 – WDL 1B Airship - Planned Route	101
Figure 49 Global Observer Planned Route	104
Figure 50 Global Observer - Departure Area	106
Figure 51 Flight Planning Services	108
Figure 52 Separation Assurance Services	110
Figure 53 Airspace Management Services	114
Figure 54 Worldwide FIR Boundaries	118
Figure 55 U.S. Domestic and Oceanic Airspace	119
Figure 56 NAS Airspace Classes	119
Figure 57 Airspace Classifications for U.S. Managed Pacific & Arctic Airspace	120
Figure 58 Airspace Classifications for U.S. Managed Atlantic & Gulf of Mexico Airspace	120
Figure 59 Airspace Rules by Class (1)	121
Figure 60 Airspace Rules by Class (2)	122
Figure 61 NRS Naming Convention	122
Figure 62 NAS Architecture Communications Roadmap	128
Figure 63 NAS Architecture Navigation Roadmap	132
Figure 64 NAS Architecture Surveillance Roadmap	135
Figure 65 NAS Architecture Automation Systems - 1	141
Figure 66 NAS Architecture Automation Systems - 2	142
Figure 67 Conceptual Model	C-2

List of Tables

Table 1	Cross-comparison of Operational Concept Views to Primary Functions	14
Table 2	Estimated Military Market by UA Category	25
Table 3	Estimated Civil Government Market by UA Category	30
Table 4	Estimated Commercial Market by UA Category	35
Table 5	Summary of Quantitative Estimates by UAS Market Segment	36
Table 6	Turbojet fixed-wing aircraft – Flight profile types by percent	41
Table 7	Global Hawk (RQ-4) – Average Usage by Time in Airspace Classes	44
Table 8	N-UCAS (X-47B) – Average Usage by Time in Airspace Classes	44
Table 9	Gulfstream 550 – Average Usage by Time in Airspace Classes	45
Table 10	Turboprop Fixed-wing Aircraft – Flight Profile Types by Percent	46
Table 11	Predator B – Average Usage by Time in Airspace Classes	49
Table 12	King Air 200 (conversion) – Average Usage by Time in Airspace Classes	49
Table 13	Cessna Caravan (conversion) – Average Usage by Time in Airspace Classes	50
Table 14	Reciprocating Prop Aircraft – Flight Profile Types by Percent	51
Table 15	Predator A – Average Usage by Time in Airspace Classes	54
Table 16	Shadow 200 – Average Usage by Time in Airspace Classes	54
Table 17	Cessna 182 (conversion) – Average Usage by Time in Airspace Classes	55
Table 18	ScanEagle – Average Usage by Time in Airspace Classes	55
Table 19	VTOL UA – Mission Types by Percent	56
Table 20	Firescout – Average Usage by Time in Airspace Classes	59
Table 21	Bell 206 (conversion) – Average Usage by Time in Airspace Classes	59
Table 22	Hummingbird A 160 – Average Usage by Time in Airspace Classes	60
Table 23	RMAX Type II – Average Usage by Time in Airspace Classes	60
Table 24	RQ-16A T-Hawk – Average Usage by Time in Airspace Classes	61
Table 25	Airship UA – Mission Types by Percent	64
Table 26	SA 60 LAA – Average Usage by Time in Airspace Classes	64
Table 27	WLD-1B – Average Usage by Time in Airspace Classes	65
Table 28	HALE UA – Mission Types by Percent	66
Table 29	Global Observer – Average Usage by Time in Airspace Classes	67
Table 30	LVS UA – Mission Types by Percent	68
Table 31	Raven – Average Usage by Time in Airspace Classes	69
Table 32	Aircraft Numbers, Utilization and Distribution by Altitude	144
Table 33	Aggregate Air Traffic Density Estimate – 2009	148
Table 34	Aggregate Air Traffic Density Estimate - 2025	149
Table 35	Sampling Distributions	C-2
Table 36	Global Hawk (RQ-4) – Physical Characteristics and Equipage	F-1
Table 37	Global Hawk (RQ-4) – Flight Performance Characteristics	F-1
Table 38	N-UCAS (X-47B) – Physical Characteristics and Equipage	F-2
Table 39	N-UCAS (X-47B) – Flight Performance Characteristics	F-2
Table 40	Gulfstream 550 – Physical Characteristics and Equipage	F-3

