Safety Regulation Group

CAP 670

Air Traffic Services Safety Requirements

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Safety Regulation Group

Civil Aviation Authority

CAP 670

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List of Effective Pages

Part	Chapter	Page	Date	Part	Chapter	Page	Date
		iii	14 May 2004		Cross - Reference Matrix	8	12 June 2003
		iv	14 May 2004		Cross - Reference Matrix	9	12 June 2003
		v	14 May 2004		Cross - Reference Matrix	10	12 June 2003
		vi	14 May 2004		Cross - Reference Matrix	11	12 June 2003
		vii	14 May 2004		Cross - Reference Matrix	12	12 June 2003
		viii	14 May 2004		Cross - Reference Matrix	13	12 June 2003
		ix	14 May 2004		Cross - Reference Matrix	14	12 June 2003
		x	14 May 2004		Cross - Reference Matrix	15	12 June 2003
		xi	14 May 2004		Cross - Reference Matrix	16	12 June 2003
		xii	14 May 2004		Cross - Reference Matrix	17	12 June 2003
		xiii	14 May 2004		Cross - Reference Matrix	18	12 June 2003
		xiv	14 May 2004		Cross - Reference Matrix	19	12 June 2003
		xv	14 May 2004	Part A		1	14 May 2004
		xvi	14 May 2004	Part A		2	12 June 2003
		xvii	14 May 2004	Part A		3	14 May 2004
		xviii	14 May 2004	Part A		4	12 June 2003
	Preamble	1	14 May 2004	Part A		5	14 May 2004
	Preamble	2	14 May 2004	Part A		6	14 May 2004
	Preamble	3	14 May 2004	Part A		7	14 May 2004
	Preamble	4	12 June 2003	Part A		8	14 May 2004
	Preamble	5	12 June 2003	Part A		9	14 May 2004
	Preamble	6	12 June 2003	Part A		10	14 May 2004
	Preamble	7	12 June 2003	Part A		11	14 May 2004
	Preamble	8	12 June 2003	Part A	Appendix A	1	14 May 2004
	Preamble	9	12 June 2003	Part A	Appendix A	2	14 May 2004
	Preamble	10	12 June 2003	Part A	Appendix B	1	12 June 2003
	Preamble	11	12 June 2003	Part B		1	12 June 2003
	Preamble	12	12 June 2003	Part B		2	12 June 2003
	Preamble	13	12 June 2003	Part B		3	12 June 2003
	Preamble	14	12 June 2003	Part B		4	12 June 2003
	Preamble	15	12 June 2003	Part B		5	12 June 2003
	Preamble	16	12 June 2003	Part B, Section 1, APP 01		1	12 June 2003
	Preamble	17	12 June 2003	Part B, Section 1, APP 01		2	12 June 2003
	Preamble	18	12 June 2003	Part B, Section 1, APP 01		3	12 June 2003
	Preamble	19	12 June 2003	Part B, Section 1, APP 01		4	12 June 2003
	Preamble	20	12 June 2003	Part B, Section 1, APP 01		5	12 June 2003
	Preamble	21	12 June 2003	Part B, Section 1, APP 01		6	12 June 2003
	Preamble	22	12 June 2003	Part B, Section 1, APP 01		7	12 June 2003
	Preamble	23	12 June 2003	Part B, Section 1, APP 01		8	12 June 2003
	Preamble	24	12 June 2003	Part B, Section 1, APP 01		9	12 June 2003
	Cross - Reference Matrix	1	12 June 2003	Part B, Section 1, Appendix A to APP 01		1	12 June 2003
	Cross - Reference Matrix	2	12 June 2003	Part B, Section 1, Appendix A to APP 01		2	12 June 2003
	Cross - Reference Matrix	3	12 June 2003	Part B, Section 1, Appendix A to APP 01		3	12 June 2003
	Cross - Reference Matrix	4	12 June 2003	Part B, Section 1, Appendix A to APP 01		4	12 June 2003
	Cross - Reference Matrix	5	12 June 2003	Part B, Section 1, Appendix A to APP 01		5	12 June 2003
	Cross - Reference Matrix	6	12 June 2003	Part B, Section 1, Appendix A to APP 01		6	12 June 2003
	Cross - Reference Matrix	7	12 June 2003	Part B, Section 1, Appendix A to APP 01		7	12 June 2003

Part Chapter	Page	Date
Part B, Section 1, Appendix A to APP 01	8	12 June 2003
Part B, Section 1, Appendix A to APP 01	9	12 June 2003
Part B, Section 1,APP 02	1	12 June 2003
Part B, Section 1,APP 02	2	12 June 2003
Part B, Section 1,APP 02	3	12 June 2003
Part B, Section 1,APP 02	4	12 June 2003
Part B, Section 1,APP 02	5	12 June 2003
Part B, Section 1,APP 02	6	12 June 2003
Part B, Section 1,APP 03	1	12 June 2003
Part B, Section 1,APP 03	2	12 June 2003
Part B, Section 1,APP 04	1	12 June 2003
Part B, Section 1,APP 04	2	12 June 2003
Part B, Section 1,APP 04	3	12 June 2003
Part B, Section 1,APP 04	4	12 June 2003
Part B, Section 2,ATC 01	1	12 June 2003
Part B, Section 2,ATC 01	2	12 June 2003
Part B, Section 2,ATC 01	3	12 June 2003
Part B, Section 2,ATC 01	4	12 June 2003
Part B, Section 2,Annex A to ATC 01	1	12 June 2003
Part B, Section 2,Annex A to ATC 01	2	12 June 2003
Part B, Section 2,ATC 02	1	12 June 2003
Part B, Section 2,ATC 02	2	12 June 2003
Part B, Section 2,ATC 02	3	12 June 2003
Part B, Section 2,ATC 02	4	12 June 2003
Part B, Section 2,ATC 02	5	12 June 2003
Part B, Section 2,Annex A to ATC 02	1	12 June 2003
Part B, Section 2,Annex A to ATC 02	2	12 June 2003
Part B, Section 2,Annex A to ATC 02	3	12 June 2003
Part B, Section 2,Annex A to ATC 02	4	12 June 2003
Part B, Section 2,Annex A to ATC 02	5	12 June 2003
Part B, Section 2,Annex A to ATC 02	6	12 June 2003
Part B, Section 2,Annex A to ATC 02	7	12 June 2003
Part B, Section 2,Annex A to ATC 02	8	12 June 2003
Part B, Section 2,Annex A to ATC 02	9	12 June 2003
Part B, Section 2,Annex A to ATC 02	10	12 June 2003
Part B, Section 2,ATC 03	1	12 June 2003
Part B, Section 2,ATC 03	2	12 June 2003
Part B, Section 3,SW 01	1	12 June 2003
Part B, Section 3,SW 01	2	12 June 2003
Part B, Section 3,SW 01	3	12 June 2003
Part B, Section 3,SW 01	4	12 June 2003
Part B, Section 3,SW 01	5	12 June 2003
Part B, Section 3,SW 01	6	12 June 2003
Part B, Section 3,SW 01	7	12 June 2003
Part B, Section 3,SW 01	8	12 June 2003
Part B, Section 3,SW 01	9	12 June 2003
Part B, Section 3,SW 01	10	12 June 2003
Part B, Section 3,SW 01	11	12 June 2003

Part Chapter	Page	Date
Part B, Section 3,SW 01	12	12 June 2003
Part B, Section 3,SW 01	13	12 June 2003
Part B, Section 3,SW 01	14	12 June 2003
Part B, Section 3,SW 01	15	12 June 2003
Part B, Section 3,SW 01	16	12 June 2003
Part B, Section 3,SW 01	17	12 June 2003
Part B, Section 3,SW 01	18	12 June 2003
Part B, Section 3,SW 01	19	12 June 2003
Part B, Section 3,SW 01	20	12 June 2003
Part B, Section 3,SW 01	21	12 June 2003
Part B, Section 3,SW 01	22	12 June 2003
Part B, Section 3,SW 01	23	12 June 2003
Part B, Section 3,Appendix A to SW 01	1	12 June 2003
Part B, Section 3,Appendix A to SW 01	2	12 June 2003
Part B, Section 3,Appendix A to SW 01	3	12 June 2003
Part B, Section 3,Appendix A to SW 01	4	12 June 2003
Part B, Section 3,Appendix B to SW 01	1	12 June 2003
Part B, Section 3,Appendix B to SW 01	2	12 June 2003
Part B, Section 3,Appendix B to SW 01	3	12 June 2003
Part B, Section 3,Appendix B to SW 01	4	12 June 2003
Part B, Section 3,Appendix C to SW 01	1	12 June 2003
Part B, Section 3,Appendix C to SW 01	2	12 June 2003
Part B, Section 3,Appendix C to SW 01	3	12 June 2003
Part B, Section 3,Appendix C to SW 01	4	12 June 2003
Part B, Section 3,Appendix D to SW 01	1	12 June 2003
Part B, Section 3,Appendix D to SW 01	2	12 June 2003
Part B, Section 3,Appendix D to SW 01	3	12 June 2003
Part B, Section 3,SW 01 Annex A	1	12 June 2003
Part B, Section 4,GEN 01	1	12 June 2003
Part B, Section 4,GEN 01	2	12 June 2003
Part B, Section 4,GEN 02	1	12 June 2003
Part B, Section 4,GEN 02	2	12 June 2003
Part B, Section 4,GEN 02	3	12 June 2003
Part B, Section 4,GEN 02	4	14 May 2004
Part B, Section 4,GEN 02	5	14 May 2004
Part B, Section 4,GEN 03	1	12 June 2003
Part B, Section 4,GEN 03	2	12 June 2003
Part B, Section 4,Appendix	1	12 June 2003
Part B, Section 4,GEN 04	1	12 June 2003
Part C	1	12 June 2003
Part C	2	12 June 2003
Part C	3	12 June 2003
Part C, Section 1,	1	12 June 2003
Part C, Section 1,COM 01	1	12 June 2003
Part C, Section 1,COM 01	2	12 June 2003
Part C, Section 1,COM 01	3	12 June 2003
Part C, Section 1,COM 01	4	12 June 2003
Part C, Section 1,COM 01	5	12 June 2003

Part Chapter	Page	Date	Part Chapter	Page	Date
Part C, Section 1,COM 01	6	12 June 2003	Part C, Section 1,COM 06	4	12 June 2003
Part C, Section 1,COM 01	7	12 June 2003	Part C, Section 1,COM 06	5	12 June 2003
Part C, Section 1,COM 01	8	12 June 2003	Part C, Section 1,COM 06	6	12 June 2003
Part C, Section 1,COM 01 Appendix	1	12 June 2003	Part C, Section 1,COM 06 Appendix	1	12 June 2003
Part C, Section 1,COM 01 Appendix	2	12 June 2003	Part C, Section 1,COM 07	1	12 June 2003
Part C, Section 1,COM 01 Appendix	3	12 June 2003	Part C, Section 1,COM 07	2	12 June 2003
Part C, Section 1,COM 01 Appendix	4	12 June 2003	Part C, Section 1,COM 07	3	12 June 2003
Part C, Section 1,COM 01 Appendix	5	12 June 2003	Part C, Section 1,COM 07	4	12 June 2003
Part C, Section 1,COM 02	1	12 June 2003	Part C, Section 1,COM 07	5	12 June 2003
Part C, Section 1,COM 02	2	12 June 2003	Part C, Section 1,COM 07	6	12 June 2003
Part C, Section 1,COM 02	3	12 June 2003	Part C, Section 1,COM 07	7	12 June 2003
Part C, Section 1,COM 02	4	12 June 2003	Part C, Section 1,COM 07	8	12 June 2003
Part C, Section 1,COM 02	5	12 June 2003	Part C, Section 1,COM 07	9	12 June 2003
Part C, Section 1,COM 02	6	12 June 2003	Part C, Section 1,COM 07	10	12 June 2003
Part C, Section 1,COM 02	7	12 June 2003	Part C, Section 1,COM 07	11	12 June 2003
Part C, Section 1,COM 02	8	12 June 2003	Part C, Section 1,COM 07	12	12 June 2003
Part C, Section 1,COM 02	9	12 June 2003	Part C, Section 2,	i	12 June 2003
Part C, Section 1,COM 02	10	12 June 2003	Part C, Section 2,ILS 01	1	12 June 2003
Part C, Section 1,COM 02	11	12 June 2003	Part C, Section 2,ILS 01	2	12 June 2003
Part C, Section 1,COM 02	12	12 June 2003	Part C, Section 2,ILS 01	3	12 June 2003
Part C, Section 1,COM 02	13	12 June 2003	Part C, Section 2,ILS 01	4	12 June 2003
Part C, Section 1,COM 02	14	12 June 2003	Part C, Section 2,ILS 01	5	12 June 2003
Part C, Section 1,COM 02	15	12 June 2003	Part C, Section 2,ILS 01	6	12 June 2003
Part C, Section 1,COM 02	16	12 June 2003	Part C, Section 2,ILS 01 Appendix	1	12 June 2003
Part C, Section 1,COM 02	17	12 June 2003	Part C, Section 2,ILS 02	1	12 June 2003
Part C, Section 1,COM 02 Appendix	1	12 June 2003	Part C, Section 2,ILS 02	2	12 June 2003
Part C, Section 1,COM 02 Appendix	2	12 June 2003	Part C, Section 2,ILS 02	3	12 June 2003
Part C, Section 1,COM 02 Appendix	3	12 June 2003	Part C, Section 2,ILS 02	4	12 June 2003
Part C, Section 1,COM 02 Appendix	4	12 June 2003	Part C, Section 2,ILS 02	5	12 June 2003
Part C, Section 1,COM 02 Appendix	5	12 June 2003	Part C, Section 2,ILS 02	6	12 June 2003
Part C, Section 1,COM 03	1	12 June 2003	Part C, Section 2,ILS 02	7	12 June 2003
Part C, Section 1,COM 03	2	12 June 2003	Part C, Section 2,ILS 02	8	12 June 2003
Part C, Section 1,COM 03	3	12 June 2003	Part C, Section 2,ILS 03	1	12 June 2003
Part C, Section 1,COM 03	4	12 June 2003	Part C, Section 2,ILS 03	2	12 June 2003
Part C, Section 1,COM 03	5	12 June 2003	Part C, Section 2,ILS 03	3	12 June 2003
Part C, Section 1,COM 03	6	12 June 2003	Part C, Section 2,ILS 03	4	12 June 2003
Part C, Section 1,COM 03	7	12 June 2003	Part C, Section 2,ILS 03	5	12 June 2003
Part C, Section 1,COM 03	8	12 June 2003	Part C, Section 2,ILS 03	6	12 June 2003
Part C, Section 1,COM 04	1	12 June 2003	Part C, Section 2,ILS 04	1	12 June 2003
Part C, Section 1,COM 04	2	12 June 2003	Part C, Section 2,ILS 04	2	12 June 2003
Part C, Section 1,COM 04 Appendix	1	12 June 2003	Part C, Section 2,ILS 04	3	12 June 2003
Part C, Section 1,COM 05	1	12 June 2003	Part C, Section 2,ILS 05	1	12 June 2003
Part C, Section 1,COM 05	2	12 June 2003	Part C, Section 2,ILS 05	2	12 June 2003
Part C, Section 1,COM 05	3	12 June 2003	Part C, Section 2,ILS 05 Annex	1	12 June 2003
Part C, Section 1,COM 05	4	12 June 2003	Part C, Section 2,ILS 05 Annex	2	12 June 2003
Part C, Section 1,COM 06	1	12 June 2003	Part C, Section 2,ILS 06	1	12 June 2003
Part C, Section 1,COM 06	2	12 June 2003	Part C, Section 2,ILS 06	2	12 June 2003
Part C, Section 1,COM 06	3	12 June 2003	Part C, Section 2,ILS 06	3	12 June 2003

Part Chapter	Page	Date	Part Chapter	Page	Date
Part C, Section 2,ILS 07	1	12 June 2003	Part C, Section 2,NAV 02	3	12 June 2003
Part C, Section 2,ILS 07	2	12 June 2003	Part C, Section 2,NAV 02	4	12 June 2003
Part C, Section 2,ILS 07	3	12 June 2003	Part C, Section 2,NAV 02	5	12 June 2003
Part C, Section 2,ILS 07	4	12 June 2003	Part C, Section 2,NAV 02	6	12 June 2003
Part C, Section 2,ILS 07 Annex	1	12 June 2003	Part C, Section 2,NAV 04	1	12 June 2003
Part C, Section 2,ILS 07 Annex	2	12 June 2003	Part C, Section 2,NAV 04	2	12 June 2003
Part C, Section 2,ILS 08	1	12 June 2003	Part C, Section 2,NAV 04	3	12 June 2003
Part C, Section 2,ILS 08	2	12 June 2003	Part C, Section 2,NAV 04	4	12 June 2003
Part C, Section 2,ILS 08	3	12 June 2003	Part C, Section 2,NAV 04	5	12 June 2003
Part C, Section 2,ILS 08	4	12 June 2003	Part C, Section 2,NAV 04	6	12 June 2003
Part C, Section 2,ILS 08	5	12 June 2003	Part C, Section 2,NAV 04	7	12 June 2003
Part C, Section 2,ILS 10	1	12 June 2003	Part C, Section 2,VDF 01	1	12 June 2003
Part C, Section 2,ILS 10	2	12 June 2003	Part C, Section 2,VDF 01	2	12 June 2003
Part C, Section 2,ILS 10	3	12 June 2003	Part C, Section 2,VDF 01	3	12 June 2003
Part C, Section 2,ILS 10	4	12 June 2003	Part C, Section 2,VDF 01	4	12 June 2003
Part C, Section 2,ILS 10	5	12 June 2003	Part C, Section 3	i	12 June 2003
Part C, Section 2,ILS 10	6	12 June 2003	Part C, Section 3,RAD 01	1	12 June 2003
Part C, Section 2,ILS 10	7	12 June 2003	Part C, Section 3,RAD 01	2	12 June 2003
Part C, Section 2,ILS 10	8	12 June 2003	Part C, Section 3,RAD 01	3	12 June 2003
Part C, Section 2,ILS 10 Annex 1	1	12 June 2003	Part C, Section 3,RAD 01	4	12 June 2003
Part C, Section 2,ILS 10 Annex 2	1	12 June 2003	Part C, Section 3,RAD 02	1	12 June 2003
Part C, Section 2,FLI 02	1	12 June 2003	Part C, Section 3,RAD 02	2	12 June 2003
Part C, Section 2,FLI 02	2	12 June 2003	Part C, Section 3,RAD 02	3	12 June 2003
Part C, Section 2,FLI 02	3	12 June 2003	Part C, Section 3,RAD 02	4	12 June 2003
Part C, Section 2,FLI 02	4	12 June 2003	Part C, Section 3,RAD 02	5	12 June 2003
Part C, Section 2,FLI 02	5	12 June 2003	Part C, Section 3,RAD 02	6	12 June 2003
Part C, Section 2,FLI 02	6	12 June 2003	Part C, Section 3,RAD 02	7	12 June 2003
Part C, Section 2,FLI 02	7	12 June 2003	Part C, Section 3,RAD 02	8	12 June 2003
Part C, Section 2,FLI 02	8	12 June 2003	Part C, Section 3,RAD 02	9	12 June 2003
Part C, Section 2,FLI 02	9	12 June 2003	Part C, Section 3,RAD 02	10	12 June 2003
Part C, Section 2,FLI 02	10	12 June 2003	Part C, Section 3,RAD 02	11	12 June 2003
Part C, Section 2,FLI 02	11	12 June 2003	Part C, Section 3,RAD 03	1	12 June 2003
Part C, Section 2,FLI 02	12	12 June 2003	Part C, Section 3,RAD 03	2	12 June 2003
Part C, Section 2,FLI 02	13	12 June 2003	Part C, Section 3,RAD 03	3	12 June 2003
Part C, Section 2,FLI 02	14	12 June 2003	Part C, Section 3,RAD 04	1	12 June 2003
Part C, Section 2,FLI 02	15	12 June 2003	Part C, Section 3,RAD 04	2	12 June 2003
Part C, Section 2,FLI 02	16	12 June 2003	Part C, Section 3,RAD 04	3	12 June 2003
Part C, Section 2,FLI 02	17	12 June 2003	Part C, Section 3,RAD 05	1	12 June 2003
Part C, Section 2,FLI 02	18	12 June 2003	Part C, Section 3,RAD 05	2	12 June 2003
Part C, Section 2,FLI 02	19	12 June 2003	Part C, Section 3,RAD 05	3	12 June 2003
Part C, Section 2,FLI 02	20	12 June 2003	Part C, Section 3,RAD 05	4	12 June 2003
Part C, Section 2,FLI 02	21	12 June 2003	Part C, Section 3,RAD 06	1	12 June 2003
Part C, Section 2,NAV 01	1	12 June 2003	Part C, Section 3,RAD 06	2	12 June 2003
Part C, Section 2,NAV 01	2	12 June 2003	Part C, Section 3,RAD 06	3	12 June 2003
Part C, Section 2,NAV 01	3	12 June 2003	Part C, Section 3,RAD 07	1	12 June 2003
Part C, Section 2,NAV 01	4	12 June 2003	Part C, Section 3,RAD 07	2	12 June 2003
Part C, Section 2,NAV 02	1	12 June 2003	Part C, Section 3,RAD 07	3	12 June 2003
Part C, Section 2,NAV 02	2	12 June 2003	Part C, Section 3,RAD 07	4	12 June 2003

Part	Chapter	Page	Date
Part C, Section 3,RAD 08		1	12 June 2003
Part C, Section 3,RAD 08		2	12 June 2003
Part C, Section 3,RAD 08		3	12 June 2003
Part C, Section 3,RAD 08		4	12 June 2003
Part C, Section 3,RAD 09		1	12 June 2003
Part C, Section 3,RAD 09		2	12 June 2003
Part C, Section 3,RAD 09		3	12 June 2003
Part C, Section 3,RAD 09		4	12 June 2003
Part C, Section 3,RAD 10		1	12 June 2003
Part C, Section 3,RAD 10		2	12 June 2003
Part C, Section 3,RAD 10		3	12 June 2003
Part C, Section 3,RAD 10		4	12 June 2003
Part C, Section 3,RAD 11		1	12 June 2003
Part C, Section 3,RAD 11		2	12 June 2003
Part C, Section 3,RAD 11		3	12 June 2003
Part C, Section 3,RAD 11		4	12 June 2003
Part C, Section 3,FLI 03		1	12 June 2003
Part C, Section 3,FLI 03		2	12 June 2003
Part C, Section 3,FLI 03		3	12 June 2003
Part C, Section 3,FLI 03		4	12 June 2003
Part C, Section 3,MET 01		1	12 June 2003
Part C, Section 3,MET 01		2	12 June 2003
Part C, Section 3,MET 01		3	12 June 2003
Part C, Section 3,MET 01		4	12 June 2003
Part C, Section 3,MET 02		1	12 June 2003
Part C, Section 3,MET 02		2	12 June 2003
Part C, Section 3,MET 03		1	12 June 2003
Part C, Section 3,MET 03		2	12 June 2003
Part C, Section 3,MET 04		1	12 June 2003
Part C, Section 3,MET 04		2	12 June 2003
Part C, Section 3,MET 04		3	12 June 2003
Part C, Section 3,MET 05		1	12 June 2003
Part C, Section 3,MET 05		2	12 June 2003
Part C, Section 3,MET 06		1	12 June 2003
Part C, Section 3,MET 06		2	12 June 2003
Part C, Section 3,MET 08		1	12 June 2003
Part C, Section 3,MET 08		2	12 June 2003
Part C, Section 3,MET 08		3	12 June 2003
Part C, Section 3,MET 09		1	12 June 2003
Part C, Section 3,MET 09		2	12 June 2003
Part C, Section 3,MET 09		3	12 June 2003
Part C, Section 3,MET 09		4	12 June 2003
Part D		1	14 May 2004
Part D	Section 1	1	14 May 2004
Part D	Section 1	2	14 May 2004
Part D	Section 1	3	14 May 2004
Part D	Section 1	4	14 May 2004
Part D	Section 2	1	14 May 2004
Part D	Section 2	2	14 May 2004
Part D	Section 2	3	14 May 2004
Part D	Annex A	1	14 May 2004
Part D	Annex B	1	14 May 2004
Part D	Annex B	2	14 May 2004
Part D	Annex B	3	14 May 2004
Part D	Annex B	4	14 May 2004
Part D	Annex B	5	14 May 2004

Contents

List of Effective Pages iii

CAP 670 Second Issue Revision History and Explanatory Note xvi

Ad Hoc Comments xvii

Ad Hoc Comments Form xviii

Preamble 1

Cross - Reference Matrix 1

Part A The Regulatory Framework

Appendix A The Articles of the Air Navigation Order

Appendix B Schedule of Equipment to be Regulated under the Air Navigation Order, Articles 104 and 105

Part B Generic Requirements and Guidance

Part B, Section 1, ATS Approval - Documents

APP 01 Safety Management Systems

Appendix A to APP 01 SMS – Additional Guidance

APP 02 Approval of Maintenance Arrangements (AMA)

APP 03 The Approval of an Air Traffic Control Unit

APP 04 Temporary ATC Units

Part B, Section 2, Air Traffic Control

ATC 01 ATC Support Systems and Facilities

Annex A to ATC 01

ATC 02 **ATC Documentation**

Annex A to ATC 02 Manual of Air Traffic Services Part 2

ATC 03 **Emergency or Contingency Facilities**

Part B, Section 3, Systems Engineering

SW 01 **Regulatory Objectives for Software Safety Assurance in ATS Equipment**

Part 1 Preliminary Material 1

Part 2 Requirements 2

Part 3 Guidance 4

Appendix A to SW 01 - Identification of AELs

Appendix B to SW 01 - Argument and Evidence Concepts

Appendix C to SW 01 - Definitions and Abbreviations

Appendix D to SW 01 Derivation of Safety Objectives

SW 01 Annex A - Guidance and Information

Part B, Section 4, Generic Requirements and Guidance - General

GEN 01 **Windfarms**

GEN 02 **Technical Safeguarding of Radio Sites; Guidance Material**

GEN 03 **Safety Requirements for Operational Trials in Air Traffic Services**

Part 1 Preliminary Material 1

Part 2 Safety Requirements 2

Appendix Acceptable Means of Compliance

GEN 04 **Electro Magnetic Compatibility**

Part C, Section 1, Communication

COM 01 **Voice / Data Recording Equipment**

	Part 1 Preliminary Material	1
	Part 2 Requirements	2
COM 02	**VHF Aeronautical Radio Stations**	
	Part 1 Preliminary Material	1
	Part 2 Requirements	10
COM 03	**Voice Communications Control Systems**	
	Part 1 Preliminary Material	1
	Part 2 Requirements	2
COM 04	**ATC Datalinks**	
	Part 1 Preliminary Material	1
	Part 2 Safety Requirements	2
	COM 04 Appendix - Acceptable Means of Compliance	
COM 05	**Information and Alerting Systems**	
	Part 1 Preliminary Material	1
	Part 2 Requirements	2
COM 06	**Automatic Terminal Information Service (ATIS)**	
	Part 1 Preliminary Material	1
	Part 2 Requirements	3
	COM 06 Appendix - ICAO Annex 11 ATIS Message Elements	
COM 07	**UHF Radio Equipment and Systems**	
	Part 1 Preliminary Material	1
	Part 2 Requirements	8

Part C, Section 2, - Navigation

ILS 01	**Requirements for ILS Equipment Monitor Alarms**	
	Part 1 Preliminary Material	1

	Part 2 Requirements	2
	ILS 01 Appendix - Calculation of Displacement Sensitivity	
ILS 02	**Flight Inspection – Limits to be Applied**	
	Part 1 Preliminary Material	1
	Part 2 Requirements	2
ILS 03	**ILS flight inspection intervals**	
	Part 1 Preliminary Material	1
	Part 2 Requirements	2
ILS 04	**Localiser Width Measurement at Threshold**	
	Part 1 Preliminary Material	1
	Part 2 Requirements	2
ILS 05	**Sideband Reference Glidepath Phase Alarms**	
	Part 1 Preliminary Material	1
	Part 2 Requirements	2
	ILS 05 Annex - Guidance for Compliance	
ILS 06	**Requirements for ILS and ILS/DME Identity Keying**	
	Part 1 Preliminary Material	1
	Part 2 Requirements	2
ILS 07	**ILS and ILS/DME Flight Inspection Types and Requirements**	
	Part 1 Preliminary Material	1
	Part 2 Requirements	2
ILS 08	**ILS Radio Noise Monitoring**	
	Part 1 Preliminary Material	1
	Part 2 Requirements	2

ILS 10	**General Requirements for ILS**	
	Part 1 Preliminary Material	1
	Part 2 Requirements	2
	ILS 10 Annex 1 Guidance Material Relating to the Automatic Calculation of ILS Category	
	ILS 10 Annex 2 Method of Putting an Established Design of ILS into Category I Service	
FLI 02	**The Approval of Flight Calibration Organisations**	
	Part 1 Preliminary Material	1
	Part 2 Requirements	2
	Annexes Specific to Individual Navigation Aids	11
	Annex 1 - Instrument Landing System	12
	Annex 2 - Microwave Landing System	16
	Annex 3 - GNSS Non-Precision Approach	20
NAV 01	**Engineering Requirements for Instrumented Runway Visual Range (IRVR) Systems**	
	Part 1 Preliminary Information	1
	Part 2 Requirements	2
NAV 02	**Engineering Requirements for MF Non-Directional Beacons**	
	Part 1 Preliminary Material	1
	Part 2 Requirements	2
NAV 04	**Engineering Requirements for Conventional and Doppler VHF Omni-Directional Range (CVOR/DVOR) Beacons**	
	Part 1 Preliminary Material	1
	Part 2 Requirements	2
VDF 01	**Requirements for Flight & Ground Inspection of VHF Direction Finding (VDF) Systems**	

	Part 1 Preliminary Material	1
	Part 2 Requirements	2

Part C, Section 3 - Surveillance

RAD 01	**Guidelines for Radar System Approval**	
	Part 1 Preliminary Material	1
	Part 2 Requirements	2
RAD 02	**Radar Sensor Engineering Requirements**	
	Part 1 Preliminary Material	1
	Part 2 Requirements	2
RAD 03	**SSR External Monitor Engineering Requirements**	
	Part 1 Preliminary Material	1
	Part 2 Requirements	2
RAD 04	**Primary Approach Radar Markers Engineering Requirements**	
	Part 1 Preliminary Material	1
	Part 2 Requirements	2
RAD 05	**Radar Display Engineering Requirements**	
	Part 1 Preliminary Material	1
	Part 2 Requirements	2
RAD 06	**Aerodrome Traffic Monitor Safety Requirements**	
	Part 1 Preliminary Material	1
	Part 2 Requirements	2
RAD 07	**Ergonomic Aspects for Radar Display Systems**	
	Part 1 Preliminary Material	1
	Part 2 Requirements	2

RAD 08	**Video Map Generation Equipment Requirements**	
	Part 1 Preliminary Material	1
	Part 2 Requirements	2
RAD 09	**Radar Recording Equipment Requirements**	
	Part 1 Preliminary Material	1
	Part 2 Requirements	2
RAD 10	**Surface Movement Radar Systems Requirements**	
	Part 1 Preliminary Material	1
	Part 2 Requirements	2
RAD 11	**Airport Remote Radar Feeds Engineering Requirements**	
	Part 1 Preliminary Material	1
	Part 2 Requirements	2
FLI 03	**Aerodrome Radar Flight Trial Requirements**	
	Part 1 Preliminary Material	1
	Part 2 Requirements	2
MET 01	**General Engineering Design Requirements for Meteorological Equipment**	
	Part 1 Preliminary Material	1
	Part 2 Requirements	2
MET 02	**Engineering Requirements for Ground Based Meteorological Displays**	
	Part 1 Preliminary Material	1
	Part 2 Requirements	2
MET 03	**Engineering Requirements Meteorological Site Communications**	
	Part 1 Preliminary Material	1
	Part 2 Requirements	2

MET 04 **Engineering Requirements for Surface Wind Speed and Direction Measurement**

Part 1 Preliminary Material 1

Part 2 Requirements 2

MET 05 **Engineering Requirements for Ground Based Pressure Measurement Equipment**

Part 1 Preliminary Material 1

Part 2 Requirements 2

MET 06 **Engineering Requirements for Ground Based Temperature and Dew-Point Measurement**

Part 1 Preliminary Material 1

Part 2 Requirements 2

MET 08 **Engineering Requirements Runway/Taxiway Surface Condition Measurement Equipment**

Part 1 Preliminary Material 1

Part 2 Requirements 2

MET 09 **Requirements for the Observation and Dissemination of Meteorological Observations**

Part 1 Preliminary Material 1

Part 2 Requirements 2

Part D **Human resources**

Section 1 **Unit Staffing and Rostering**

Section 2 **Scheme for Regulation of the Hours of Civil ATCOs in the UK**

Annex A **Operational Duty in Excess of SRATCOH**

Annex B **Revised Scheme for Regulation of the Hours of Civil ATCOs in the UK (effective from November 2005)**

CAP 670 Second Issue Revision History and Explanatory Note

Amendment 1/2003 (first amendment)

The ATC licensing requirements in Part D, Human Resources, were replaced by new requirements for the harmonised European air traffic controller licence in CAP 744, Manual of Air Traffic Services – Personnel Licensing effective 16 December 2003.

Amendment 1/2004 (second amendment)

This amendment covers the following:

1 Editorial corrections to update pages in the Preamble.

2 Revised guidance regarding ATS Standards Department's formal consultation process.

3 Tidying up of the residual content of Part D following removal of the ATC licensing requirements.

4 Addition of a new Appendix B to Part D, to include the revised Scheme for the Regulation of Controllers' Hours, which will be implemented in November 2005.

Ad Hoc Comments

We are always seeking to make improvements and therefore welcome your comments on the content of this document. Please address them to the CAP 670 Editor, by either using the form provided on the following page or e-mail[1], with the assistance of the guidance notes below.

Guidance Notes

Ad hoc comments on CAP 670 should be submitted in accordance with the following guidelines which are intended to ensure that they receive efficient and appropriate attention by ATS Standards Department.

1.1 **Identification**

Please provide the necessary details at the top of the Ad Hoc Comments Form identifying yourself so that a response to your comments can be provided if required.

1.2 **Numbering**

Each comment should be numbered sequentially, prefixed by your personal initials or letters of your company/organisation and classified as **General**, **Editorial** or **Substantive**.

NOTE: The classifications of comments are defined as follows:–

General – relating to the structure and format or global changes.

Editorial – typographical errors and changes to improve readability or layout of text.

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Each comment should reference the relevant item in the publication using the Part, Section, Paragraph and Sub-Paragraph where appropriate.

1.3 **Comment Structure**

Each comment should relate only to a single item, and where possible, propose an action giving the rationale for the proposal.

1. cap670editor@srg.caa.co.uk

Ad Hoc Comments Form

All comments should be sent to:

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Please complete the following details:

Title & Surname	
Company	

Comment Number	General Editorial Substantive	Part/Section Paragraph Sub-Paragraph	Comment / Action	Rationale

Preamble

1 Addresses

Some contact addresses which may be useful are given below:

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ATS Standards Department En-route and College Regulation 2W Aviation House Gatwick Airport South West Sussex RH6 0YR	Tel: Fax:	01293 573060 01293 573974	Regulation of En-route ATS and ATC colleges.
ATS Licensing ATS Standards Department CAA Safety Regulation Group Aviation House Gatwick Airport South West Sussex RH6 0YR	Tel: Fax: Email:	01293 573355 01293 573329 01293 573974 ats.licensing@srg.caa.co.uk	Applications for Student ATC Licence and Air Traffic Controller's Licence; FISO licence; Air/Ground and Offshore Radio Operator's Certificate of Competence.

NOTE: The recognised colleges offering approved courses of initial ATC training are listed on the CAA website at: http://www.caa.co.uk/srg/ats/link.asp?groupid=551

Medical Department CAA Safety Regulation Group Aviation House Gatwick Airport South West Sussex RH6 0YR	Tel:	01293 573685	Initial Medical Examinations and Renewals

2 Definitions and Abbreviations

2.1 Glossary of Definitions and Abbreviations

2.1.1 This Glossary contains terms that have a specific meaning in civil aviation, safety, or regulatory matters.

2.1.2 The definitions annotated 'ICAO' have been taken directly from Annex 2 or PANS/RAC (Document 4444). Terms annotated 'A' have a different interpretation to ICAO and those annotated 'B' are not defined by ICAO but require clarification in the United Kingdom. The complete list of terms 'A' and 'B' appear in the UKAIP.

2.1.3 The definitions annotated 'ITU RR' have been taken from the International Telecommunication Union (ITU) Radio Regulations Edition of 1998.

2.1.4 The definitions annotated 'ANO' have been taken from the current version of the Air Navigation Order.

2.1.5 The definitions annotated 'JAR' have been taken from the referenced Joint Aviation Authorities Requirements documents.

2.1.6 Those terms not annotated are used frequently and are not considered to require clarification or explanation.

Definitions

A

Accuracy	Recommended accuracy requirement for general operational use. The stated value of required accuracy represents the uncertainty of the reported value with respect to the true value and indicates the interval in which the true value lies with a stated probability. The recommended probability level is 95 per cent which corresponds to the 2’s level for a normal (Gaussian) distribution of the variable. The assumption that all known corrections are taken into account implies that the errors in the reported values will have a mean value (or bias) close to zero. Any residual bias should be small compared with the stated accuracy requirement. The true value is that value which, under operational conditions, characterises perfectly the variable to be measured/observed over the representative time, area and/or volume interval required, taking into account siting and exposure. (CIMO)
Act (the)	The current version of the Civil Aviation Act.
Aerodrome	Any area of land or water designed, equipped, set apart or commonly used for affording facilities for the landing and departure of aircraft.
Aerodrome Authority	In relation to any aerodrome, the person in charge of the aerodrome.
Aerodrome Traffic Monitor	A cathode ray tube or electronic display indicating the position and distance from touchdown of arriving aircraft relative to the extended centre-line of the runway in use. It may also be used for other purposes. It is also known as the Distance From Touchdown Indicator (DFTI).
Aeronautical Fixed Service	A telecommunication service between specified fixed points provided primarily for the safety of air navigation and for the regular, efficient and economical operation of air services. (ICAO Annex 11, Chapter 1) NOTE: The ITU RR S1.19 defines the term 'A Radio-communication service' which is restricted to the utilisation of radio systems, whereas the ICAO definition includes transmissions by wire, optical or other electromagnetic systems. (For the purposes of this publication the ICAO definition will be used.)
Aeronautical Information Service (AIS)	Publisher of Notices to Airmen (NOTAM)
Aeronautical Mobile Service	A mobile service between aeronautical stations and aircraft stations, or between aircraft stations, in which survival craft stations may participate; emergency position-indicating radio beacon stations may also participate in this service on designated distress and emergency frequencies. (ITU RR S1.32) (ICAO Annex 11, Chapter 1)

Aeronautical Radio Station	A radio station on the surface, which transmits or receives signals for the purpose of assisting aircraft. (ANO)
Aeronautical Station	A land station in the aeronautical mobile service. In certain instances, an aeronautical station may be located, for example, on board ship or on a platform at sea. (ICAO Annex 11, Chapter 1)
Air-Ground Communications	Two-way communication between aircraft and stations or locations on the surface of the earth. (ICAO Annex 11, Chapter 1)
Airspace Management	Is a generic term covering any management activity provided for the purpose of achieving the most efficient use of airspace based on actual needs and, where possible, avoiding permanent airspace segregation.
Air to Ground Communications	One-way communication from aircraft to stations or locations on the surface of the earth. (ICAO Annex 11, Chapter 1)
Air Traffic	All aircraft in flight or operating on the manoeuvring area of an aerodrome. (ICAO Annex 11, Chapter 1)
Air Traffic Control Centre	An air traffic control unit established to provide an area control service to aircraft flying within a notified flight information region which are not receiving an aerodrome control service or an approach control service. (ANO)
Air Traffic Control Radar Unit	An air traffic service unit which uses radar equipment.
Air Traffic Control Unit	A person appointed by the CAA or by any other person maintaining an aerodrome or place to give instructions or advice or both instructions and advice by means of radio signals to aircraft in the interests of safety but does not include a person so appointed solely to give information to aircraft, and 'Air Traffic Control Service' shall be construed accordingly. (ANO)
Air Traffic Flow Management	Is a generic term covering any management activity provided for the purpose of ensuring an optimum flow of traffic to or through areas during times when demand exceeds the available capacity of ATC system.
Air Traffic Management	The aggregation of ground based (comprising ATS, ASM, ATFM) and airborne functions required to ensure the safe and efficient movement of aircraft during all appropriate phases of operations.
Air Traffic Management Service	A service for the purpose of ATM. (ESARR 3)
Air Traffic Management Service Provider	An organisation responsible and authorized to provide ATM service(s). (ESARR 3)
Air Traffic Service	A generic term meaning air traffic control service, flight information service and air-ground communication.
Airway	A control area or part of a control area established in the form of a corridor equipped with radio navigation aids. (ICAO)
Altitude	The vertical distance of a level, a point or object considered as a point, measured from mean sea level. (ICAO)

Angular Displacement Sensitivity	The ratio of measured DDM to the corresponding angular displacement from the appropriate reference line.
Annex 'n'	Annex 'n' means the Annex number n to the Convention on International Civil Aviation.
Approval	The approval, in writing, required under the ANO before a person can provide an air traffic service.
Articulation Index (AI)	A measure of a communication system's expected intelligibility, derived from electrical and acoustic measurements on a system. (EUROCAE ED-18)
ATS Facility	Systems and equipment that are required in order to provide an Air Traffic Service.
ATSSD	Air Traffic Services Standards Department of the Safety Regulation Group.
ATS Standards Officer	ATS Standards Officers are persons, authorised by the CAA, for the purposes defined within applicable sections of the ANO.
Authorised by the CAA	An authorisation in writing which amplifies instructions and/or specifies conditions of operation.
Availability	The ability of a system to perform within specified limits, a required function under given conditions at a given time.

B

Base Turn	A turn executed by the aircraft during the intermediate approach between the end of the outbound track and the beginning of the final approach track. These tracks are not reciprocal. (ICAO)
Blocking	When a switching matrix cannot make an immediate connection between any input and output it is said to be blocked. This may also be termed 'limited availability'. The opposite to this condition is 'non-blocking' or 'full availability'.

C

CAA	In this publication 'the CAA' means the Safety Regulation Group of the Civil Aviation Authority.
Chief Executive	The person with the ultimate authority and responsibility for all aspects of the control, planning and organisation of the business.
Codes of Practice	A Code of Practice is nominally a guideline document that provides guidance or recommendations. The document is not mandatory unless it is made a specific requirement by the regulator.
Conditional Maintenance	Maintenance performed after an event or specified condition, where the systems function, components, etc. are potentially at risk of degradation to the point where the required system performance / integrity is compromised.
Connection Delay	The time between a request to establish a connection with a system and the corresponding confirmation of connection.

Continuity of Service	The ability of a system to complete its required function.
Controlled Airspace	Airspace which has been notified as Class A, Class B, Class C, Class D or Class E airspace. (ANO)
Critical Equipment Parameter	Means a facility performance parameter that can have a direct effect on the operational integrity of the facility.

D

Data Communications Network	The communication equipment, sub-networks and nodes that provide for the routing for the transfer of data from one system to another.
Data Communications Service Provider	An organisation that provides the means to transfer data between an ATS facility and aircraft.
Data Link Application	The implementation of data link technology to achieve specific Air Traffic Management (ATM) operational functionalities.
Data Link Service	A set of ATM related transactions, both system supported and manual, within a data link application, which have a clearly defined operational goal. Each data link application is a description of its recommended use from an operational point of view.
Data Link Service Provider	The organisation with overall accountability for the data link service. This includes the operational requirements of the data link system.
Data Link System	The total set of component parts, equipment, software and protocols that is required to provide the data link service.
Dead Band	A term used to describe the cross-over characteristic on a 360° potentiometer or position resolver and optical encoder alignment errors.
Decision Height	A specified height measured in feet, at which a missed approach must be initiated if the required visual reference to continue the approach to land has not been established. (ICAO)
Displayed Gust	This is a wind speed, averaged over a 3 second sample, that has increased from the 2 or 10 minute mean wind speed by 10 knots. or more.
Distance From Touchdown Indicator	See Aerodrome Traffic Monitor.