Table 41	Gulfstream 550 – Flight Performance Characteristics	F-3
Table 42	Predator B – Physical Characteristics and Equipage	F-4
Table 43	Predator B – Flight Performance Characteristics	F-4
Table 44	King Air 200 – Physical Characteristics and Equipage	F-5
Table 45	King Air 200 – Flight Performance Characteristics	F-5
Table 46	Cessna Caravan – Physical Characteristics and Equipage	F-6
Table 47	Cessna Caravan – Flight Performance Characteristics	F-6
Table 48	Predator A – Physical Characteristics and Equipage	F-7
Table 49	Predator A – Flight Performance Characteristics	F-7
Table 50	Shadow 200– Physical Characteristics and Equipage	F-8
Table 51	Shadow 200 – Flight Performance Characteristics	F-8
Table 52	Cessna 182 – Physical Characteristics and Equipage	F-9
Table 53	Cessna 182 – Flight Performance Characteristics	F-9
Table 54	Aerosonde – Physical Characteristics and Equipage	F-10
Table 55	Aerosonde – Flight Performance Characteristics	F-10
Table 56	ScanEagle – Physical Characteristics and Equipage	F-11
Table 57	ScanEagle – Flight Performance Characteristics	F-11
Table 58	Firescout – Physical Characteristics and Equipage	F-12
Table 59	Firescout – Flight Performance Characteristics	F-12
Table 60	Bell 206 – Physical Characteristics and Equipage	F-13
Table 61	Bell 206 – Flight Performance Characteristics	F-13
Table 62	Hummingbird A-160 – Physical Characteristics and Equipage	F-14
Table 63	Hummingbird A-160 – Flight Performance Characteristics	F-14
Table 64	RMAX TYPE II – Physical Characteristics and Equipage	F-15
Table 65	RMAX TYPE II – Flight Performance Characteristics	F-15
Table 66	Honeywell RQ-16A T-Hawk – Physical Characteristics and Equipage	F-16
Table 67	GoldenEye 50 – Flight Performance Characteristics	F-16
Table 68	SA 60 LAA – Physical Characteristics and Equipage	F-17
Table 69	SA 60 LAA – Flight Performance Characteristics	F-17
Table 70	WLD 1B – Physical Characteristics and Equipage	F-18
Table 71	WLD 1B – Flight Performance Characteristics	F-18
Table 72	Global Observer – Physical Characteristics and Equipage	F-19
Table 73	Global Observer – Flight Performance Characteristics	F-19
Table 74	Raven – Physical Characteristics and Equipage	F-20
Table 75	Raven – Flight Performance Characteristics	F-20

1 Introduction

1.1 Purpose

The purpose of the Operational Services & Environment Definition (OSED) is to provide a basis for assessing and establishing operational, safety, performance, and interoperability requirements for UAS operations in the NAS. Its contents are based on guidance contained in RTCA DO-264, *Guidelines for Approval of the Provision and Use of Air Traffic Services Supported by Data Communications*. Though DO-264 is specific to data communications, it provides a generic framework and process being followed by SC-203 in accordance with their Terms of Reference. As stated in DO-264, the OSED results from the Operational Services Environmental Information Capture (OSEIC) process. Information from the OSEIC is used to provide a description of operational objectives, stakeholders, air traffic services, and operational environment.

Traditionally, OSEDs have been written for specific applications whose breadth of operational function and environmental interactions with the NAS are limited (e.g., ADS-B). Such applications have generally sought to *augment or replace* capabilities within the NAS. In contrast, UAS applications are intended to *integrate* into the NAS, not to modify fundamentals of its infrastructure or procedures. Further, unlike the well-defined and limited applications found in other OSED's, UAS vary widely in design, concept, use, and interact with virtually all services, infrastructure and users of the NAS. This document seeks to characterize those highly differentiated attributes of UAS and define their relationship to airspace users, air traffic services, and operating environments of the NAS. It is a baseline information source intended to support subsequent assessments leading to the development of Operational, Safety, Performance and Interoperability Requirements (OSPIR) which, in turn, will support development of UAS Minimum Aviation System Performance Standards (MASPS), and specific Sense & Avoid (SAA) MASPS, and Control & Communication (C2) MASPS.

Specific objectives of the OSED are to:

- Characterize UAS operations in the NAS, with emphasis on civil applications
- Identify where UAS share similar issues with manned aviation in the NAS
- Characterize the operational environment of UAS with respect to airspace classes, operating rules and conditions, and the nature of interactions with other airspace users
- Categorize UAS based on attributes of greatest interest to the NAS
- Provide a basis for identifying specific incompatibilities with the current NAS in terms of operations, systems, standards and procedures, or some combination thereof
- Articulate differences in UAS operations relative to NAS constraints and requirements
- Map UAS operational functions and interfaces relative to the NAS
- Identify where additional research or data may be required to effectively describe and characterize the nature of UAS/NAS incompatibilities
- Provide source data for assessing the scope of operations and environments to be considered for the initial set of MASPS development work

The OSED is an iterative document that is subject to change based on modifications to underlying data or descriptions (e.g., implementation of new air traffic procedures or technologies) or the need for additional information to support future assessments.