E

Endorse	Wherever the term 'endorse' is used in connection with safety regulation matters this shall be taken to mean acceptance. It is not to be confused with an ANO approval where formal methods have been applied to secure acceptable regulatory confidence in the approval holder.

Equipment	A non-specific term used to denote any product (which may be called by a specific name) designed and built to perform a specific function as a self contained unit or to perform a function in conjunction with other units. Units are physical hardware entities, possibly with software and firmware.
Error	A deviation in any system output from normal system output parameters.
Error Detection	A process of testing for non valid data, bit error, syntax, and addressing problems or the event of an error being detected.
Error Rate	The number of allowable errors detected within a specified time interval.

F

Facility Performance Category I – ILS	An ILS which provides guidance information from the coverage limit of the ILS to the point at which the localiser course line intersects the ILS glide path at a height of 60m (200 ft) or less above the horizontal plane containing the threshold.
Facility Performance Category II – ILS	An ILS which provides guidance information from the coverage limit of the ILS to the point at which the localiser course line intersects the ILS glide path at a height of 15 m (50 ft) or less above the horizontal plane containing the threshold.
Facility Performance Category III – ILS	An ILS which, with the aid of ancillary equipment where necessary, provides guidance information from the coverage limit of the facility to, and along, the surface of the runway.
Failure	A loss of function, or malfunction, of a system or part thereof. (JAR 25)
Fault Tolerance	The built-in capability of a system to provide continued correct execution, i.e. provision of service as specified, in the presence of a limited or specified number of equipment faults.
Final Approach-Instrument	That part of an instrument approach from the time the aircraft has either:

a) completed the last procedure turn or base turn, where one is specified,

b) crossed a specified fix, or

c) intercepted the last track specified for the procedure, until either:

   i) the aircraft has landed,

   ii) a position is reached from which the approach can be completed by visual reference, or

   iii) a missed approach procedure is initiated.

G

Ground to Air Communications	One-way communication from stations or locations on the surface of the earth to aircraft. (ICAO Annex 11, Chapter 1)

Ground-Ground Communications	Two-way communications between or with ATS facilities located on the surface of the earth.
Gust	This is the maximum 3 second running average recorded windspeed sample over the defined measurement period where the variation from the mean speed is 10 knots or more.

H

Hazard	A physical situation, often following from some initiating event, that can lead to an accident. (DEF STAN 00-55)
Heading	The direction in which the longitudinal axis of an aircraft is pointed, usually expressed in degrees from north (true, magnetic or compass).
Height	The vertical displacement of a level, point, or object considered as a point measured from a specified datum.

I

Illumination	(E, Lux or Metre Candela) At a point on a surface, is infinitesimal element of the surface containing the point under consideration by the area of this element. (CIE)
ILS Course Line	The locus of points nearest to the runway centre line in any horizontal plane at which the DDM is zero.
ILS Integrity	That quality which relates to the trust which can be placed in the correctness of the information supplied by the facility. The level of integrity of the localizer or the glide path is expressed in terms of the probability of not radiating false guidance signals.
Information Urgency	The order of display, processing or other action in accordance with the sequencing of essential, routine and time-expired data.
Initial Approach	That part of an instrument approach procedure consisting of the first approach to the first navigational facility associated with the procedure, or to a pre-determined fix. When not associated with an instrument approach procedure that portion of the flight of an aircraft immediately prior to arrival over the aerodrome of destination or over the reporting point from which the final approach to the aerodrome is commenced.
Instrument Meteorological Conditions	Weather precluding flight in compliance with the Visual Flight Rules. (ANO)
Integrity	That quality which relates to the confidence that can be placed in the validity of the information provided by a system.
Integrity Risk	The probability of an undetected failure, event or occurrence within a given time interval.
Intermediate Approach	That part of an instrument approach procedure from the first arrival at the first navigational facility or pre-determined fix to the beginning of the final approach. (ICAO)

L

Lines of Communication	A communications link which can be accessed at a particular operating position. Selected lines of communication are those available lines which have been selected by the operator for a particular mode of operation.
Luminance	(L or B, Candela Metre^{-2}) In a given direction at the point on a surface, is the luminous intensity in that direction, of an infinitesimal element of the surface containing the point, by the area of the orthogonal projection of this element on a plane perpendicular to the direction considered. (CIE)
Luminous Flux	(F, Lumen) Quantity relating to a characteristic radiant flux, which expresses its capacity to produce visual sensation, evaluated according to the values of relative luminous efficiency for the light-adapted eye adopted by the Commission Internationale De L'Eclairage. (CIE).
Luminous Intensity	(I, Candela) In a given direction it is the quotient of the luminous flux emitted from a source or from an element of a source containing the point under consideration by the area of this element. (CIE)

M

Maintenance	The preservation or restoration of the required system performance over the system lifecycle.
MATS Part 2	The instructions to controllers produced by the Provider of the Air Traffic Control Service.
May	Used to indicate that the following clause is optional, alternative, or permissive.
Mitigation	Steps taken to control or prevent a hazard from causing harm and reduce risk to a tolerable or acceptable level.

N

Non-Radar Separation	The separation used when the aircraft position information is derived from sources other than radar. (ICAO)

O

Obstacle Clearance Limit	The height above aerodrome or threshold elevation for a given final approach direction and instrument approach aid below which the minimum specified vertical clearance above obstacles cannot be maintained either on approach or in the event of a missed approach. (A)
Operational Control (OPC)	An aeronautical radio station which is licensed and established for company use and only used with company aircraft or aircraft for which the company is the operating authority (CAP 452).
Operational Requirement (OR)	The basic operational need in the aeronautical environment from the air traffic service perspective.

P

Plan Position Indicator	A cathode ray tube display indicating in plan the positions of objects producing radar echoes.
Primary Radar	A radar system that uses reflected radio signals. (ICAO)
Provider (of an Air Traffic Service)	A legal person nominated by an aerodrome or other authority to provide an air traffic control service. The Provider will usually be a legal entity such as a company and it is to this entity that the ANO refers in the legal form of a 'person'.
Provider's Representative	An individual identified to the CAA by the Provider who is the 'Representative' responsible for the management of the Air Traffic Control unit and who will be the focal point for day-to-day dealings with the CAA.

Q

QNH	The pressure to be set on the sub-scale of an aircraft altimeter that would read the aerodrome elevation if the aircraft were on the ground at that aerodrome. (ICAO Abbreviations and codes DOC 8400/4)
Qualitative	Those analytical processes that are subjective and non-numerical in manner.
Quantitative	Those analytical processes that are numerical in manner.

R

Radar	A radio detection device which provides information on range, azimuth and/or elevation of objects. (ICAO)
Radar Approach	An approach, executed by an aircraft, under the direction of a radar controller. (ICAO)
Radar Blip	A generic term for the visual indication, in non-symbolic form, on a radar display of the position of an aircraft obtained by primary or secondary radar. (ICAO)
Radar Clutter	The visual indication on a radar display of unwanted signals. (ICAO)
Radar Contact	The situation which exists when the radar blip or radar position symbol of a particular aircraft is seen and identified on a radar display. (ICAO)
Radar Control	Term used to indicate that radar-derived information is employed directly in the provision of air traffic control service. (ICAO)
Radar Display	An electronic display of radar-derived information depicting the position and movement of aircraft. (ICAO)
Radar Echo	The visual indication on a radar display of a radar signal reflected from an object. (ICAO)
Radar Identification	The process of correlating a particular radar blip or radar position symbol with a specific aircraft. (ICAO)

Radar Map	Information superimposed on a radar display to provide ready indication of selected features. (ICAO)
Radar Monitoring	The use of radar for providing aircraft with information and advice relative to significant deviations from nominal flight path. (ICAO)
Radar Position Symbol	A generic term for the visual indication in a symbolic form on a radar display, of the position of an aircraft obtained after digital computer processing of positional data derived from primary radar, SSR, or both. (ICAO)
Radar Response	The visual indication on a radar display of a radar signal transmitted from an object in reply to an interrogation.
Radar Return	A generic term meaning variously a radar blip or radar position symbol.
Radar Separation	The separation used when aircraft position information is derived from radar sources. (ICAO)
Radar Unit	That element of an air traffic services unit which uses radar equipment to provide one or more services. (ICAO)
Radial	A magnetic bearing extending from a VOR/VORTAC/ TACAN. (B)
Radiation Shield	A reflective radiation shield housing capable of protecting the internal sensors from direct and reflected solar and terrestrial (long wave) radiation and from precipitation. The shield shall provide adequate ventilation and shall not represent a significant thermal mass.
Reliability	The ability of a system to perform a required function under given conditions for a given time interval.
Reporting Point	A specified geographical location in relation to which the position of an aircraft can be reported. (ICAO)
Requirement	A requirement is an expressed or implied need that is satisfied through appropriate compliance action. A requirement may call for compliance to such standards, codes of practice, or specifications as considered appropriate by the regulator. A requirement may be satisfied by appropriate means actioned by the regulated and as approved by the regulator.
Risk	The combination of the probability, or frequency of occurrence of a defined hazard and the magnitude of the consequences of the occurrence. (BS 4778)
Risk Assessment	Assessment to establish that the achieved or perceived risk is lower or equal to an acceptable or tolerable level.
Routine Maintenance	Maintenance at regular periodic intervals, identified at the systems design stage of equipments, functions, components etc., which are known to cause or potentially cause degradation to the required system performance.
Rule	One of the rules of the ANO.

Runway	A defined rectangular area on a land aerodrome prepared for the landing and take-off run of aircraft along its length.

S

Safety	Freedom from unacceptable risk of harm. (IEC 1508)
Safety Assurance Document / Safety Case	A document which clearly and comprehensively presents sufficient arguments, evidence and assumptions that system hazards have been identified and controlled for both engineering and operational areas to demonstrate that a facility, facilities or organisation is/are adequately safe in air traffic service respects.
Safety Critical	An item or system the failure of which could lead to, or directly contribute to, the possibility of an accident or serious loss of functionality, integrity, or safety margins will be identified as safety critical.
Safety Objective	A safety objective is a planned and considered goal that has been set by a design or project authority. The satisfaction of an objective may be demonstrated by appropriate means to be determined in agreement with the regulator.
Safety Policy	A safety policy is a declaration of a general plan of action set by the authority of management.
Safety Related	Since the ability to cause a catastrophic incident is often linked to a series of apparently innocuous and seemingly unrelated events all processes are assumed to be safety related. If something or some process is to be excluded from this precept the burden of proof for exclusion lies with the regulated party.
Secondary Surveillance Radar	A system of radar using ground interrogators and airborne transponders to determine the position of aircraft in range and azimuth and, when agreed modes and codes are used, height and identity of flight and airframe as well. (A)
Shall (is to, are to, and must)	Means that the requirement or instruction is mandatory.
Should	Means that it is strongly advisable that an instruction or action is carried out, it is recommended or discretionary. It is applied where the more positive ‘shall' is unreasonable but nevertheless a provider would need good reason for not complying.
Sidetone	A speech signal derived from the transmit path and fed back at a reduced level to the receive path with negligible delay.
Special Event	A Royal Flight, an airshow, air rally, or other organised event requiring the establishment of a temporary ATC unit.
Specification	A precise technical definition of the required parameters or performance to be achieved.

Standard	Characteristics, methods, principles and practices that can be used to satisfy a requirement. Standards may be international, national or company internal Standards may be adopted by a regulated organisation in response to a regulatory requirement provided that it is acceptable to the regulator. The regulator may specify a standard to satisfy part or all of a requirement.
Station Time Marking	All recorded information requires a time label. The time reference or standard used for this shall be the station clock. This will require the system to be interfaced to the station master clock or station operational procedures put in place to ensure that the system clock is within ±5 seconds of the station clock.
Stopway	A defined rectangular area at the end of the take-off run available, prepared and designated as a suitable area in which an aircraft can be stopped in the case of a discontinued take-off.
Suitably Qualified Engineer	An engineer with appropriate working experience on the equipment or system, or has attended a manufacturer's course or similar that covers the areas necessary to provide a competent response / repair to restore the service.
Surface Movement Control Service	An aerodrome control service with a two-way communications facility for the control of vehicles on the manoeuvring area.
Surveillance Radar	Radar equipment used to determine the position of an aircraft in range and azimuth. (ICAO)
System Failure	The inability of a system to fulfil its operational requirements. Failure may be systematic or due to a physical change.
System Self Test	An automatic test procedure that ensures the system is free from error.

T

Technical Response Time	The time from the issue of a triggering event by the originator / user process to the moment a logical system response is received by the originator / user process. It therefore includes the technical data extraction, the composition of the data message, the data transmission and processing, the logical checks at the destination, and the transmission and receipt of a response.
Temporary ATC unit	An ATC unit established at a special event or as a result of an actual or potential evacuation of a permanent Air Traffic Control Unit, normally comprising not more than 8 consecutive days of air operations.
Terminal Control Area	A control area normally established at the confluence of airways in the vicinity of one or more major aerodromes.
Threshold	The beginning of that portion of the runway usable for landing. (ICAO)
Touchdown	The point where the predetermined glide path intercepts the runway.

Track — The direction of the path of an aircraft over the ground usually expressed in degrees from north (true magnetic).

Transfer Delay — The time from the issue of a triggering event by the originator user process to the moment the message is received, validated and ready for further treatment at the destination user process. It therefore includes the technical data extraction, the composition of the data message, the data transmission and processing.

Transponder — A receiver/transmitter which will generate a reply signal upon proper interrogation, the interrogation and reply being on different frequencies.

V

Video Mapping — The electronic superimposing of a map or plan on a radar display.

Visibility — The ability, determined by atmospheric conditions and expressed in units of distance, to see and identify prominent unlit objects by day and prominent lighted objects by night. (ICAO)

a) Flight Visibility: The visibility forward from the flight desk of an aircraft in flight.

b) Ground Visibility: The horizontal visibility at ground level.

c) RVR: Horizontal visibility along runway.

Visual Approach — An approach by an IFR flight when part or all of an instrument approach procedure is not completed and the approach is executed with visual reference to terrain. (ICAO)

Abbreviations

A

AAIB	Air Accident Investigation Branch.
ABS	Anti-Blocking System.
ACC	Area Control Centre.
ADC	Aerodrome Control.
ADF	Automatic Direction Finder.
ADS	Automatic Dependent Surveillance.
AFIS	Aeronautical Flight Information Service.
AFTN	Aeronautical Fixed Telecommunications Network.
A/G	Air/Ground.
AGL	Aerodrome Ground Lighting.
AI	Articulation Index.
AIS	Aeronautical Information Service.
AMC	Acceptable Means of Compliance.
amsl	Above Mean Sea Level.
ANO	Air Navigation Order.
AOC	Air Operators Certificate
APC	Approach Control.
APHAZ	Aircraft Proximity Hazard.
APR	Approach Radar Control.
ASM	Airspace Management.
ASMI	Aerodrome Surface Movement Indicator.
ASR	Altimeter Setting Region.
ATA	Actual Time of Arrival.
ATC	Air Traffic Control.
ATCC	Air Traffic Control Centre.
ATCI	Air Traffic Control Investigation.
ATCO	Air Traffic Control Officer.
ATCU	Air Traffic Control Unit.
ATFM	Air Traffic Flow Management.
ATIS	Automatic Terminal Information Service.

ATM	Air Traffic Management.
ATN	Aeronautical Telecommunication Network.
ATS	Air Traffic Service.
ATSOM	Air Traffic Service Operational Memorandum.
ATSSD	Air Traffic Services Standards Department.
ATSU	Air Traffic Service Unit.

C

CAA	Civil Aviation Authority.
CAP	Civil Aviation Publication.
CAT	Category.
CCTV	Closed Circuit Television.
CIE	Commission Internationale De L'Eclairage.
CIMO	Commission Instruments & Methods of Observation.
CRT	Cathode Ray Tube.
CPDLC	Controller Pilot Data Link Communications.
CSU	Categorisation and Status Unit.
CV	Curriculum Vitae.
CVOR	Conventional VHF Omni-directional Ranger.
CW	Carrier Wave.

D

DDM	Difference in Depth of Modulation.
DDS	Data Display System.
DETR	Department of the Environment, Transport and Regions.
D/F	Direction Finding.
DFIS	Digital Flight Information Services.
DFTI	Distance from Touchdown Indicator (also known as aerodrome traffic monitor).
DLIC	Data Link Initiation Capability.
DME	Distance Measuring Equipment.
DOC	Designated Operational Coverage.
DVOR	Doppler VHF Omni-directional Ranger.

E

EDDS	Electronic Data Display System.
EMC	Electro Magnetic Compatibility.
E_t	Illuminance Threshold.
ESARR	EUROCONTROL Safety Regulatory Requirement
EUROCAE	The European Organisation for Civil Aviation Electronics.

F

FIR	Flight Information Region.
FMEA	Failure Modes and Effects Analysis.
FMECA	Failure Modes, Effects and Criticality Analysis.
FPPS	Flight Plan Processing System.
FPS	Flight Progress Strip.
ft	Foot (feet).

G

GAT	General Air Traffic.
GMC	Ground Movement Control.
GMR	Ground Movement Radar.

H

HF	High Frequency.
HMI	Human Machine Interface.
hPa	Hectopascal.

I

IATC	Inspector Air Traffic Control.
IATS	Inspectorate of Air Traffic Services.
i/c	In charge.
ICAO	International Civil Aviation Organisation.
IFR	Instrument Flight Rules.
IISLS	Improved Interrogation Side Lobe Suppression.
ILS	Instrument Landing System.
IMC	Instrument Meteorological Conditions.
INS	Inertial Navigation System.
IRVR	Instrumented Runway Visual Range.

ISLS	Interrogation Side Lobe Suppression.
ITU	International Telecommunication Union.

J

JAS	Joint Airmiss Section.
JATCRU	Joint Air Traffic Control Radar Unit.

K

kg	Kilogramme.
km	Kilometre(s).
km/h	Kilometres per hour.
kt	Knots.

L

Lat	Latitude.
LCI	Landing Clearance Indicator.
LDA	Landing Distance Available.
Long	Longitude.
LVP	Low Visibility Procedures.

M

MATS	Manual of Air Traffic Services.
mb	Millibars.
Met	Meteorology/Meteorological.
METAR	Aviation routine weather report.
MF	Medium Frequency.
MID	Middle point on a runway.
MLS	Microwave Landing System.
MNR	Minimum Noise Route.
MOD (PE)	Ministry of Defence (Procurement Executive).
MOR	Mandatory Occurrence Report.
MTBF	Mean Time Between Failure.
MTBO	Mean Time Between Outages.
MTD	Moving Target Detection.
MTI	Moving Target Indicator.
MTTR	Mean Time To Repair.

N

NATS	National Air Traffic Services Limited.
NDB	Non-Directional Beacon.
NM	Nautical Mile.
NOTAM	Notice To Airmen.

O

OPC	Operational Control.
OR	Operational Requirement.

P

PAPI	Precision Approach Path Indicator.
PE	Primary Echo.
PES	Proposed Eurocontrol Standard.
PFE	Path Following Error.
PFN	Path Following Noise.
PIATS	Principal Inspector of Air Traffic Services.
PRF	Pulse Repetition Frequency.
PSIL	Perceived Speech Interference Level.
PSR	Primary Surveillance Radar.
PTT	Press To Talk.

Q

QNH	The pressure to be set on the sub-scale of an aircraft altimeter that would read the aerodrome elevation if the aircraft were on the ground at that aerodrome. (ICAO Abbreviations and codes DOC 8400/4).

R

RAF	Royal Air Force.
RFFS	Rescue and Fire Fighting Service.
RN	Royal Navy.
RPM	Revolutions per minute.
RPS	Radar Position Symbol.
RSLS	Receiver Side Lobe Suppression.
RSS	The Square-root of the Sum of the Squares.
R/T	Radio Telephone.
RTF	Radio Telephone Facility.
RVR	Runway Visual Range.

S

SAR	Search and Rescue.
SARPs	Standards and Recommended Practices (ICAO).
SBO	Side Band Oscillator.
ScOACC	Scottish and Oceanic Area Control Centre.
SDM	Sum of the Depths of Modulation.
SI	Supplementary Instruction.
SID	Standard Instrument Departure.
SIL	Speech Interference Level.
SMGCS	Surface Movement Guidance and Control System.
SMR	Surface Movement Radar.
SPI	Special Position Identification.
SRA	Surveillance Radar Approach.
SRATCOH	Scheme for the Regulation of Air Traffic Controllers' Hours.
SRG	Safety Regulation Group.
SSR	Secondary Surveillance Radar.
STO	Station Telecommunications Officer.
STP	Stop end of a runway.
SVFR	Special Visual Flight Rules.

T

TDZ	Touch Down Zone (Runway).
THD	Total Harmonic Distortion.
TLS	Target Level of Safety.
TMA	Terminal Manoeuvring Area.
TOI	Temporary Operating Instruction.

U

UHF	Ultra High Frequency.
UTC	Universal Co-ordinated Time.

V

VASI	Visual Approach Slope Indicator.
VCCS	Voice Communications Control Systems.
VCR	Visual Control Room.

VDF	VHF Direction Finding.
VDU	Visual Display Unit.
VFR	Visual Flight Rules.
VHF	Very High Frequency.
VMC	Visual Meteorological Conditions.
VOR	VHF Omni-directional Range.
VSWR	Voltage Standing Wave Ratio.

3 Units of Measurement

The units of measurement to be used by controllers in communication with aircraft are listed in the table below:

Measurement of	Units
Distance used in navigation, position reporting, etc: generally in excess of 2 to 3 nautical miles.	Nautical miles and tenths but spoken as 'miles'
Relatively short distances such as those relating to aerodromes (e.g. runway lengths, distances of obstructions from runway or of facilities from the aerodrome where accuracy of greater than one tenth is required).	Metres
Radar position reporting and ranges from touchdown.	Nautical miles and/or fractions thereof but spoken as 'miles'.
Radar azimuth displacement from final approach track.	Metres
Altitudes, elevations and heights.	Feet
Depths of snow and slush.	Centimetres or millimetres
Horizontal speed, including wind speed.	Knots
Vertical speed.	Feet per minute
Wind direction for landing and take off.	Degrees Magnetic
Wind direction except for landing and take off.	Degrees True
Visibility.	Kilometres and Metres
Runway visual range.	Metres
Altimeter setting.	Millibars
Temperature.	Degrees Celsius
Weight.	Metric Tonnes or Kilogrammes
Time.	Hours and minutes, the day beginning at midnight UTC.

4 Bibliography

ICAO:	Meteorological Service for International Air Navigation, Annex 3
ICAO:	Aeronautical Telecommunications, Annex 10, Vol 1 & 2
ICAO:	Aerodromes, Annex 14, Vol 1 & 2
ICAO:	Rules of the Air and Air Traffic Services, Doc 4444
ICAO:	Air Traffic Services Planning Manual, Doc 9426
CAA:	Licensing of Aerodromes, CAP 168
CAA:	Air Navigation Order, Rules of the Air Regulations and Air Navigation (General) Regulations CAP 393
CAA:	Manual of Air Traffic Services Part 1, CAP 493
C.Duerden:	'Noise Abatement', Butterworth, 1972

Report of the Committee for the Regulation of Air Traffic Control Officers’ Hours

Cross - Reference Matrix

No	Part	Document	Paragraph
8	B	ATC01	1.1.3
9	B	ATC01	1.1.4
10	B	ATC01	1.1.5
11	B	ATC01	1.1.5
12	B	ATC01	2.1
13	B	ATC01	2.2(a)
14	B	ATC01	2.2(b)
15	B	ATC01	2.3
16	B	ATC01	2.4
17	B	ATC01	2.4
18	B	ATC01	2.4
19	B	ATC01	2.4
20	B	ATC01	2.5(a)
21	B	ATC01	2.5(b)
22	B	ATC01	2.5(b)
23	B	ATC01	3.1
24	B	ATC01	3.3
25	B	ATC01	3.6
26	B	ATC01	3.7
27	B	ATC01	3.9
28	B	ATC01	3.9
29	B	ATC01	3.11
30	B	ATC01	4.1
31	B	ATC01	4.1
32	B	ATC01	4.2
33	B	ATC01	4.3
34	B	ATC01	4.3
35	B	ATC01	5
36	B	ATC01	6.1
37	B	ATC01	6.2
38	B	ATC01	6.3
39	B	ATC01	6.4
40	B	ATC01	6.4
41	B	ATC01	6.5
42	B	ATC01	
43	B	ATC01	7.1
44	B	ATC01	7.1
45	B	ATC01	7.2
46	B	ATC01	7.2
47	B	ATC01	7.2
48	B	ATC01	8.1
49	B	ATC01	Annex A 1.1
50	B	ATC01	Annex A 1.3
51	B	ATC01	Annex A 1.4.1
52	B	ATC01	Annex A 1.4.1
53	B	ATC01	Annex A 1.4.1
54	B	ATC01	Annex A 1.4.2
55	B	ATC01	Annex A 1.4.2
56	B	ATC01	Annex A 1.4.2
57	B	ATC01	Annex A 1.4.2
58	B	ATC01	Annex A 1.4.3
59	B	ATC01	Annex A 1.4.3
60	B	ATC01	Annex A 1.4.3
61	B	ATC01	Annex A 1.4.4
62	B	ATC01	Annex A 1.4.4
63	B	ATC01	Annex A 1.4.5
64	B	ATC01	Annex A 1.4.5
65	B	ATC01	Annex A 1.4.6(a)
66	B	ATC01	Annex A 1.4.6(a)
67	B	ATC01	Annex A 1.4.6(b)
68	B	ATC01	Annex A 1.4.7
69	B	ATC01	Annex A 1.4.7
70	B	ATC01	Annex A 1.4.7
71	B	ATC01	Annex A 1.4.7
72	B	ATC01	Annex A 1.4.7
73	B	ATC01	Annex A 1.4.7(a)
74	B	ATC01	Annex A 1.4.7(a)
75	B	ATC01	Annex A 1.4.8
76	B	ATC01	Annex A 1.4.9
77	A	5.3	
78	B	APP03	1.1
79	B	APP03	2.1
80	B	APP03	2.1
81	B	APP03	3.1
82	B	APP03	3.1
83	B	APP03	3.1
84	B	APP03	3.2
85	B	APP03	3.2
86	B	APP03	3.3
87	B	APP03	4.1
88	B	APP04	1.2
89	B	APP04	1.4
90	B	APP04	2.1
91	B	APP04	2.2

No	Part	Document	Paragraph
92	B	APP04	5.2
93	B	APP04	5.3
94	B	APP04	5.3
95	B	APP04	5.3
96	B	APP04	5.3
97	B	APP04	5.3
98	B	APP04	7
99	B	APP04	8.1
100	B	APP04	8.1
101	B	APP04	8.2
102	B	APP04	8.3
103	B	APP04	8.3
104	B	APP04	8.4
105	B	APP04	8.4
106	B	APP04	8.5
107	B	APP04	8.6
108	B	APP04	8.7
109	B	APP04	8.8
110	B	APP04	8.9
111	B	APP04	8.11
112	B	APP04	8.11
113	B	APP04	9
114	B	APP04	10(a)
115	B	APP04	11
116	B	APP04	11
117	B	ATC02	1.1.1
118	B	ATC02	1.1.1
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120	B	ATC02	1.1.2
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149	B	ATC02	1.3.8
150	B	ATC02	1.3.8
151	B	ATC02	1.3.8
152	B	ATC02	1.3.9(a)
153	B	ATC02	1.3.9(b)
154	B	ATC02	1.3.9(c)
155	B	ATC02	1.3.9(d)
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159	B	ATC02	1.3.10
160	B	ATC02	1.4(a)
161	B	ATC02	1.4(b)
162	B	ATC02	1.4(c)
163	B	ATC02	1.4(d)
164	B	ATC02	1.4(e)
165	B	ATC02	1.4(f)
166	B	ATC02	1.4(g)
167	B	ATC02	1.4(h)
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178	B	ATC02	3
179	B	ATC02	3
180	B	ATC02	4
181	B	ATC02	5.1(a)
182	B	ATC02	5.1(b)
183	B	ATC02	5.1(c)

No	Part	Document	Paragraph
184	B	ATC02	5.1(d)
185	B	ATC02	5.1(e)
186	B	ATC02	5.1(e)
187	B	ATC02	5.2
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221	C	COM05	8.3
222	C	COM05	8.4
223	C	COM05	9
224	C	COM05	9
225	C	COM05	9
226	C	COM05	10
227	C	COM05	10
228	C	COM05	10
229	C	COM05	10

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230	C	COM05	11
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234	C	COM05	12.3
235	C	COM05	12.3
236	C	COM06	6.1.1
237	C	COM06	6.2
238	C	COM06	6.3
239	C	COM06	6.4.1
240	C	COM06	7.1.1
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249	C	COM06	7.2.6
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252	C	COM06	7.3.3
253	C	COM06	7.4.1
254	C	COM06	7.4.2
255	C	COM06	7.4.3
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261	C	COM06	7.5.5
262	C	COM07	6.1
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266	C	COM07	6.5
267	C	COM07	6.6
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271	C	COM07	11
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273	C	COM07	13.1
274	C	COM07	14.1
275	C	COM07	14.5

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287	C	COM07	17.3
288	C	COM07	17.4
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293	C	COM07	18.3
294	C	COM07	19
295	C	COM07	20.1
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303	C	RAD01	3.1(b)
304	C	RAD01	3.1(c)
305	C	RAD01	3.1(d)
306	C	RAD01	3.1(e)
307	C	RAD01	3.1(f)
308	C	RAD01	3.1(g)
309	C	RAD01	3.1(h)
310	C	RAD01	3.1(I)
311	C	RAD01	4.1
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313	C	RAD01	4.2.1.2
314	C	RAD01	4.2.2
315	C	RAD01	5.1
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317	C	RAD01	5.1(b)
318	C	RAD01	5.1(c)
319	C	RAD01	5.1(d)
320	C	RAD01	5.1(e)
321	C	RAD01	5.1(f)
322	C	RAD01	5.1(g)
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324	C	RAD01	8.2.1

No	Part	Document	Paragraph
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334	C	RAD01	8.4.4
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358	C	RAD02	8.5.4
359	C	RAD02	8.5.5
360	C	RAD02	8.6.1
361	C	RAD02	8.6.2
362	C	RAD02	8.6.3
363	C	RAD02	9.1
364	C	RAD02	9.2
365	C	RAD02	10.1.1
366	C	RAD02	10.1.2
367	C	RAD02	10.1.3
368	C	RAD02	10.1.4
369	C	RAD02	10.2.1
370	C	RAD02	10.2.2(a)

No	Part	Document	Paragraph
371	C	COM04	4.1
372	C	COM04	4.2
373	C	COM04	4.2
374	C	COM04	4.3
375	C	COM04	4.4
376	C	COM02	6.1.1
377	C	COM02	6.1.2
378	C	COM02	6.2.1
379	C	COM02	6.2.1
380	C	COM02	6.2.1
381	C	COM02	6.2.2
382	C	COM02	6.2.3
383	C	COM02	6.2.4
384	C	COM02	6.3.1
385	C	COM02	6.3.2
386	C	COM02	6.4.1
387	C	COM02	6.4.2
388	C	COM02	6.5.1
389	C	COM02	6.6.1
390	C	COM02	6.7.1
391	C	COM02	6.7.2
392	C	COM02	6.7.2
393	C	COM02	6.7.3
394	C	COM02	7.1
395	C	COM02	7.1.1.1
396	C	COM02	7.1.1.2
397	C	COM02	7.1.1.3
398	C	COM02	7.1.1.4
399	C	COM02	7.1.2.1
400	C	COM02	7.1.2.2
401	C	COM02	7.1.3
402	C	COM02	7.1.4.1
403	C	COM02	7.1.4.2
404	C	COM02	7.1.4.2
405	C	COM02	7.1.4.3
406	C	COM02	7.1.4.3
407	C	COM02	7.1.4.3
408	C	COM02	7.1.4.3
409	C	COM02	7.1.4.3
410	C	COM02	7.1.4.3
411	C	COM02	7.1.5
412	C	COM02	7.1.5
413	C	COM02	7.1.5
414	C	COM02	7.1.5
415	C	COM02	7.1.5
416	C	COM02	7.1.5

No	Part	Document	Paragraph
417	C	COM02	7.1.5
418	C	COM02	7.1.5
419	C	COM02	7.1.5
420	C	COM02	7.2.1
421	C	COM02	7.3.1
422	C	COM02	7.4.1
423	C	COM02	7.5.1
424	C	COM02	7.5.2
425	C	COM02	7.5.2
426	C	COM02	7.5.2
427	C	RAD02	10.2.2(b)
428	C	RAD02	10.2.2(c)
429	C	RAD02	10.2.2(d)
430	C	RAD02	10.2.2(e)
431	C	RAD02	10.2.2(f)
432	C	RAD02	10.2.2(g)
433	C	RAD02	10.2.2(g)
434	C	RAD02	10.2.2(h)
435	C	RAD02	10.2.3(a)
436	C	RAD02	10.2.3(b)
437	C	RAD02	10.2.3(c)
438	C	RAD02	10.2.4
439	C	RAD02	10.3.1
440	C	RAD02	10.3.2
441	C	RAD02	10.3.3
442	C	RAD02	10.3.4
443	C	RAD02	10.3.5
444	C	RAD02	10.3.6
445	C	RAD02	10.3.7
446	C	RAD02	10.4.1
447	C	RAD02	10.4.2
448	C	RAD02	10.4.3
449	C	RAD02	10.4.9
450	C	RAD02	10.4.5
451	C	RAD02	10.5.1
452	C	RAD02	10.5.2(a)
453	C	RAD02	10.5.2(b)
454	C	RAD02	10.5.2(c)
455	C	RAD02	10.5.2(d)
456	C	RAD02	11
457	C	RAD02	12.1.1
458	C	RAD02	12.1.2
459	C	RAD02	12.1.3
460	C	RAD02	12.1.3
461	C	RAD02	12.1.4
462	C	RAD02	12.1.5

No	Part	Document	Paragraph
463	C	RAD02	12.2.1
464	C	RAD02	12.2.2
465	C	RAD02	12.2.3
466	C	RAD02	12.2.3
467	C	RAD02	12.2.4
468	C	RAD02	12.2.4
469	C	RAD02	12.2.5
470	C	RAD02	12.2.6
471	C	RAD02	12.2.7
472	C	RAD02	12.2.8
473	C	RAD02	12.2.9
474	C	RAD02	13.1.1(a)
475	C	RAD02	13.1.1(a)
476	C	RAD02	13.1.1(a)
477	C	RAD02	13.1.1(b)
478	C	RAD02	13.1.1(c)
479	C	RAD02	13.1.1(d)
480	C	RAD02	13.1.2
481	C	RAD02	13.1.3
482	C	RAD02	13.2.1
483	C	RAD02	13.2.2
484	C	RAD02	13.3.1
485	C	RAD02	13.3.2
486	C	RAD02	13.4.1
487	C	RAD02	13.4.2
488	C	RAD02	14
489	C	RAD02	15
490	C	RAD02	16.1
491	C	RAD02	16.2
492	C	RAD02	16.2
493	C	RAD02	16.3
494	C	RAD02	16.3
495	C	RAD02	16.3
496	C	RAD02	16.4
497	C	RAD02	16.5
498	C	RAD02	16.6
499	C	RAD02	17.1
500	C	RAD02	17.1
501	C	RAD02	17.2
502	C	RAD02	17.2
503	C	RAD02	17.3(a)
504	C	RAD02	17.3(b)
505	C	RAD02	17.4
506	C	RAD02	17.5
507	C	RAD02	18.1.1
508	C	RAD02	18.1.2
509	C	RAD02	18.1.2
510	C	RAD02	18.1.2
511	C	RAD02	18.1.3
512	C	RAD02	19.1
513	C	RAD02	19.2
514	C	RAD02	19.3
515	C	RAD02	19.3(a)
516	C	RAD02	19.3(b)
517	C	RAD02	19.3(c)
518	C	RAD02	19.4
519	C	RAD02	19.5
520	C	RAD02	20.1
521	C	RAD03	1
522	C	RAD03	4.1
523	C	RAD03	4.2
524	C	RAD03	5.1.1
525	C	RAD03	5.1.2
526	C	RAD03	5.1.3
527	C	RAD03	5.2
528	C	RAD03	5.3
529	C	RAD03	5.3
530	C	RAD03	5.4
531	C	RAD04	1
532	C	RAD04	4(a)
533	C	RAD04	4(b)
534	C	RAD04	4(c)
535	C	RAD04	5.1
536	C	RAD04	5.2
537	C	RAD04	5.3
538	C	RAD04	5.3.1
539	C	RAD04	5.3.1.1
540	C	RAD04	5.3.1.1(a)
541	C	RAD04	5.3.1.1(b)
542	C	RAD04	5.3.1.1(c)
543	C	RAD04	5.3.2
544	C	RAD04	5.3.2.1
545	C	RAD04	5.3.2.1
546	C	RAD04	5.3.3.1
547	C	RAD04	5.3.2.2
548	C	RAD04	6.1
549	C	RAD04	6.2
550	C	RAD04	6.2(a)
551	C	RAD04	6.2(b)
552	C	RAD04	6.2(c)
553	C	RAD05	4.1(a)
554	C	RAD05	4.1(b)

No	Part	Document	Paragraph
555	C	RAD05	4.1(b)
556	C	RAD05	4.1(c)
557	C	RAD05	4.1(d)
558	C	RAD05	4.1(d)
559	C	RAD05	4.1(e)
560	C	RAD05	4.1(f)
561	C	RAD05	4.1(g)
562	C	RAD05	4.1(h)
563	C	RAD05	4.1(I)
564	C	RAD05	4.1(I)
565	C	RAD05	4.1(j)
566	C	RAD05	4.1(k)
567	C	RAD05	5.1
568	C	RAD05	5.2
569	C	RAD05	5.3.1
570	C	RAD05	5.3.2
571	C	RAD05	5.3.3
572	C	RAD05	5.4
573	C	RAD05	5.5
574	C	RAD05	5.6
575	C	RAD05	6.1
576	C	RAD05	6.2
577	C	RAD05	6.3.1(a)
578	C	RAD05	6.3.1(b)
579	C	RAD05	6.3.1(c)
580	C	RAD05	6.3.1(d)
581	C	RAD05	6.3.1(e)
582	C	RAD05	6.3.1(e)
583	C	RAD05	6.3.1(f)
584	C	RAD05	6.3.1(g)
585	C	RAD05	6.3.1(h)
586	C	RAD05	6.3.1(I)
587	C	RAD05	6.3.1(j)
588	C	RAD05	6.3.1(k)
589	C	RAD05	6.3.1(l)
590	C	RAD05	6.3.1(m)
591	C	RAD05	7.1
592	C	RAD05	7.1.1
593	C	RAD05	7.1.2
594	C	RAD05	7.2
595	C	RAD05	7.3.1
596	C	RAD05	7.3.2
597	C	RAD05	7.3.3
598	C	RAD05	7.4.1
599	C	RAD05	7.4.2
600	C	RAD05	7.5.1
601	C	RAD05	7.5.2
602	C	RAD05	7.6(a)
603	C	RAD05	7.6(b)
604	C	RAD05	7.6(c)
605	C	RAD05	7.6(d)
606	C	RAD05	7.6(e)
607	C	RAD05	7.6(f)
608	C	RAD05	7.6(g)
609	C	RAD05	7.6(h)
610	C	RAD05	7.6(I)
611	C	RAD05	7.7
612	C	RAD06	1
613	C	RAD06	4.1
614	C	RAD06	4.2
615	C	RAD06	4.3
616	C	RAD06	5.1.1
617	C	RAD06	5.2.1
618	C	RAD06	5.2.2
619	C	RAD06	5.2.3
620	C	RAD06	5.3.1
621	C	RAD06	5.4.1
622	C	RAD06	5.4.2
623	C	RAD06	5.5
624	C	RAD06	6.1
625	C	RAD06	6.2.1
626	C	RAD06	6.2.2
627	C	RAD06	6.2.3
628	C	RAD06	6.3.1
629	C	RAD06	6.3.2
630	C	RAD06	6.4.1
631	C	RAD06	6.4.2
632	C	RAD06	6.5
633	C	RAD06	6.5
634	C	RAD07	1.1
635	C	RAD07	1.2
636	C	RAD07	4.1
637	C	RAD07	4.2.1
638	C	RAD07	4.3
639	C	RAD07	4.3.1
640	C	RAD07	4.3.2
641	C	RAD07	4.3.3
642	C	RAD07	4.3.4
643	C	RAD07	5.1.1
644	C	RAD07	5.2.1
645	C	RAD07	5.2.2(a)
646	C	RAD07	5.2.2(b)

No	Part	Document	Paragraph
647	C	RAD07	5.2.2(c)
648	C	RAD07	5.3.1
649	C	RAD07	5.3.2
650	C	RAD07	5.4
651	C	RAD07	6.1
652	C	RAD07	6.2
653	C	RAD07	6.3(a)
654	C	RAD07	6.3(b)
655	C	RAD07	6.3(c)
656	C	RAD07	6.3(d)
657	C	RAD07	6.3(e)
658	C	RAD07	6.3(f)
659	C	RAD07	6.3(g)
660	C	RAD07	6.3(h)
661	C	RAD07	6.4
662	C	RAD07	6.5
663	C	RAD07	6.6
664	C	RAD07	6.7
665	C	RAD07	6.8.1
666	C	RAD07	6.8.2
667	C	RAD07	6.8.3
668	C	RAD07	6.8.4
669	C	RAD07	6.8.5
670	C	RAD07	6.8.6
671	C	RAD08	4.1
672	C	RAD08	4.2
673	C	RAD08	4.2
674	C	RAD08	4.2
675	C	RAD08	4.2.1
676	C	RAD08	4.3
677	C	RAD08	4.3.1(a)
678	C	RAD08	4.3.1(b)
679	C	RAD08	4.3.1(c)
680	C	RAD08	4.3.1(d)
681	C	RAD08	4.3.1(e)
682	C	RAD08	4.3.1(f)
683	C	RAD08	4.3.1(g)
684	C	RAD08	4..2
685	C	RAD08	4.3.3
686	C	RAD08	4.3.3
687	C	RAD08	4.3.4
688	C	RAD08	4.3.5
689	C	RAD08	4.4.1
690	C	RAD08	4.4.2
691	C	RAD08	4.4.3
692	C	RAD08	4.4.4

No	Part	Document	Paragraph
693	C	RAD08	4.5.1
694	C	RAD08	4.5.2
695	C	RAD08	4.6
696	C	RAD08	5
697	C	RAD08	6.1
698	C	RAD08	6.1.1
699	C	RAD08	6.2
700	C	RAD08	7.1.1
701	C	RAD08	7.1.1
702	C	RAD08	7.1.2
703	C	RAD08	7.1.3
704	C	RAD08	7.1.4
705	C	RAD08	7.2.1
706	C	RAD08	7.2.1
707	C	RAD08	7.2.2
708	C	RAD08	7.3
709	C	RAD08	8
710	C	RAD09	4.1
711	C	RAD09	4.2
712	C	RAD09	4.2.1
713	C	RAD09	4.2.2
714	C	RAD09	4.3.1
715	C	RAD09	4.3.2(a)
716	C	RAD09	4.3.2(b)
717	C	RAD09	4.3.2(c)
718	C	RAD09	4.3.2(d)
719	C	RAD09	4.3.2(e)
720	C	RAD09	4.3.3
721	C	RAD09	4.4.1
722	C	RAD09	4.4.2
723	C	RAD09	4.4.3
724	C	RAD09	4.4.4
725	C	RAD09	4.5.1
726	C	RAD09	4.5.2
727	C	RAD09	4.5.3(a)
728	C	RAD09	4.5.3(b)
729	C	RAD09	4.5.3(c)
730	C	RAD09	4.5.3(d)
731	C	RAD09	5.1
732	C	RAD09	5.2
733	C	RAD09	5.3(a)
734	C	RAD09	5.3(b)
735	C	RAD09	5.3(c)
736	C	RAD09	5.3(d)
737	C	RAD09	5.3(e)
738	C	RAD09	5.3(f)

No	Part	Document	Paragraph
739	C	RAD09	5.3(g)
740	C	RAD09	5.3(h)
741	C	RAD09	5.4
742	C	RAD09	5.5
743	C	RAD09	5.6
744	C	RAD09	5.7
745	C	RAD10	4.2
746	C	RAD10	5.1.1
747	C	RAD10	5.1.2
748	C	RAD10	5.1.3
749	C	RAD10	5.1.4
750	C	RAD10	5.1.5
751	C	RAD10	5.1.6
752	C	RAD10	5.1.6
753	C	RAD10	5.2.1
754	C	RAD10	5.2.2
755	C	RAD10	5.3.1
756	C	RAD10	5.3.2
757	C	RAD10	5.4.1
758	C	RAD10	5.4.2
759	C	RAD10	5.5
760	C	RAD10	5.6
761	C	RAD10	5.7(a)
762	C	RAD10	5.7(b)
763	C	RAD10	5.7(c)
764	C	RAD10	5.7(d)
765	C	RAD10	5.7(e)
766	C	RAD10	5.7(f)
767	C	RAD10	5.7(g)
768	C	RAD10	5.7(h)
769	C	RAD10	5.7(I)
770	C	RAD10	5.8.1
771	C	RAD10	5.8.2
772	C	RAD10	5.9
773	C	RAD10	5.10.1
774	C	RAD10	5.10.2
775	C	RAD11	4.1
776	C	RAD11	4.1(a)
777	C	RAD11	4.1(b)
778	C	RAD11	4.1(c)
779	C	RAD11	4.1(d)
780	C	RAD11	4.1(e)
781	C	RAD11	4.1(f)
782	C	RAD11	4.1.1
783	C	RAD11	5.1.1
784	C	RAD11	5.1.2

No	Part	Document	Paragraph
785	C	RAD11	5.1.3
786	C	RAD11	5.2.1
787	C	RAD11	5.2.2
788	C	RAD11	5.3
789	C	RAD11	5.4.1
790	C	RAD11	5.4.2
791	C	RAD11	5.4.3
792	C	RAD11	5.5.1
793	C	RAD11	5.5.2
794	C	RAD11	5.6
795	C	RAD11	5.6
796	C	RAD11	6.1
797	C	RAD11	6.2.1
798	C	RAD11	6.2.2
799	C	RAD11	6.2.2
800	C	RAD11	6.3
801	C	RAD11	7.1
802	C	RAD11	7.2
803	C	FLI03	1
804	C	FLI03	4.1
805	C	FLI03	4.1
806	C	FLI03	4.1.1
807	C	FLI03	4.2
808	C	FLI03	4.2.1
809	C	FLI03	4.3
810	C	FLI03	5.1.1
811	C	FLI03	5.1.2
812	C	FLI03	5.1.3
813	C	FLI03	5.1.4
814	C	FLI03	6.1.1
815	C	FLI03	6.1.2
816	C	FLI03	6.1.3(a)
817	C	FLI03	6.1.3(b)
818	C	FLI03	6.1.3(c)
819	C	FLI03	6.1.4
820	C	FLI03	6.2.2(a)
821	C	FLI03	6.2.2(b)
822	C	FLI03	6.2.2.1
823	C	FLI03	6.2.2.2
824	C	FLI03	6.2.2.3
825	C	FLI03	6.3.1
826	C	FLI03	6.3.1
827	C	FLI03	6.3.2(a)
828	C	FLI03	6.3.2(b)
829	C	FLI03	6.3.2(c)
830	C	FLI03	6.3.2(d)

No	Part	Document	Paragraph
831	C	FLI03	7.1
832	C	FLI03	7.2
833	B	GEN03	4.1
834	B	GEN03	4.2
835	B	GEN03	4.3
836	B	GEN03	4.3
837	B	GEN03	4.3
838	B	GEN03	4.4
839	B	GEN03	4.5
840	B	GEN03	4.6
841	B	GEN03	4.6
842	B	GEN03	4.7
843	B	GEN03	4.7
844	B	GEN03	4.8
845	B	APP04	10(b)
846	B	APP04	10(c)
847	B	APP04	10(d)
848	B	APP04	10(e)
849	B	APP04	10(f)
850	A	6.2	
851	A	6.6	
852	B	APP01	4
853	B	APP01	5.1.1(a)
854	B	APP01	5.1.1(b)
855	B	APP01	5.1.1(c)
856	B	APP01	5.2.1
857	B	APP01	5.2.1
858	B	APP01	5.2.3
859	B	APP01	5.2.4
860	B	APP01	5.2.4
861	B	APP01	5.2.4
862	B	APP01	5.2.5
863	B	APP01	5.2.5
864	B	APP01	5.2.5
865	B	APP01	5.2.5
866	B	APP01	5.2.6
867	B	APP01	5.3.1
868	B	APP01	5.3.2
869	B	APP01	5.3.2
870	B	APP01	5.4
871	B	APP01	5.5.1
872	B	APP01	5.5.3
873	B	APP01	5.5.4
874	B	APP01	5.5.5
875	B	APP01	5.5.6
876	B	APP01	5.5.7

No	Part	Document	Paragraph
877	B	APP01	5.6(a)
878	B	APP01	5.6(b)
879	B	APP01	5.6(c)
880	B	APP01	5.6(d)
881	B	APP01	5.7.1
882	B	APP01	5.7.3
883	B	APP01	5.8(a)
884	B	APP01	5.8(b)
885	B	APP01	5.8(b)
886	B	APP01	5.8(c)
887	B	APP01	5.9
888	B	APP01	5.9
889	B	APP01	5.9
890	B	APP01	5.10.1
891	B	APP01	5.11.1
892	B	APP01	5.11.1
893	B	APP01	5.11.1.1
894	B	APP01	5.11.1.2
895	B	APP01	5.11.1.3
896	B	APP01	5.11.1.4
897	B	APP01	5.11.1.4(a)
898	B	APP01	5.11.1.4(b)
899	B	APP01	5.11.1.4(c)
900	B	APP01	5.11.1.4(d)
901	B	APP01	5.11.1.4(e)
902	B	APP01	5.11.1.5
903	B	APP01	5.12.1
904	B	APP01	5.12.1
905	B	APP01	5.12.1
906	B	APP01	5.12.3
907	B	APP01	5.12.4
908	B	APP01	5.12.5
909	B	APP01	5.12.6
910	B	APP01	5.12.6
911	B	APP01	5.12.6
912	B	APP01	5.13.1
913	B	APP01	5.13.3
914	B	APP01	5.14.1
915	B	APP01	5.14.2
916	B	APP01	5.14.3
917	B	APP01	5.15.1
918	B	APP01	5.15.1
919	B	APP01	5.15.1
920	B	APP01	5.15.1
921	B	APP01	5.15.1
922	B	APP01	5.15.1

No	Part	Document	Paragraph
923	B	APP01	5.15.1
924	B	APP01	5.15.3.1
925	B	APP01	5.15.3.2
926	B	APP01	5.16.1(a)
927	B	APP01	5.16.1(b)
928	B	APP01	5.16.3
929	B	APP01	5.16.4
930	B	APP01	5.16.4
931	B	APP01	5.18.1
932	B	APP01	5.18.2
933	B	APP01	5.18.3
934	B	APP01	5.18.3
935	B	APP01	5.21.1
936	B	APP01	5.21.1
937	B	APP01	5.21.2
938	B	APP01	5.21.3
939	B	APP01	5.21.3
940	B	APP01	5.22.1
941	B	APP01	5.22.1
942	B	APP01	5.22.2
943	B	APP01	5.23.1
944	B	APP01	5.23.2
945	B	APP01	5.23.3
946	B	APP01	Appendix A 1.5.2
947	B	APP01	Appendix A 1.5.2.1(a)
948	B	APP01	Appendix A 1.5.2.1(c)
949	B	APP01	Appendix A 1.5.2.1(c)
950	B	APP01	Appendix A 1.5.2.1(c)
951	B	APP01	Appendix A 1.5.2.1(c)
952	B	APP01	Appendix A 1.5.2.1(c)
953	B	APP01	Appendix A 1.5.2.1(c)
954	B	APP01	Appendix A 1.5.2.1(c)
955	B	APP01	Appendix A 1.5.2.1(c)
956	B	APP01	Appendix A 1.5.2.1(c)
957	B	APP01	Appendix A 1.5.2.2(a)
958	B	APP01	Appendix A 1.5.2.2(b)
959	B	APP01	Appendix A 1.6.1
960	C	COM01	3
961	C	COM01	4.1.1
962	C	COM01	4.2.1
963	C	COM01	4.3.1
964	C	COM01	4.3.2
965	C	COM01	4.3.3
966	C	COM01	4.3.4
967	C	COM01	5.1.1
968	C	COM01	5.1.2
969	C	COM01	5.1.3
970	C	COM01	5.1.4
971	C	COM01	5.1.5
972	C	COM01	5.2.1.1
973	C	COM01	5.2.1.2
974	C	COM01	5.2.2.1.
975	C	COM01	5.2.2.2.
976	C	COM01	5.2.2.3.
977	C	COM01	5.2.2.4
978	C	COM01	5.2.3.1
979	C	COM01	5.2.4.1
980	C	COM01	6.1.1
981	C	COM01	6.1.2
982	C	COM01	6.2.1
983	C	COM01	6.2.2
984	C	COM01	6.2.3
985	C	COM01	6.3.1
986	C	COM01	6.3.2
987	C	COM01	6.4.1
988	C	COM01	6.5.1
989	C	COM01	7.1.1
990	C	COM01	7.2.1
991	C	COM01	7.3.1
992	C	COM01	7.3.2
993	C	COM01	7.4.1.1
994	C	COM01	7.4.1.2
995	C	COM01	7.4.2.1
996	C	COM01	7.4.2.2
997	C	COM01	7.4.3.1
998	C	COM01	7.5.1
999	C	COM01	7.6.1
1000	C	COM01	7.7.1
1001	C	COM01	7.8.1
1002	C	COM02	5
1003	C	COM04	3
1004	C	COM06	5
1005	C	COM07	5

No	Part	Document	Paragraph
1006	C	COM02	6.7.3
1007	C	COM02	2.1.1
1008	C	COM02	2.1.2
1009	C	COM02	2.1.3
1010	C	COM02	2.2.1
1011	C	COM02	2.2.2
1012	C	COM02	2.3
1013	C	COM02	2.3
1014	C	COM02	2.3
1015	C	COM02	2.3
1016	C	COM02	2.4
1017	C	COM02	3.1.1
1018	C	COM02	3.2.1
1019	C	COM02	3.2.3
1020	C	COM02	3.2.4
1021	C	COM02	3.2.5
1022	C	COM02	3.3.1
1023	C	COM02	3.3.2
1024	C	COM02	3.4
1025	C	COM02	3.5
1026	C	COM02	3.6.1
1027	C	COM02	3.6.1
1028	C	COM02	3.6.2
1029	C	COM02	3.6.2
1030	C	COM02	3.6.2
1031	C	COM02	3.6.3
1032	C	COM02	3.6.3
1033	C	COM02	3.6.4
1034	C	COM02	3.6.4
1035	C	COM02	3.6.4
1036	C	COM02	3.6.4
1037	C	COM02	3.7.1
1038	C	COM02	3.7.2
1039	C	COM02	3.7.3
1040	C	COM02	3.7.3
1041	C	COM02	3.7.4
1042	C	COM02	3.7.4
1043	C	COM02	3.7.5
1044	C	COM01	2.1.1
1045	C	COM01	2.2.1
1046	C	COM01	2.2.2
1047	C	COM01	2.3.1
1048	C	COM01	2.3.2
1049	C	COM01	2.4.1
1050	C	COM01	2.4.2
1051	C	COM01	2.4.3

No	Part	Document	Paragraph
1052	C	COM01	2.4.3
1053	C	COM01	2.4.4
1054	C	COM01	2.4.5
1055	C	COM01	2.5.1
1056	C	COM01	2.5.2
1057	C	COM01	2.6.1.2
1058	C	COM01	2.6.1.3
1059	C	COM01	2.6.1.4
1060	C	COM01	2.6.2.2
1061	C	COM01	2.7.1
1062	C	COM01	2.8.1.1
1063	C	COM01	2.8.1.2
1064	C	COM01	2.8.2.1
1065	C	COM01	2.8.2.2
1066	C	COM01	2.8.3.1
1067	C	COM01	2.9.1
1068	C	COM01	2.9.2
1069	C	COM01	2.10.1
1070	C	COM01	3.1.1
1071	C	COM01	3.2.1
1072	C	COM01	3.2.2
1073	C	COM01	3.2.3
1074	C	COM01	3.2.4
1075	C	COM01	3.2.5
1076	C	COM01	4.1.1.1
1077	C	COM01	4.1.1.2
1078	C	COM01	4.1.1.3
1079	C	COM01	4.1.2.1
1080	C	COM01	4.2.1
1081	C	COM01	4.2.1
1082	C	COM01	4.2.2
1083	C	COM01	4.2.3
1084	C	COM01	4.3.1.
1085	C	COM01	4.3.2.1.
1086	C	COM01	4.4.1.
1087	C	COM03	4
1088	C	COM03	5.1.1
1089	C	COM03	5.2.1
1090	C	COM03	6.1.1
1091	C	COM03	6.1.2
1092	C	COM03	6.1.3
1093	C	COM03	6.1.4
1094	C	COM03	6.1.5
1095	C	COM03	6.1.6
1096	C	COM03	6.1.7
1097	C	COM03	6.1.8

No	Part	Document	Paragraph
1098	C	COM03	6.1.9
1099	C	COM03	6.1.10
1100	C	COM03	6.1.11
1101	C	COM03	6.1.12
1102	C	COM03	6.1.12
1103	C	COM03	6.1.13
1104	C	COM03	6.1.13
1105	C	COM03	6.1.14
1106	C	COM03	6.1.15
1107	C	COM03	6.1.16
1108	C	COM03	6.1.17
1109	C	COM03	6.2
1110	C	COM03	6.2.1
1111	C	COM03	6.2.2
1112	C	COM03	6.2.2
1113	C	COM03	6.2.2
1114	C	COM03	6.2.3
1115	C	COM03	6.2.4
1116	C	COM03	6.2.5
1117	C	COM03	6.2.6
1118	C	COM03	6.2.6
1119	C	COM03	6.2.6
1120	C	COM03	6.2.7
1121	C	COM03	6.2.8
1122	C	COM03	6.2.9
1123	C	COM03	6.2.10
1124	C	COM03	6.2.11
1125	C	COM03	6.2.12
1126	C	COM03	6.2.12
1127	C	COM03	6.2.13
1128	C	COM03	6.2.14
1129	C	COM03	6.2.14
1130	C	COM03	6.2.14
1131	C	COM03	6.2.14
1132	C	COM03	6.2.15
1133	C	COM03	6.2.15
1134	C	COM03	6.2.16
1135	C	COM03	6.2.17
1136	C	COM03	6.2.18
1137	C	COM03	6.3.1
1138	C	COM03	6.3.1
1139	C	COM03	6.3.2
1140	C	COM03	6.3.3
1141	C	COM03	6.3.4
1142	C	COM03	6.3.5
1143	C	COM03	6.3.6

No	Part	Document	Paragraph
1144	C	COM03	6.3.7
1145	C	COM03	6.3.8
1146	C	COM03	6.3.9
1147	C	COM03	6.4
1148	C	COM03	7.1
1149	C	COM03	7.2.1
1150	C	COM03	7.2.1
1151	C	COM03	7.2.1
1152	C	COM03	7.3.1
1153	C	COM03	7.3.2
1154	C	COM03	7.3.2
1155	C	COM03	7.3.2
1156	C	COM03	7.3.2
1157	C	COM04	1
1158	C	COM04	1
1159	C	COM04	1
1160	C	COM04	1
1161	C	COM04	2
1162	C	COM04	2
1163	C	COM04	2
1164	C	ILS01	3
1165	C	ILS01	4.1
1166	C	ILS01	4.2
1167	C	ILS01	4.3
1168	C	ILS01	4.4
1169	C	ILS01	4.4
1170	C	ILS01	5.1
1171	C	ILS01	5.2
1172	C	ILS01	5.2
1173	C	ILS01	5.2
1174	C	ILS01	5.4.1
1175	C	ILS01	5.4.1
1176	C	ILS01	5.4.1
1177	C	ILS01	5.4.2
1178	C	ILS01	5.4.3
1179	C	ILS01	5.5
1180	C	ILS01	5.5
1181	C	ILS01	5.5.1
1182	C	ILS01	5.5.2
1183	C	ILS01	5.5.3
1184	C	ILS01	6.1
1185	C	ILS01	6.2
1186	C	ILS01	6.3
1187	C	ILS01	7.1
1188	C	ILS01	7.2
1189	C	ILS01	7.3

No	Part	Document	Paragraph
1190	C	ILS01	Appendix
1191	C	ILS01	Appendix
1192	C	ILS02	3
1193	C	ILS02	4.1
1194	C	ILS02	5.1.1
1195	C	ILS02	5.1.1
1196	C	ILS02	5.1.1
1197	C	ILS02	5.1.2
1198	C	ILS02	5.2.1
1199	C	ILS02	5.2.2
1200	C	ILS02	5.3
1201	C	ILS02	5.3
1202	C	ILS02	5.4
1203	C	ILS02	5.5
1204	C	ILS02	5.5.1
1205	C	ILS02	5.5.2
1206	C	ILS02	5.5.3
1207	C	ILS02	5.6
1208	C	ILS02	5.6
1209	C	ILS02	5.6
1210	C	ILS02	5.6
1211	C	ILS02	5.7.1
1212	C	ILS02	5.7.2.1
1213	C	ILS02	5.7.2.2
1214	C	ILS02	5.7.2.3
1215	C	ILS02	5.8
1216	C	ILS02	5.8
1217	C	ILS02	5.8
1218	C	ILS02	5.9
1219	C	ILS02	5.9.1
1220	C	ILS02	5.9.2
1221	C	ILS02	5.10
1222	C	ILS02	5.11
1223	C	ILS02	6.1.1
1224	C	ILS02	6.1.2
1225	C	ILS02	6.2.1
1226	C	ILS02	6.2.2
1227	C	ILS02	6.3.1
1228	C	ILS02	6.4
1229	C	ILS02	6.4
1230	C	ILS02	6.4
1231	C	ILS02	6.5.1
1232	C	ILS02	6.5.2
1233	C	ILS02	6.5.3
1234	C	ILS02	6.6
1235	C	ILS02	6.7

No	Part	Document	Paragraph
1236	C	ILS02	6.7
1237	C	ILS02	6.8
1238	C	ILS02	6.9
1239	C	ILS02	6.9.1
1240	C	ILS02	6.9.2
1241	C	ILS02	6.9.3
1242	C	ILS02	6.10
1243	C	ILS02	6.10.1
1244	C	ILS02	6.10.2
1245	C	ILS02	6.11
1246	C	ILS02	7.11
1247	C	ILS02	8.2.1
1248	C	ILS02	8.2.2
1249	C	ILS03	1
1250	C	ILS03	3
1251	C	ILS03	4
1252	C	ILS03	4
1253	C	ILS03	4
1254	C	ILS03	4.1
1255	C	ILS03	4.2
1256	C	ILS03	4.2
1257	C	ILS03	4.3
1258	C	ILS03	4.3
1259	C	ILS03	4.4
1260	C	ILS03	4.4
1261	C	ILS03	4.4
1262	C	ILS03	4.4
1263	C	ILS03	4.4
1264	C	ILS03	4.5.1
1265	C	ILS03	4.5.2
1266	C	ILS03	4.5.2
1267	C	ILS03	4.5.3
1268	C	ILS03	4.5.3
1269	C	ILS03	5
1270	C	ILS03	5
1271	C	ILS03	5.2
1272	C	ILS03	5.3
1273	C	ILS03	5.3
1274	C	ILS03	5.3
1275	C	ILS03	5.3
1276	C	ILS03	5.3.1.1
1277	C	ILS03	5.3.1.1
1278	C	ILS03	5.3.1.2
1279	C	ILS03	5.3.1.2
1280	C	ILS03	5.3.1.3
1281	C	ILS03	5.3.1.4

No	Part	Document	Paragraph
1282	C	ILS03	5.3.1.5
1283	C	ILS03	5.3.1.6
1284	C	ILS03	5.3.1.6(a)
1285	C	ILS03	5.3.1.6(b)
1286	C	ILS03	5.3.1.7
1287	C	ILS03	5.3.2
1288	C	ILS03	5.4
1289	C	ILS03	5.4
1290	C	ILS03	5.4.1.1
1291	C	ILS03	5.4.1.2
1292	C	ILS03	5.4.1.3
1293	C	ILS03	5.4.1.4
1294	C	ILS03	5.4.2.1
1295	C	ILS03	5.4.2.2
1296	C	ILS03	5.4.2.3
1297	C	ILS03	5.4.2.3
1298	C	ILS03	5.5
1299	C	ILS04	3.1.1
1300	C	ILS04	3.1.1
1301	C	ILS04	3.1.2
1302	C	ILS04	3.1.3
1303	C	ILS04	4.1
1304	C	ILS04	4.1
1305	C	ILS04	4.2
1306	C	ILS04	4.3(a)
1307	C	ILS04	4.3(b)
1308	C	ILS04	5.1
1309	C	ILS04	5.2
1310	C	ILS04	5.3
1311	C	ILS04	5.4
1312	C	ILS04	6.1
1313	C	ILS04	6.2
1314	C	ILS05	3
1315	C	ILS05	4(a)
1316	C	ILS05	4(b)
1317	C	ILS05	4(c)
1318	C	ILS05	5.1
1319	C	ILS05	5.2
1320	C	ILS05	5.3
1321	C	ILS05	5.4
1322	C	ILS05	5.5
1323	C	ILS05	5.6
1324	C	ILS05	5.6
1325	C	ILS05	5.7
1326	C	ILS05	5.7
1327	C	ILS06	3

No	Part	Document	Paragraph
1328	C	ILS06	4.1
1329	C	ILS06	4.2
1330	C	ILS06	4.3
1331	C	ILS06	6.1
1332	C	ILS06	6.2
1333	C	ILS06	6.3
1334	C	ILS06	6.4
1335	C	ILS06	6.5
1336	C	ILS06	6.5
1337	C	ILS06	7.1
1338	C	ILS06	8
1339	C	ILS06	9
1340	C	ILS06	10.1
1341	C	ILS06	10.2
1342	C	ILS07	1
1343	C	ILS07	3
1344	C	ILS07	4
1345	C	ILS07	5.1
1346	C	ILS07	5.2
1347	C	ILS08	5
1348	C	ILS08	6.1
1349	C	ILS08	6.2
1350	C	ILS08	6.3
1351	C	ILS08	6.4
1352	C	ILS08	6.5
1353	C	ILS08	6.5
1354	C	ILS08	6.6
1355	C	ILS08	6.7
1356	C	ILS08	6.9
1357	C	ILS08	6.10
1358	C	ILS08	6.11.1
1359	C	ILS08	6.11.2
1360	C	ILS08	6.12
1361	C	ILS08	6.12
1362	C	ILS08	6.13
1363	C	ILS08	6.13.1
1364	C	ILS08	6.14
1365	C	ILS08	6.15
1366	C	ILS08	6.16(a)
1367	C	ILS08	6.16(b)
1368	C	ILS08	6.17.1
1369	C	ILS08	6.17.2
1370	C	ILS08	6.18
1371	C	ILS08	6.19
1372	C	ILS08	6.20.1
1373	C	ILS08	6.20.2

No	Part	Document	Paragraph
1374	C	ILS08	6.20.3
1375	C	ILS08	7.1
1376	C	ILS08	7.1
1377	C	ILS08	7.2
1378	C	ILS08	7.2
1379	C	ILS08	7.3
1380	C	ILS08	7.3
1381	C	ILS08	8.1
1382	C	ILS08	8.1
1383	C	ILS08	9.1(a)
1384	C	ILS08	9.1(b)
1385	C	ILS08	9.1(c)
1386	C	ILS08	9.2
1387	C	ILS08	10.1.1
1388	C	ILS08	10.1.1
1389	C	ILS08	10.1.2
1390	C	ILS08	10.2
1391	C	ILS08	10.2
1392	C	ILS08	11.1
1393	C	ILS08	12.1
1394	C	ILS08	12.2
1395	C	ILS08	13.1(a)
1396	C	ILS08	13.1(b)
1397	C	ILS08	13.2
1398	C	ILS08	13.2
1399	C	ILS08	13.3
1400	C	ILS08	13.4
1401	C	ILS08	13.5
1402	C	ILS10	3
1403	C	ILS10	4.1
1404	C	ILS10	4.2
1405	C	ILS10	4.3
1406	C	ILS10	4.3
1407	C	ILS10	4.4
1408	C	ILS10	5
1409	C	ILS10	6.1.1
1410	C	ILS10	6.1.2
1411	C	ILS10	6.1.3
1412	C	ILS10	6.2.1
1413	C	ILS10	6.2.2
1414	C	ILS10	6.3.1
1415	C	ILS10	6.3.2
1416	C	ILS10	6.3.3
1417	C	ILS10	6.3.3
1418	C	ILS10	6.3.4
1419	C	ILS10	6.3.5

No	Part	Document	Paragraph
1420	C	ILS10	6.3.5
1421	C	ILS10	6.3.6
1422	C	ILS10	6.4
1423	C	ILS10	6.4
1424	C	ILS10	7.1(a)
1425	C	ILS10	7.1(b)
1426	C	ILS10	7.1(b)
1427	C	ILS10	7.2.1
1428	C	ILS10	7.2.2
1429	C	ILS10	7.2.3
1430	C	ILS10	7.2.3
1431	C	ILS10	7.2.3
1432	C	ILS10	7.2.4
1433	C	ILS10	7.2.5
1434	C	ILS10	7.2.5
1435	C	ILS10	7.2.6
1436	C	ILS10	8.1
1437	C	ILS10	8.2
1438	C	ILS10	8.3
1439	C	ILS10	8.4
1440	C	ILS10	8.4
1441	C	ILS10	8.4
1442	C	ILS10	8.5
1443	C	ILS10	8.6
1444	C	ILS10	8.7
1445	C	ILS10	9.1
1446	C	ILS10	9.2
1447	C	ILS10	9.3
1448	C	ILS10	9.3
1449	C	ILS10	10.1
1450	C	ILS10	11.1
1451	C	ILS10	11.1
1452	C	ILS10	11.2
1453	C	ILS10	12.1
1454	C	ILS10	12.1
1455	C	ILS10	12.2
1456	C	ILS10	13
1457	C	ILS10	14
1458	C	ILS10	15.1.2
1459	C	ILS10	15.1.3
1460	C	ILS10	15.2.2
1461	C	ILS10	15.3.2
1462	C	ILS10	15.3.3
1463	C	ILS10	16
1464	C	ILS10	16
1465	C	ILS10	17.1

No	Part	Document	Paragraph
1466	C	ILS10	17.1
1467	C	ILS10	17.2
1468	C	ILS10	18
1469	C	ILS10	19.1.1
1470	C	ILS10	19.1.2
1471	C	ILS10	20
1472	C	ILS10	21(a)
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1475	C	ILS10	21(b)(ii)
1476	C	ILS10	21(c)
1477	C	ILS10	21(d)
1478	C	ILS10	21(e)
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1481	C	FLI02	4.2
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1491	C	FLI02	6.2
1492	C	FLI02	6.2.1
1493	C	FLI02	6.2.1
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1495	C	FLI02	6.4
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1522	C	FLI02	8.4
1523	C	FLI02	8.4
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1526	C	FLI02	10.2(b)
1527	C	FLI02	10.2(c)
1528	C	FLI02	10.2(d)
1529	C	FLI02	10.2(e)
1530	C	FLI02	10.2(f)
1531	C	FLI02	10.2(g)
1532	C	FLI02	10.2(h)
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1534	C	FLI02	11.2
1535	C	FLI02	11.3
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1537	C	FLI02	11.4
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1557	C	FLI02	Annex 1 6.1.6

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1562	C	FLI02	Annex 1 7.1.4
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1565	C	FLI02	Annex 1 7.2.2
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1589	C	FLI02	Annex 2 6.2.4
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1592	C	FLI02	Annex 2 6.2.6
1593	C	FLI02	Annex 2 6.2.7
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1608	C	FLI02	Annex 3 6.2.2
1609	C	FLI02	Annex 3 6.3.1
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1611	C	FLI02	Annex 3 6.4
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1616	C	FLI02	Annex 3 13.3
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1623	C	ILS10	7.2.6(a)
1624	C	ILS10	7.2.6(b)
1625	C	ILS10	7.2.6(b)
1626	C	ILS10	7.2.6(b)
1627	C	ILS10	7.2.6
1628	C	ILS10	7.2.6
1629	C	ILS10	7.2.6
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1650	C	NAV01	5

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1654	C	NAV01	6.4
1655	C	NAV01	6.5
1656	C	NAV01	7.1
1657	C	NAV01	7.2
1658	C	NAV01	8.1 (a)
1659	C	NAV01	8.1 (b)
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1663	C	NAV01	8.5
1664	C	NAV01	8.6
1665	C	NAV01	8.7 (a)
1666	C	NAV01	8.7 (b)
1667	C	NAV01	8.7 (c)
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1671	C	NAV01	9.2 (c)
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1688	B	APP02	3.4
1689	B	APP02	4.1
1690	B	APP02	5.1
1691	B	APP02	5.2
1692	B	APP02	5.3
1693	B	APP02	5.4
1694	B	APP02	5.4 (f)
1695	B	APP02	5.4 (f to k inc.)
1696	B	APP02	5.5
1697	B	APP02	5.6

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1701	B	APP02	6.3.2
1702	B	APP02	7.1
1703	B	SW01	3.1.1
1704	B	SW01	3.1.2
1705	B	SW01	3.2(A)
1706	B	SW01	3.2(B)
1707	B	SW01	3.2(C)
1708	B	SW01	3.2(D)
1709	B	SW01	3.2(E)
1710	C	RAD03	3
1711	C	RAD04	3
1712	C	RAD05	3
1713	C	RAD06	3
1714	C	RAD07	3
1715	C	RAD08	3
1716	C	RAD09	3
1717	C	RAD10	3
1718	C	RAD11	3
1719	C	FLI03	3
1720	C	GEN03	3

Contents to Part A

Part A The Regulatory Framework

Introduction	2
Scope	3
International Standards Compliance Statement to CAP 670	4
Principles of Regulation	4
Regulation of Air Traffic Services and Air Traffic Service Facilities	7
Change of Provider of Air Traffic Control Services	10

Appendix A The Articles of the Air Navigation Order

Appendix B Schedule of Equipment to be Regulated under the Air Navigation Order, Articles 104 and 105

Part A The Regulatory Framework

1 Introduction

1.1 The Air Navigation Order (ANO) requires an air traffic service and certain related elements to be approved or licensed by the CAA.

1.1.1 The provision of air traffic services and, where appropriate, the technical aspects of associated services such as Operational Control (OPC) are regulated by the Air Traffic Service Standards Department (ATSSD) of the United Kingdom Civil Aviation Authority Safety Regulation Group (UK CAA SRG).

1.1.2 CAP 670 Air Traffic Services Safety Requirements describes the manner in which approval is granted, the means by which Air Traffic Service (ATS) providers can gain approval and the ongoing process through which approval is maintained.

1.1.3 The material contained in this document sets out the requirements to be met by providers of civil air traffic services and associated services in the UK in order to ensure that those services are safe for use by aircraft and meet internationally agreed standards. In addition to requirements, the text offers explanatory notes and guidance material on acceptable methods of compliance with the requirements.

1.1.4 Whilst the contents of the document may be of interest to other parties, this document is addressed to ATS providers who are expected to demonstrate compliance with applicable requirements either directly or through the provision of safety assurance documentation which may be in the form known as a safety case.

1.1.5 Where material produced by a third party (an equipment manufacturer, for example) is submitted by an ATS provider in support of application for approval, the content must be endorsed by the provider.

1.2 **CAP 670 Structure**

1.2.1 Document control pages contain the title page, contents, amendment record page, checklist of pages, change of details form, ad hoc comments guidance notes and form.

1.2.2 Contents Pages, contains an overall list of contents for CAP 670 covering the Preamble, Parts A, B, C & D.

1.2.3 Preamble, contains information on the structure of the ATS Standards Department, addresses, definitions and abbreviations, units of measurement and bibliography.

1.2.4 **Part A** – Requirements and the Regulatory Framework - this part.

1.2.5 **Part B** – Generic Requirements and Guidance, contains material which is structured according to the subject matter, and organised into individual documents within sections. The documents contain requirements, recommendations and notes which are interpreted in the same way as those for Part C.

1.2.6 **Part C** – Communication, Navigation and Surveillance, contains individual documents which are structured into Part 1 Preliminary Material and Part 2 Requirements. The Part 1 typically contains an Introduction and Scope. The Part 2 typically contains requirements and guidance material which are divided into:

a) safety objectives,

b) mandatory requirements which have to be satisfied,

c) recommendations with which compliance is desirable but may not be appropriate in all situations,

d) acceptable means of compliance,

e) guidance and/or notes which provide additional information which may be useful to providers.

Annexes and appendices associated with individual documents may also be used for guidance and notes.

1.2.7 **Part D** – Human Resources addresses ATC unit manning and duty hours.

1.2.8 **Reference Numbering** - Safety objectives, requirements and recommendations are identified by a unique number which is to be found in round brackets after the applicable text e.g. (123). This system of numbering enables providers and regulators to know the exact wording against which any means of compliance was implemented and approval granted. Paragraph numbering may change but this reference number will never change whilst the text remains the same. If the text changes a new number will be allocated to it. Numbering is not sequential and not coded so nothing can be inferred from the number alone. Consecutive requirements may have numbers many hundreds apart. A cross-reference matrix to assist location of requirements etc against paragraph numbers may be found after the Preamble.

2 Scope

2.1 Civil aviation in the United Kingdom is governed by legislation (principally the Air Navigation Order) and International Standards and Conventions (principally those published by ICAO and EUROCONTROL) with which the United Kingdom, as a State, has agreed to comply.

2.2 The requirements contained in this document are applicable to air traffic services and technical aspects of associated services being provided from the United Kingdom, and to services provided to aircraft within the UK Flight Information Region (FIR) and other airspace for which responsibility has been designated to the United Kingdom through international agreement.

2.3 Special arrangements may exist in the vicinity of the UK FIR boundary and in respect of certain off-shore installations. ATS service providers to whom such arrangements apply, are expected to discuss their particular circumstances with the appropriate Regional Manager ATS Safety Regulation, or the Head of En-Route and College Regulation at Aviation House, Gatwick.

2.4 The requirements in this document do not directly consider externally provided services (such as public telephone/telecommunication services), but do encompass the manner in which these services are used within an air traffic service. It should be noted that such services, although external to the provision of an air traffic service, may be subject to regulation by other parts of the CAA or other agency.

2.5 Externally supplied services are assumed to meet all relevant requirements and Standards. It is the responsibility of the ATS provider to ensure that the consequences of safety-related failures associated with externally provided data or services are adequately considered and mitigated against.

2.6 It should be noted that requirements described in this document may not apply to all types of service.

3 International Standards Compliance Statement to CAP 670

3.1 CAP 670 is published in support of the powers of the Civil Aviation Authority contained in the Articles of Part IX Air Traffic Services and Part X Aerodromes, Aeronautical Lights and Dangerous Lights of the Air Navigation Order.

3.2 CAP 670 includes international standards contained in Annexes to the Chicago Convention and EUROCONTROL Safety Regulatory Requirements (ESARRs).

3.3 It is the policy of Civil Aviation Authority to have reference to CAP 670 when exercising the discretionary powers referred to above and in particular it will normally exercise those powers so as to ensure the effective implementation of any such international standards.

4 Principles of Regulation

4.1 The Regulatory Framework

4.1.1 The Civil Aviation Act established the Civil Aviation Authority (the 'CAA') and provides the framework for its regulatory powers.

4.1.2 The Act enables further legislation, Air Navigation Orders and General Regulations, to be made in order to permit the CAA to fulfil its regulatory obligations.

4.1.3 Air Navigation Orders are presented by way of Articles and Regulations, each dealing with a particular subject.

4.1.4 The CAA publishes Civil Aviation Publications (CAPs) which provide details of means of compliance with the Articles which are acceptable to the CAA.

4.1.5 Civil air traffic services (ATS) and technical elements of associated services are principally regulated in the UK by the ATS Standards Department. Regulation is achieved, as appropriate, through the grant of Approval to equipment and systems, licensing and certification of personnel, and auditing and inspecting the subsequent systems and service provision.

4.1.6 Appendix A to Part A comprises a list of the Articles of the ANO, which directly affect ATS provision, together with a brief description of the subject area covered.

4.1.7 Appendix B to Part A comprises a schedule of equipment to be regulated under the ANO Articles 104 and 105.

4.2 Related Legislation

4.2.1 The requirements in this document are not intended to supersede or conflict with statutory requirements, and therefore the obligation to comply with statutory requirements remains. This includes compliance with European Regulations that automatically become UK Law and European Directives that are enacted into UK legislation before they become binding.

4.2.2 The CAA has a specific responsibility for certification and enforcement in relation to air traffic management systems under the UK Electromagnetic Compatibility Regulations, which is related to the European EMC Directive 89/336/EEC.

4.2.3 The Transport Act 2000 is the empowering legislation to enable the separation of NATS from the CAA.

4.3 Requirements and Guidance Material

4.3.1 The CAA regulates civil aviation in the United Kingdom in order to ensure that high safety standards are set and achieved in co-operation with those regulated whilst minimising the regulatory burden.

4.3.2 This objective is achieved by providing the industry with requirements and guidance material to aid the assessment of initial and ongoing compliance with those requirements by service providers.

4.3.3 The CAA's Safety Regulation Group (SRG) will continually review its published aviation safety requirements and, where practical, restate them in terms of the objective that is to be achieved.

4.3.4 This process will result in many currently prescriptive requirements being expressed as a safety objective. Many safety objectives will be accompanied by one or more methods of compliance which are acceptable to the CAA (commonly referred to as acceptable means of compliance or AMCs). ATS Providers will be at liberty to utilise an AMC or an alternative solution of their own choice provided that it is demonstrated that the safety objective is achieved.

4.3.5 It should be noted that not all of the requirements in this document have been restated in objective terms.

4.3.6 Existing approval holders must recognise that these requirements may be changed from time to time on grounds of safety, potentially necessitating re-approval. A reasonable period of prior notification would normally be given in such circumstances.

4.4 Requirements Capture

4.4.1 Requirements capture is the process of identifying a need for new or amended requirements and may be triggered by:

a) Ad Hoc Comments and Formal Consultation on CAP 670

b) International Obligations

   Changes to ICAO Standards and Recommended Practices related to the provision of Air Traffic Services.

c) Eurocontrol Safety Regulation Commission

   Changes introduced as Eurocontrol Safety Regulation Requirement (ESARR).

d) U.K. & European Legislation

   Changes to U.K. Legislation, EU Regulations and EU Directives, directly or indirectly related to the provision of Air Traffic Services.

e) CAA SRG Policy & Strategy

   Changes to the scope of regulation or the indication of the CAA SRG position on a particular issue. Re-drafting of existing requirements into Objective Based Safety Requirements.

f) Air Traffic Service Environment

   Monitoring the Air Traffic Service environment, by means of the MOR Scheme or other mechanism, to identify safety risks.

g) Industry Demand

   Air Traffic Service providers may wish to bring into service systems or equipment, or to implement procedures, for which no applicable requirements currently exist.

h) New Technology

Introduction and developments of new technology in the provision of Air Traffic Services.

4.5 **Requirements Production**

Requirements production includes the authorisation and drafting of requirements, internal review processes, consultation and publication. The consultation process is briefly outlined in the following section. As part of the requirements drafting process, the requirements author may draw on any appropriate additional expertise both from within the CAA SRG and externally.

4.6 **Requirements Consultation**

A procedure has been established for the Formal Consultation process and the management of ad hoc comments for CAP 670 in accordance with SRG Group and Divisional Procedures and SRG Code of Practice.

With the exception of editorial changes and requirements or guidance material which need urgent promulgation, all other material is subject to the Formal Consultation process.

Ad hoc comments and those received during the Formal Consultation process will be considered by the authors of the requirements and responses prepared as necessary. Where appropriate, changes will be incorporated into an amendment to CAP 670.

4.6.1 **Formal Consultation**

The ATS Standards Department (ATSSD) of the CAA's Safety Regulation Group invites comments on proposals that may have an impact on the provision of air traffic services in the UK, or on the organisations that provide those services. Once the necessary stages of the CAA internal development and production process have been completed, the consultative material is published on the CAA website to allow consideration by a notified date that marks the end of the consultation period. This Formal Consultation process enables comments on proposed changes to be made by individuals and industry prior to the effective date of the changes.

Any documents currently under review as part of the Formal Consultation process may be accessed by following the link to the CAA website: http://www.caa.co.uk/srg/ats/document.asp?groupid=282

4.6.2 **Consultation List**

A consultation list of individuals who have expressed an interest in offering comments on material proposed for publication is maintained by ATSSD. When consultative material is made available on the CAA website, addressees on the consultation list who have notified an interest in the subject matter are notified by letter. Requests to join the CAP670 consultation list may be made by letter or e-mail to the CAP 670 editor; see contact details at Preamble Page 1.

4.6.3 **Ad-hoc Comments**

Ad-hoc comments on the material in this or other regulatory requirements that relate to the provision of air traffic services may be submitted at any time using the 'Ad-hoc Comments Form' at the front of this publication (Page xviii) or by e-mail to the editor at cap670editor@srg.caa.co.uk.

4.7 **Publication of Requirements and Guidance Material**

4.7.1 At the end of the consultation process, requirements and guidance material, incorporating any changes that are considered appropriate following the consultation period, are published in CAP 670 as an amendment to the publication. The amendment is published in electronic (pdf) format and may be downloaded from the list of ATS publications available on the CAA website at: http://www.caa.co.uk/publications/publications.asp?action=subcat&id=4

A printed version may be purchased from Documedia Solutions Limited, if required. Contact details can be found at: http://www.caa.co.uk/publications/faq.asp?faqid=138

4.7.2 Amendments should be incorporated into CAP 670 on receipt, in accordance with any Amendment Instructions, and an entry made in the Amendment Record Page as confirmation that the publication has been updated. The effective date of the amendment should be taken to be the date of publication unless a different date is prescribed. If so, this will be indicated clearly. An example of where this might happen would be publication of requirements in advance of their taking effect in order to allow ATS Providers time to introduce appropriate arrangements.

4.7.3 All changes to the text from the previous version are identified by the use of sideline revision marks. The date of publication on each page is also amended and reflected in the Checklist of Pages. Where the only changes needed are to the headers and footers, such as page numbering, the date of publication will need to be revised, but sideline revision marks will not be used.

4.7.4 **Amendment notification service**

A free e-mail amendment notification service for CAA documents is available on the CAA web site. Those interested may subscribe to the service at: http://www.caa.co.uk/publications/subscription.asp

5 Regulation of Air Traffic Services and Air Traffic Service Facilities

5.1 Air Navigation Order

Reference should be made to the current issue of the ANO and Appendix A of this document.

5.2 Introduction

International standards have come into force which States are required to implement. From 1 November 2001, ICAO Annex 11 Air Traffic Services requires the UK CAA to implement a programme that ensures that a Safety Management System (SMS) is used at all ATS units. EUROCONTROL, under the auspices of the Safety Regulation Commission (SRC), has published ESARR 3 Use of Safety Management Systems by Air Traffic Management (ATM) Service Providers which requires all providers of ATM to have established a SMS and put it into use by 16 July 2003.

5.3 Requirements

An Applicant for an Approval under the ANO shall demonstrate that all safety issues within the provision of an Air Traffic Management (ATM) service have been addressed in a satisfactory manner (77).

5.4 Process and Regulatory methods for demonstrating safety adequacy

5.4.1 General

5.4.1.1 Regulation of civil air traffic services (ATS) and technical elements of associated services, is achieved through the grant of Approval to equipment and systems, licensing and certification of personnel, and auditing and inspecting the subsequent systems and service provision.

5.4.1.2 The term 'approval' is used generically in the following descriptions to mean any relevant form of regulatory approval, certification or grant of a licence.

5.5 Non-SMS Regulatory method

5.5.1 From 16th July 2003 all ATC service providers will have established and put into use a SMS. It is accepted that, on this date, some units will still be transitioning to full operation of their SMS and during this period the following regulatory method may continue to be used. This method will also apply to those non-ATC service providers (eg AFIS) who have not implemented a SMS.

A service provider's primary point of contact with the ATS Standards Department is the Regional Manager ATS Safety Regulation. The Regional Manager may delegate the day to day responsibility for oversight of the service provider to the appropriate Engineering or ATC Inspector or other system specialist. The establishment of a new ATS facility or a safety-related change to an existing facility will require approval under the ANO. This may take the form of an Approval document or a letter of satisfaction. A new facility or a change to an existing facility, that is subject to the ANO, may not be used operationally without such Approval.

5.5.2 The applicant will be advised of the evidence, level of detail and method of presentation that is required in order to provide assurance that the project or change satisfies all regulatory requirements and will be accomplished and implemented safely.

5.5.3 Following submission, the safety assurance documentation will be reviewed and the service provider advised whether it is acceptable or not. Any areas that are deficient will be identified. The time taken to review the document will depend upon its complexity. If the documentation is not acceptable, the service provider should make amendments to address the identified deficiencies and resubmit as necessary.

5.5.4 The Department will require to be satisfied that all applicable requirements have been met and that the safety assurance documentation is complete before granting approval.

5.5.5 In exceptional circumstances, a service provider may propose an alternative to compliance with a specific requirement. This may be acceptable provided that an equivalent level of safety can be demonstrated. It should be noted that it is unlikely than an alternative method of compliance will be acceptable for requirements derived from international standards.

5.5.6 The department's representative may wish to inspect any physical aspects, at any time, of the project or change. Milestones may be specified which need to be successfully achieved before project or change progression.

5.5.7 Continuing approval is achieved through periodic inspection. In the event that applicable regulatory requirements are not satisfied or any form of safety assurance which has been given by the provider is not achieved, the approval may be withdrawn.

5.6 Approval of a Safety Management System

5.6.1 Before an ATS Provider is regulated under a safety management system (SMS) regime, the supporting documentation must be accepted by the department's representative as specified above. Until such time as approval to operate in accordance with a safety management system is granted, Non-SMS regulatory methods will be applied if necessary.

5.6.2 Following submission, the SMS descriptive and supporting documentation will be reviewed and the service provider advised whether it is acceptable or not. Any areas that are deficient will be identified. The time taken to review the document will depend upon its complexity. If the documentation is not acceptable, the service provider should make amendments to address the identified deficiencies and resubmit as necessary.

5.6.3 An acceptable safety management system should address all the principles described in CAP 670, Part B, Section 1, document APP 01 and will document the strategies by which the stated objectives are to be achieved.

5.6.4 In association with the implementation of a safety management system it is necessary to carry out an analysis of the safety significance of existing systems and to demonstrate that they satisfy the current safety requirements of both the CAA and those set out in the unit's SMS. This is usually presented in the form of safety assurance documentation.

5.6.5 When the department's representative is satisfied that the safety management system and safety assurance documentation provide acceptable assurance that the facility is and will continue to be operated safely, the service provider will be granted approval to operate in accordance with its safety management system.

5.7 **Safety Management System Regulatory Method**

5.7.1 A service provider's primary point of contact with the ATS Standards Department is either the Head of En Route Regulation (for Area Control Centres) or the Regional Manager ATS Safety Regulation (for Aerodromes).

5.7.2 Following approval to operate in accordance with a safety management system, any safety-related projects or changes to the facility are required to be notified to the CAA. The method by which this is achieved will be described in the safety management system. The department's representative will respond to notification of a project or change in one of three ways:

simply acknowledge receipt of notification; the change may then take place at the service provider's convenience

advise the service provider that the change will be subject to audit, either before, during or following change implementation.

instruct the service provider not to make the change until further advised. The reason for preventing the change being implemented will be stated. This course of action is only likely to be taken in exceptional circumstances.

5.7.3 Guidance is given in CAP 670 Part B Section 1, document APP 01, on the typical changes that may require a safety assessment.

5.8 **SMS Audit**

5.8.1 The SMS and supporting safety assurance documentation will be subject to periodic audit to ensure that the processes designed to assure safety are achieving their objectives. In addition to these audits, individual safety-related changes to the ATM unit may also be audited. Such audit will be used to seek assurance that Approval of the subject of the audit may continue.

5.8.2 The routine audits will systematically examine the effectiveness of the processes documented in the SMS to ensure that applicable safety requirements have been met. In addition to assessing whether the process is practical and comprehensive, the audit will sample the results of the process to ensure that it achieves its objectives.

5.8.3 It is not anticipated that all projects or changes will be audited. Samples of common areas within projects or changes may instead be audited.

5.8.4 Should the audit findings be unsatisfactory or if concern arises that the safety management system is failing to assure the continued safe operation of the facility, approval to operate in accordance with the safety management system may be withdrawn and Non-SMS regulatory methods will be introduced. In exceptional circumstances, approval may be withdrawn either temporarily or permanently.

6 Change of Provider of Air Traffic Control Services

6.1 At some licensed aerodromes the Air Traffic Control (ATC) services are provided by contractors. Occasionally the contractor will change and the Aerodrome Licensee will wish the transition to be as seamless as possible, while maintaining high levels of safety, particularly if continuous operations are to be provided. Aerodrome Licensees are reminded of their responsibilities under the ANO to secure the aerodrome and airspace especially during the change-over of Providers of ATC. The importance of the contract with their chosen ATC Provider cannot be under stated: Licensees may wish to assure themselves that appropriate arrangements are in place to cover the transfer of ATC services to an alternative provider and that ownership of the Manual of Air Traffic Services Part 2 is addressed.

6.2 The Aerodrome Licence is granted by the Aerodrome Standards Department of the CAA and the approval to provide ATC services is granted by the Air Traffic Services Standards Department (ATSSD) of the CAA. In all cases an ANO Approval to provide ATC services must be granted by ATSSD before operations by the new Provider can commence (850).

6.3 When the change of Provider of ATC services involves a hand-over/take-over to a replacement company or organisation, the outgoing Provider has the following responsibilities:

a) agree with the incoming Provider a transition plan which addresses aspects of requirements that will need to be actioned by the incoming Provider, taking particular note of training and familiarisation issues;

b) allow mutually agreed access to the incoming Provider prior to handover;

c) provide the incoming Provider and the CAA, well in advance of the handover date, detailed information on equipment and facilities to be handed over within the terms of any change of contract;

d) make relevant documentation available to the incoming Provider which may affect the safety of the service provided after the handover.

NOTE: This does not necessarily mean documentation which may be considered the 'intellectual property' of the incumbent. It would however be relevant to maintenance documentation and instruction manuals for equipment to be transferred and used by the incoming Provider.

6.4 If the nominated incoming Provider is from a replacement company or organisation, the CAA will need to be informed of the approval requirements based on the submission of the detail of all aspects of the proposed operation of the new company or organisation, including opening times of control positions, staffing levels, management structure and support staff.

6.5 The CAA will ask the incoming Provider to submit the following, usually to a specified time scale:

a) a transition plan which addresses all aspects of requirements that will need to be actioned with the outgoing Provider, including training and familiarisation issues;

b) a list of controllers, details of their licences, together with any necessary requests for exemptions to full licensing requirements and justification for same;

c) details of all equipment and facilities to be used to support the air traffic control service;

d) all documentation required for the approval of the service provision.

6.6 The incoming Provider should give the CAA as much notice as possible of the take-over of service provision but at least that stated in APP 03 of this document (851).

6.7 The CAA will agree a programme with the incoming Provider for the following:

a) On site training for all licensed and other operational staff. The training will need to include a period of operational familiarisation in co-operation with the outgoing Provider.

b) Presentation of all operational staff for examination or assessment to the CAA. These examinations include oral examination and written examination as required and cover all aspects of local knowledge and use of equipment. At the appropriate time practical examinations will also need to be conducted.

6.8 If the agreed timescale for the above items is not achieved, it is possible the CAA will apply restrictions to the proposed operations or require that a new approval process is followed.

6.9 The aerodrome licensee has responsibility for making sure that, on satisfactory completion of the items above and compliance with any other notified requirements, the incoming Provider has been granted by the CAA an approval for the provision of an ATC services as required by the Air Navigation Order.

6.10 At the discretion of the CAA, any conditional Approval that may have been granted may be amended to a full Approval.

Appendix A The Articles of the Air Navigation Order

1 The Articles of the Air Navigation Order which directly affect ATS Providers are listed below together with a brief description of the subject area covered. It should be noted that the descriptions below are not a reproduction of the legislation and therefore are neither definitive nor exhaustive.

Article 88	requires that any person wishing to provide an air traffic control service is approved by the CAA.
Article 88A	duty of person in charge to satisfy himself as to competence of controllers.
Article 89	requires each ATC unit to produce a Manual of Air Traffic Services.
Article 90	requires an approach control service to be provided during promulgated hours at aerodromes which have a notified instrument let down.
Article 90A	empowers the CAA to direct that an air traffic service shall be provided.
Article 91	requires that only the appropriate RTF callsign is used.
Article 92	grant of air traffic controller and student air traffic controller licences.
Article 93	provides for the approval of individuals, courses and simulators involved with the training of air traffic controllers.
Article 94	prevents an individual who does not hold an air traffic controller licence from providing an air traffic control service.
Articles 94A to 94H	set out privileges and conditions associated with air traffic controller licences.
Article 95	deals with the actions air traffic controllers should take if they are ill or incapacitated.
Article 96	precludes an air traffic controller from providing an air traffic control service whilst under the influence of alcohol or drugs.
Article 97	deals with an air traffic controller's responsibilities if he/she is fatigued.
Article 98	deals with the licensing of flight information service officers.
Article 99	prevents an individual who does not hold a flight information service officer's licence providing a flight information service.
Article 100	requires each FIS unit to produce a Flight Information Service Manual.
Article 104	defines requirements for approval and use of ground based radio stations (for both communication and navigation) used to provide assistance to aircraft.
Article 105	describes the records to be kept for ground based radio stations (includes the requirement to record certain RTF communications).

Article 117	requires the mandatory reporting of certain incidents.
Article 123	deals with the extra-territorial effect of the Order.
Article 127	allows the CAA to exercise its discretion in providing exemptions from certain Articles of the ANO.
Article 129	interpretation of terms used in the ANO.

2 The Articles listed above are those which the ATS Standards Department is specifically involved with implementing. It should be remembered that other Articles in the Order (and other regulations) may affect air traffic service providers.

3 The Article numbers are those of the Air Navigation Order.

Appendix B Schedule of Equipment to be Regulated under the Air Navigation Order, Articles 104 and 105

- Communications systems used to communicate with aircraft or vehicles/personnel operating on the aerodrome including any VCCS (and VHF/UHF RT transmitters and receivers and antennae).
- Systems associated with broadcast services (e.g. ATIS/VOLMET) including VHF transmitters/antennae and the message preparation or generation equipment.
- Radar transmitter/receiver equipment including data processing and display equipment and dependent elements (e.g. AMA or radar-based runway incursion detection systems).
- DF receiver and associated processing and display equipment.
- ILS equipment and associated monitoring and control systems.
- IRVR equipment and associated monitoring and control systems.
- MLS equipment and associated monitoring and control systems.
- NDB equipment and associated monitoring and control systems.
- DME equipment and associated monitoring and control systems.
- VOR equipment and associated monitoring and control systems.
- Data processing and communications equipment used for ATM messaging such as OLDI, AFTN and flight data processing systems (e.g. flight progress strip printers). Regulation to be limited to gaining assurance of data integrity only.
- Alarm/alerting systems not covered above.
- Information display systems such as general information displays and CCTV. Regulation to be limited to gaining assurance of data integrity only and applied only where safety-related information is displayed.
- AGL control and monitoring systems except where these are subject to approval by ASD.
- Any other specific item or class of equipment/system deemed to be safety-related and used to support the provision of an air traffic service. These items or classes of equipment/system to be promulgated in CAP 670.

Contents to Part B

Part B Generic Requirements and Guidance

Introduction 5
Scope 5

Part B, Section 1, ATS Approval - Documents

APP 01 Safety Management Systems

Introduction 1
Scope / Applicability 1
Rationale 1
Safety Objective 2
Safety Management Systems (SMS) Requirements 2

APP 02 Approval of Maintenance Arrangements (AMA)

Introduction 1
Safety Objective 1
Acceptable means of compliance 1
Person responsible for the Safety adequacy of Maintenance Arrangements 1
Typical aspects for which Safety Adequacy should be considered 2
Personal Technical Certificates 5
Inspections and Audits 6

APP 03 The Approval of an Air Traffic Control Unit

Air Traffic Service Facility Approvals 1
Nomination of Provider and Provider's Representative 1
Initial Approval of an Air Traffic Control Unit 1
Maintaining Air Traffic Control Unit Approval 2
ATSSD Regional Office and En-Route Regulation Responsibilities 2
Additional Information 2

APP 04 Temporary ATC Units

Introduction	1
General	1
Staffing Requirements – Ref: CAP 670 Part D, Annex B	2
Communication – Ref: CAP 670 Part C, Section 1	2
Surface Wind Indication – Ref: CAP 670 Part C, Section 3	2
Pressure Setting Information – Ref: CAP 670 Part C Section 3	2
Visual Control Room – Ref: CAP 670 Part B, Section 2, ATC 01	2
Manual of Air Traffic Services Part 2 – Ref: CAP 670 Part B, Section 2, ATC 02	3
Watch Log – Ref: CAP 670 Part B, Section 2, ATC 02	3
Other Documents – Ref: CAP 670 Part B, Section 2, ATC 02	3
Other Records	4

Part B, Section 2, Air Traffic Control

ATC 01 ATC Support Systems and Facilities

Operations Rooms	1
Information Systems	1
Visual Control Room (VCR)	2
Furniture	3
Noise	3
Lighting	4
Heating and Air Conditioning	4
Rest Facilities	4

Annex A to ATC 01

Surface Wind Indication	1

ATC 02 ATC Documentation

Manual of Air Traffic Services Part 2 (MATS Part 2)	1
Letters of Agreement	3
Watch Log	3
Retention of Records	4
Other Documents	4

Annex A to ATC 02 Manual of Air Traffic Services Part 2

List of Contents by Section 1

ATC 03 Emergency or Contingency Facilities

Introduction 1
General 1
Documentation 2

Part B, Section 3, Systems Engineering

SW 01 Regulatory Objectives for Software Safety Assurance in ATS Equipment

Introduction 1
Scope 1
Safety Objectives 2
Introduction 4
Guidance on Presenting Arguments and Evidence that the Assurance Objectives have been met 4
Guidance On Credible Arguments And Evidence To Demonstrate Requirements Validity Relating to Objective A 4
Guidance on Credible Arguments and Evidence to Demonstrate Requirements Satisfaction Relating to Objective B 6
Guidance on Credible Arguments and Evidence to Demonstrate Requirements Traceability Relating to Objective C 21
Guidance on Credible Arguments and Evidence to Demonstrate Freedom from Interference by Non Safety Functions Relating to Objective D 22
Guidance on Credible Arguments and Evidence to Demonstrate Configuration Consistency Relating to Objective E 22

Appendix A to SW 01 - Identification of AELs

Introduction 1
Safety Criticality 1
Calculation of AEL 2
Software Components 3

Appendix B to SW 01 - Argument and Evidence Concepts

Safety Arguments 1
Evidence 1
Rigour of Arguments 2

Arguing Requirements Satisfaction 2
Safety Cases 4

Appendix C to SW 01 - Definitions and Abbreviations

Definitions 1
Abbreviations 4

Appendix D to SW 01 Derivation of Safety Objectives

SW 01 Annex A - Guidance and Information

GEN 01 Windfarms

Introduction 1
Capture by ATS Provider of development proposal 1
Responsibilities and limitations 1
Assessment of effect 2
Additional guidance 2

GEN 02 Technical Safeguarding of Radio Sites; Guidance Material

Introduction 1
Definition 1
Background 1
Physical Protection 1
Radio Spectrum Protection 4

GEN 03 Safety Requirements for Operational Trials in Air Traffic Services

Introduction 1
Scope 1
Safety Objective 2
Requirements 2

Appendix Acceptable Means of Compliance

GEN 04 Electro Magnetic Compatibility

Part B Generic Requirements and Guidance

1 Introduction

The generic requirements and guidance material in Part B have been organised into individual documents within sections under the categories of ATS Approval, Air Traffic Control, Systems Engineering and General. These documents should be used in conjunction with those contained in Part C as appropriate.

2 Scope

The 'APP' documents in Section 1 ATS Approvals cover the areas of gaining and maintaining approval, approval of maintenance arrangements and approval of an ATCU.

The 'ATC' documents in Section 2 Air Traffic Control cover the areas of temporary ATCUs, support systems and facilities, documentation and emergency or contingency facilities.

The documents in Section 3 Systems Engineering provide regulatory objectives for safety assurance for ATS systems and ATS equipment comprising hardware and software elements.

The 'GEN' documents in Section 4 General cover a number of miscellaneous subjects comprising guidance on the safeguarding of ATS operations including possible degradation of radio signals due to the presence of windfarms (wind powered turbine generators), the technical safeguarding of radio sites consisting of the two processes of physical protection and radio spectrum protection and operational trials.

Part B, Section 1, ATS Approval - Documents

APP 01 Safety Management Systems

1 Introduction

1.1 International standards have come into force which States are required to implement. From 1st November 2001, ICAO Annex 11 Air Traffic Services requires the UK CAA to implement a programme that ensures that a SMS is used at all ATS units. EUROCONTROL, under the auspices of the Safety Regulation Commission (SRC), has published ESARR 3 Use of Safety Management Systems by Air Traffic Management (ATM) Service Providers which builds on the ICAO Standards and Recommended Practices and requires all providers of ATM to have established a SMS and put it into use by 16th July 2003.

1.2 Compliance with the requirements laid down in ESARR 3 are taken as compliance with the ICAO Standards and Recommended Practices (SARPs), therefore the SARPs are not reproduced within the CAP.

1.3 Where approval under the ANO is required, it is the responsibility of the service provider to satisfy the CAA that the system under consideration will be safe for use by aircraft and satisfies all appropriate requirements throughout its lifecycle.

1.4 This applies both to initial approval and any subsequent changes to the approved system.

1.5 The following sections provide the requirements and guidance that can be used by Service Providers when constructing and maintaining a Safety Management System. It contains examples of typical components of an SMS and includes the requirements contained within the Eurocontrol Safety Regulation Commission (SRC), Eurocontrol Safety Regulatory Requirement (ESARR) 3 publication. Further information may be found in CAP 730 Safety Management Systems for Air Traffic Management,

1.6 The text of the ESARR is printed in **bold** and additional recommendations and explanatory text are provided. These provide further reasoning for the requirement itself. They are provided to assist service providers in understanding the particular issue that the requirement attempts to address.

2 Scope / Applicability

The terms of ESARR 3 apply to Air Traffic Management (ATM) service providers from 16th July 2003. In the UK this requirement applies only to Air Traffic Control service providers from 16th July 2003. Other ATS service providers will be advised in due course when they will be required to comply.

3 Rationale

3.1 The prime responsibility for the safety of an ATM service rests with the service provider. Within the overall management of the service, the service provider has a responsibility to ensure that all relevant safety issues have been satisfactorily dealt with, and to provide assurance that this has been done.

3.2 Safety management is that function of service provision, which ensures that all safety risks have been identified, assessed and satisfactorily mitigated. A formal and systematic approach to safety management will maximise safety benefits in a viable and traceable way.

4 Safety Objective

The overall safety objective is to ensure that all safety issues within the provision of an ATM service have been addressed in a satisfactory manner, and to a satisfactory conclusion (852).

5 Safety Management Systems (SMS) Requirements

5.1 Safety Management

5.1.1 An ATM Service Provider shall, as an integral part of the management of the ATM service, have in place a SMS which:

a) ensures a formalised, explicit and pro-active approach to systematic safety management in meeting its safety responsibilities within the provision of Air Traffic Management (ATM) services (853);

b) operates in respect of all ATM and supporting services which are under its managerial control (854);

c) includes, at its foundation, a statement of safety policy defining the organisation's fundamental approach to managing safety (855).

5.1.2 **Rationale:** An intuitive or ad hoc approach to the management of safety is not, as a fundamental principal of SMS, acceptable.

5.1.3 An acceptable SMS may be defined within several tiers of documentation, for example Safety Management Manuals, Quality Management Manuals, Safety Cases, MATS Pt 2 or others. Similarly the SMS may be spread between Corporate and local level documents.

5.1.4 Where the service provider uses external standards to achieve a safety objective, the scope, depth and use of these should be explained.

5.1.5 An acceptable SMS will set out the service provider's safety management policies and strategy and give assurance that, irrespective of the events which may take place on the ATS unit, clear processes are established and implemented to ensure that the necessary safety standards are maintained at all times.

5.2 Safety Responsibility

5.2.1 An ATM Service Provider shall, as an integral part of the management of the ATM service, have in place a SMS which ensures that everyone involved in the safety aspects of ATM service provision has an individual safety responsibility for their own actions (856), and that managers are responsible for the safety performance of their own organisations (857).

5.2.2 **Rationale:** Safety responsibilities are necessary to ensure that the service provider's organisation is committed, at all levels, to the fulfilment of its stated safety policy. Accountability for safety belongs to all levels of management and the attainment of satisfactory safety performance requires the commitment and participation of all members of the service provider's organisation. The SMS depends upon individuals understanding and accepting their delegated responsibility within the service provider's organisation. Everybody within the organisation should be made aware of the consequences of mistakes and strive to avoid them. Management should foster this basic motivation within members of the organisation so that everybody accepts their responsibility for safety.

5.2.3 The service provider should define and document the safety accountabilities of personnel to explain how any safety significant roles are undertaken (858).

5.2.4 The service provider should make a safety policy statement which confirms that everyone has an individual responsibility for the safety of their own actions (859) and that managers are accountable for the safety performance of the activities for which they and their staff have responsibility (860). Additionally, the service provider should identify who is ultimately accountable for safety and how the associated responsibility is delegated (861).

5.2.5 There should be a description of the Organisational Framework for the Management and Operating Team of the service provider (862). This should define the Functions, Responsibilities, Authority and Communication Interfaces and accountabilities of all staff with defined safety responsibilities (863). This should include either individual or generic staff (e.g. Watch staff), Operating, Maintenance and Managerial staff (864). Care should be taken to ensure that there is no overlap or duplication of responsibilities (865).

5.2.6 Arrangements should be in place to ensure that individuals are also aware of their safety responsibilities under emergency conditions (866).

5.3 **Safety Priority**

5.3.1 An ATM Service Provider shall, as an integral part of the management of the ATM service, have in place a SMS which ensures that the achievement of satisfactory safety in ATM shall be afforded the highest priority over commercial, environmental or social pressures (867).

5.3.2 **Rationale:** The safety management system should clearly address and resist business pressures that challenge the safety of the provision of the service (868). Conversely, the safety management system should ensure that safety is not used to support commercial, financial, environmental etc. decisions inappropriately, which have little real safety significance (869). If the term 'safety' is abused in this way the safety management system cannot be focused on controlling the real risks.

5.4 **Safety Objective of the ATM Service**

An ATM Service Provider shall, as an integral part of the management of the ATM service, have in place a SMS which ensures that while providing an ATM service, the principal safety objective is to minimise the ATM contribution to the risk of an aircraft accident as far as is reasonably practicable (870).

NOTE: Where risk is concerned there is no such thing as absolute safety. 'As far as is reasonably practicable' means that risk in a particular activity can be balanced against the time, cost and difficulty of taking measures to avoid the risk. The greater the risk to safety, the more likely it is that it is reasonable to go to substantial effort to reduce it. It is implicit, therefore, that hazards have to be identified and the risk assessed before a judgment can be made upon their tolerability.

5.5 **Competency**

5.5.1 Within the operation of the SMS, the service provider shall ensure that staff are adequately trained, motivated and competent for the job they are required to do, in addition to being properly licensed if so required (871).

5.5.2 **Rationale:** Staff competence is fundamental to safety.

5.5.3 The service provider should ensure that staff are competent and qualified to carry out their role and responsibilities (872).

5.5.4 The service provider should ensure that the appropriate training necessary to maintain staff competence and qualification is conducted (873).

5.5.5 The service provider should ensure that all staff are provided with training in safety and safety related quality aspects, and audited that this training has taken place, including the checking of continued competency (874).

5.5.6 The service provider should ensure that the continuing competency is recorded (875).

5.5.7 The service provider should ensure the collation of the training and competency records for all personnel (876).

5.6 **Safety Management Responsibility**

Within the operation of the SMS, the service provider:

a) shall ensure that a safety management function is identified with organisational responsibility for development and maintenance of the safety management system (877).

b) shall ensure that this point of responsibility is, wherever possible, independent of line management and accountable directly to the highest organisational level (878).

c) shall ensure that, in the case of small organisations where combination of responsibilities may prevent sufficient independence in this regard, the arrangements for safety assurance are supplemented by additional independent means (879).

d) shall ensure that the highest level of the service provider organisation plays a general role in ensuring safety management (880).

5.7 **Quantitative Safety Levels**

5.7.1 Within the operation of the SMS, the service provider shall ensure that, wherever practicable, quantitative safety levels are derived and maintained for all systems (881).

5.7.2 **Rationale:** If the safety performance of a service or product is to be assessed and monitored it is necessary to define the safety objectives that need to be met.

5.7.3 The service provider should ensure that for each system the safety analysis leads to a series of quantifiable safety objectives (with the exception of human factors or areas to which only qualitative analysis is applicable) (882).

5.8 **Risk Assessment and Mitigation**

Within the operation of the SMS, the service provider:

a) shall ensure that a risk assessment and mitigation is conducted to an appropriate level to ensure that due consideration is given to all aspects of ATM (883).

b) shall ensure that changes to the ATM system are assessed for their safety significance (884) and ATM system functions are classified according to their safety severity (885).

c) shall ensure appropriate mitigation of risks where assessment has shown this to be necessary due to the safety significance of the change (886).

NOTE: Risk assessment involves, in broad terms, hazard identification, hazard assessment for severity and frequency of occurrence, risk tolerability assessment and risk removal or mitigation. More details of this process can be found later in this section.

5.9 **SMS Documentation**

Within the operation of the SMS, the service provider shall ensure that the SMS is systematically documented in a manner which provides a clear linkage to the organisation's safety policy (887).

NOTE: The service provider should define the Structure, Contents, Authorities, Responsibilities and Mechanisms for SMS Documentation (888). Where available any referenced standards or requirements should be clearly traceable to Corporate, Safety Regulatory, National or International Standards or Requirements (889). In this context, 'Corporate' means applicable to all parts of the organisation, not just a 'headquarters' area. There are no precise definitions of 'standards' or 'requirements'. Both relate generally to objectives that have to be met and can be interchangeable in meaning. The mandating of such objectives can be organisational or statutory.

5.10 **External Services**

5.10.1 Within the operation of the SMS, the service provider shall ensure adequate and satisfactory justification of the safety of the externally provided services, having regard to their safety significance within the provision of the ATM service (890).

5.10.2 **Rationale:** A safety assessment requires input from all phases of a product or service development. For externally supplied products or services the external supplier must understand and comply with the organisation's safety and safety management system requirements.

5.11 **Safety Occurrences**

5.11.1 **Within the operation of the SMS, the service provider shall ensure that ATM operational or technical occurrences which are considered to have significant safety implications are investigated immediately (891) and any necessary corrective is taken (892).**

5.11.1.1 **Rationale:** If lessons are to be learnt and remedial action is to be taken promptly, safety occurrences need to be investigated in a timely manner by the organisation. This activity should be additional to any statutory reporting requirements (893).

5.11.1.2 The service provider should have in place a process for investigating potentially safety significant occurrences, identifying any failure of the service provider's management of safety, and take corrective action if required (894).

5.11.1.3 Under the Mandatory Reporting Requirements of the ANO and CAP382, 'reportable occurrences' shall be reported to the CAA (895).

5.11.1.4 The service provider should address the responsibilities and mechanisms that control the reporting, recording, analysis and dissemination of data relating to MORs, incidents, occurrences and failures (896). These should include:

a) Interface to external organisations (897).

b) Internal reporting paths (898).

c) Responsibilities (899).

d) Auditing of process (900).

e) Notification of incidents to the CAA (901).

5.11.1.5 Corresponding arrangements should include regular communication to amass, assess and clear safety concerns (902).

5.12 **Safety Surveys**

5.12.1 Within the operation of the SMS, the service provider shall ensure that safety surveys are carried out as a matter of routine, to recommend improvements where needed (903), to provide assurance to managers of the safety of activities within their areas (904) and to confirm conformance with applicable parts of their Safety Management Systems (905).

5.12.2 **Rationale:** A safety audit is the pro-active safety management mechanism by which any risks within the organisation's operation are identified and controlled.

5.12.3 The service provider should consider detailing the arrangements for the Implementation, Planning, Analysis, Dissemination of Audit Results and Rectification or Enforcement Action in respect of faults found (906).

5.12.4 The service provider should consider documentation that details the policy and arrangements for auditing the effectiveness and implementation of the SMS at various levels in the organisation (907).

5.12.5 The service provider's safety auditing should be based on the objective of determining the safety consequences if the person, function, facility, procedure or structure failed to perform the pre-planned operational requirements (908).

5.12.6 The service provider should define and ensure the competency of the persons responsible for the safety audit, together with reporting and enforcement arrangements (909). Enforcement arrangements should be applicable to the accountabilities assigned to the various levels and areas in the service provider's organisation (910). The reason for the rejection of any safety survey recommendations should be documented and held centrally (911).

5.13 **Safety Monitoring**

5.13.1 Within the operation of the SMS, the service provider shall ensure that methods are in place to detect changes in systems or operations which may suggest any element is approaching a point at which acceptable standards of safety can no longer be met and that corrective action is taken (912).

5.13.2 **Rationale**: Safety performance can deteriorate, or the operational environment can change over time. Such events need to be detected and managed, proactively and reactively, to ensure that adequate safety performance continues to be achieved.

5.13.3 The service provider should consider the responsibilities, mechanism, authorities and recording arrangements for the collection, analysis and circulation of data to confirm that the safety objectives (where defined) of reliability, integrity and availability continue to be met (913).

5.14 **Safety Records**

5.14.1 Within the operation of the SMS, the service provider shall ensure that the safety records are maintained throughout the SMS operation as a basis for providing safety assurance to all associated with, responsible for or dependent upon the services provided, and to the safety regulatory authority (914).

5.14.2 **Rationale**: The safety assessment documentation should provide the evidence to the organisation (and other parties) that it meets and continues to meet its safety objectives (915).

5.14.3 A service provider should record the safety requirements for its area of activity and the results of the safety assessment process (916).

5.15 **Risk Assessment and Mitigation Documentation**

5.15.1 **Within the operation of the SMS, the service provider shall ensure that the results and conclusions of the risk assessment and mitigation process of a new or changed safety significant system are specifically documented, and that this documentation is maintained throughout the life of the system (917).**

NOTE: The following areas of an ATS operation are those in which issues can arise that may have implications on the safety of a unit. As such the service provider should have processes in place to conduct safety assessments of these areas.

- ATM Occurrences (918)
- ATM staff (919)
- ATM Procedures (920)
- ATM Equipment (921)
- the SMS (922)
- Compliance with requirements (923)

5.15.2 Guidance on the possible conduct of safety assessments for these areas is provided below.

5.15.3 **Lesson Dissemination**

5.15.3.1 Within the operation of the SMS, the service provider shall ensure that lessons arising from safety occurrence investigations and other safety activities are disseminated widely within the organisation at management and operational levels (924).

5.15.3.2 The service provider should ensure that lessons learnt from its safety occurrence investigations, and the case histories or experience from other organisations, are distributed widely and, where appropriate, actioned to minimise the risk of recurrence (925).

5.15.3.3 **Rationale**: It is essential that lessons should be learned and then remembered, so that the chance of recurrence is reduced. Including the results of such lessons in training programmes will raise staff awareness levels.

5.16 **Safety Improvement**

5.16.1 Within the operation of the SMS, the service provider:

a) shall ensure that all staff are actively encouraged to propose solutions to identified hazards (926);

b) shall ensure that changes are made to improve safety where they appear needed (927).

5.16.2 **Rationale**: This requires an effective means of communicating safety issues and the development of an internal safety culture that encourages every member of staff to focus on the achievement of safety, and to report errors and deficiencies without fear of punitive actions against them.

5.16.3 The service provider should have arrangements to allow safety concerns to be highlighted and communicated to those accountable for safety (928).

5.16.4 The service provider should have arrangements that allow comments to be raised, discussed and implemented, should the SMS be found to be deficient (929). These arrangements should address Interfaces and Audits (930).

5.17 Occurrences

5.17.1 The requirements for assessing safety related incidents at a unit are given in section 5.3.2 'Safety Assurance'. Guidance on items to be reported under the MOR scheme are given in CAP382.

5.17.2 Occurrences include; ATC incident reports, Engineering Occurrence reports, Post incident ATCO licensing.

5.18 Staffing Levels and Training

5.18.1 There should be a policy and arrangements in place that define the person responsible and the process to be followed that ensure that an adequate number of suitably trained and rated staff are available in respect of ATS Safety (931).

5.18.2 Documentation should define the method by which staffing levels are determined in relation to the maintenance requirements and availability of engineering facilities (932).

5.18.3 There should be a policy and arrangements in place that define the management responsibilities and process for ensuring adequate staff supervision (933). Arrangements should include the mechanisms that ensure only trained and competent staff undertake maintenance functions (934).

5.19 Procedures

5.19.1 Guidance on the safety assessment of changes to ATC procedures, including Temporary Operating Instructions (TOI) and Supplementary Instructions (SI), is given in Appendix A to APP01 'Risk and Hazard Assessment guidance'.

5.19.2 Guidance on compliance with MATS part1 (CAP493) is given in CAP 670 Part B, Section 2, document ATC 02.

5.19.3 Guidance on the hazard and risk assessment of changes that may impact upon Airspace, is available from the Directorate of Airspace Policy, at CAA House.

5.20 Equipment

5.20.1 Guidance on the assessment of the safety implications of changes to maintenance arrangements of equipment is given in CAP 670 Part B, Section 1, document APP 02.

5.20.2 Guidance on the safety assessment of a change of function or change of equipment is given in Appendix A to APP01 'Risk and Hazard Assessment guidance'. Equipment requirements to be achieved are given in CAP 670 Part C.

5.21 Changes to the SMS

5.21.1 Changes in the organisational structure of the unit that change the safety accountabilities of individuals defined in the SMS should be considered as a change to current operations (935) and assessed in accordance with the guidance given in Appendix A to APP01 'Safety Assurance Documentation' (936).

5.21.2 Any changes to the SMS should be assessed to ensure the requirements in this section are still met (937).

5.21.3 The results of any internal Safety Surveys should be assessed for safety significance (938). The Safety Regulator is to be informed of any items of Safety Significance that are not notified through other means such as the Mandatory Occurrence Reporting (MOR) scheme (939).

5.22 **The communication arrangements for safety concerns**

5.22.1 Documentation should define the responsibilities, timing and scope for the regular communication that addresses safety concerns (940). This documentation should define the responsibilities for the collection, assessment, and distribution of safety concerns and implementing solutions (941).

5.22.2 There should be an arrangement for organising and disseminating the results of communication in respect of ATS safety issues, both related to on-going safety management, safety improvement programmes and follow-ups to incidents or occurrences (942).

5.23 **Compliance with Standards and Requirements**

5.23.1 The service provider should make a safety policy statement committing it to complying with all appropriate safety standards and requirements (943).

5.23.2 The service provider should demonstrate the existing facility's compliance with all relevant safety regulatory requirements (944).

5.23.3 Any change to the unit should be assessed for its compliance with national and international requirements (945).

Appendix A to APP 01 SMS – Additional Guidance

1 Safety Assurance Documentation

1.1 Safety assurance documentation contains **argument** and **evidence** that the system meets or exceeds the appropriate standard of safety.

1.2 Safety assurance documentation usually reflects one of two situations; the safety of the existing, on-going, operation or a change to the existing operation, such as a new project or procedure.

1.3 A service provider may use any reasonable format for presenting safety assurance documentation, as long as its scope is well defined and it provides the necessary arguments and evidence required for its purpose.

1.4 Safety assurance documentation may require amendment to reflect changes in requirements or other external factors.

1.5 Unit Safety Assurance Documentation

1.5.1 The presentation of safety assurance documentation will be different depending upon the subject under consideration. Safety assurance documentation presented in the form that describes the safety arguments and provides evidence that a unit is operating in a safe manner is often presented as unit safety assurance documentation or a Unit Safety Case. These submissions are often associated with a formal safety management system.

1.5.2 Unit safety assurance documentation will be supported by individual safety documentation that describes projects or changes which occur during the lifetime of the unit. Such documentation should be notified to SRG, who will advise if specific approval under the ANO is required, or if the safety documentation may be considered for later audit activity, if considered necessary (946). This is likely to be the situation when SRG has agreed the adoption of a formal SMS at the unit. The approval or acceptance of such documentation may require the amendment of the unit safety assurance documentation.

1.5.2.1 Current Operations

a) The current operations of the unit should be described in the Unit safety assurance documentation (947). The purpose of this documentation is to provide assurance that the operations are safe and will continue to be safe.

b) The documentation is used for managing operational safety. It may be accepted by the regulator as a prime regulatory document within the context of a formal safety management system.

c) In order to provide the necessary assurance, the documentation should present evidence and arguments that demonstrate the safety adequacy of existing operations for their role (948). The following areas should be addressed:

- Safety management system (949)
- Description of operation (950)
- Safety assessment of operation (951)
- Compliance with regulations (952)
- Safety performance (953)
- Operational procedures (954)

- Safety accountabilities (955)
- Safety communications (956)

1.5.2.2 **Safety related changes to current operations**

a) Changes to the current operations, which may have an impact on the safe operation of the unit's ATS provision, should be notified to SRG (957). The following illustrates but is not limited to, the anticipated activities requiring such notification:

- the installation and commissioning of a system
- a modification to a piece of equipment which is in service
- a change to maintenance arrangements
- the withdrawal of a service or facility
- the introduction of a new, or a change to an existing, ATS procedure

b) The safety assurance documentation supporting the proposed activity should consider all aspects of the proposal, from inception through to routine operational use (958). Typically the following areas should be considered:

- The identification of operational and functional requirements;
- The management of the implementation of the activity;
- The completion of a risk assessment and identification of the safety requirements to be satisfied;
- The presentation of evidence that the system design will achieve the safety, operational and functional requirements identified;
- The presentation of measures to control any risks which cannot be satisfactorily mitigated by the system design;
- The presentation of measures taken to achieve an equivalent level of safety where identified requirements cannot be satisfied by the system design;
- Evidence that no unpredicted impact will occur to other components of the system as a result of the change;
- Evidence that operating and maintenance procedures are acceptable for routine operation.

1.6 **Submission of Safety related change assurance documentation**

1.6.1 The safety assurance documentation produced that addresses, but is not limited to, the foregoing should be submitted to SRG if requested, following notification of the intent to introduce the change (959). Typically the submitted documentation may take the form of several sequential parts. The following provides **guidance** and **expansion** of each typical area.

1.6.2 **System description, Requirements and Hazard Identification**

1.6.2.1 This should contain the reason for and an overview of, the proposal and intended changes, together with an identification of the safety objectives and regulatory requirements, which must be satisfied, including identification of approval under the ANO.

1.6.2.2 A description of the operational and functional requirements should be included to define why the change is needed and what the end result should be.

1.6.2.3 A risk assessment should be carried out to identify hazards associated with the change and assess their impact. This may result in additional safety requirements which will remove or mitigate the identified hazards. This process may need to be repeated at a later stage if the design solution does not satisfy all requirements that have been identified.

1.6.2.4 Any assumptions that have been made should be clearly stated and justified.

1.6.2.5 It should be clearly stated who is responsible for the management and implementation of the change to current operations.

1.6.3 Justification of selected system or operational change

1.6.3.1 It should be demonstrated how the selected solution to the required change will meet the identified safety, operational, legislative and functional requirements, during installation, commissioning and operational deployment.

1.6.3.2 This may include a high level overview of the new system with lower level detail examining safety related areas of design. The justification should consider any features of the design which are not included in the operational or functional requirements but may still affect system safety. Any such features will need to be mitigated, for example, by disabling a feature or instituting a procedure to preclude the feature being invoked.

1.6.3.3 In many cases, it will be necessary for the service provider to obtain assurance from equipment suppliers that any assumptions that have been made are valid. Reference should be made to pertinent sections of CAP 670, particularly when seeking assurances involving software or system installations.

1.6.3.4 Any identified safety requirements that cannot be satisfied by the selected solution should be clearly described and mitigated as appropriate, in the safety documentation.

1.6.4 Physical integration and Handover into Routine Operation

1.6.4.1 The safety assurance documentation should describe how the change will be safely integrated into current operations. Any risks introduced by integrating the new system should be identified and mitigation arguments presented.

1.6.4.2 Assurance that all staff, including contractors, involved in the change, are competent to perform their task, should be provided. The documentation should describe any operational training and familiarisation which is required and provide assurance that it will have taken place prior to introduction to service.

1.6.4.3 Operational and support procedures necessary during the introduction of the change should be described. In many cases it may be necessary to include reversion procedures to be followed if some unforeseen problem prevents the change being completed.

1.6.4.4 The documentation should include a summary showing that all hazards identified in the safety assessment have been addressed and that the system will be safe for operational use.

1.6.4.5 The safety assurance documentation should provide a description of the steps to be taken during Operational deployment or handover of the change and those required for its continued operation. This should include the satisfactory completion and recording of any test results.

1.6.4.6 This should also include a description of any engineering, maintenance, support or operational tasks. It should be demonstrated that any instructions to be followed by ATS staff will provide sufficient guidance for safe operation.

1.6.4.7 Following the acceptance of the submitted safety assurance documentation it should be possible for ATSSD to grant approval for operational use / deployment of the change.

1.6.5 **Post Operational activity**

The safety assurance documentation should be retained for the life of any part of the system to which it relates. Subsequent changes can then be assessed against the safety, operational, legislative and functional requirements which were originally identified.

1.6.6 **Safety Assurance Documentation presentation guidance**

1.6.6.1 The Documentation should be uniquely identifiable.

1.6.6.2 A system that defines the status of the document should be implemented. This can usually be achieved by a version numbering scheme. It is important that the document clearly indicates whether it is in draft form or has been accepted by the CAA and should provide a point of contact able to confirm the validity of the version number.

2 Risk and Hazard Assessment guidance

NOTE: More detailed guidance on Risk Assessment and Mitigation is available in the Eurocontrol publication ESARR 4.

2.1 **Risk Assessment guidance**

2.1.1 The generic risk assessment process can be summarised as follows:

- Systematically identify all possible hazards to aircraft
- Evaluate the seriousness of the consequences of each hazard occuring.
- Evaluate the probability of each hazard occuring.
- Determine whether the consequent risk of each hazard occuring is acceptable. If not, take action to reduce the risk to a tolerable level by reducing the severity of the hazard or the probability of it arising.

2.1.2 A brief description of the methods and tools used should be included.

2.2 **Hazard Identification guidance**

Initially, a high level assessment of the reasonably foreseeable hazards should be carried out. Suitable techniques might include:

- Checklists:

  Review experience and available data from accidents, incidents or similar systems and draw up a hazard checklist. Checklists identify potentially hazardous areas which will require further detailed evaluation.

- Group Review:

  This may be a true brainstorming session or may be based on a review of the checklist. The group should consist primarily of people with as wide a background as possible and chosen for their relevant experience and competence.

2.3 **Evaluate the Seriousness of the Consequences of the Hazard Occurring**

2.3.1 The consequence of each identified hazard occurring shall be assessed for its effect on aircraft safety. A number of criticality classifications are in common use or a specific scheme may be developed by an individual service provider.

2.3.2 Figure 2.1 provides one recognised safety criticality classification scheme (derived from JAR 25).

2.3.3 Figure 2.2 expands this classification scheme into one which is more appropriate to the ATS environment.

2.4 Consider the Chances of it Happening

2.4.1 The probability of occurrence can be defined in both qualitative and quantitative terms.

2.4.2 Numerical (quantitative) methods may be required to support further the analysis of systems which have the potential to produce catastrophic or hazardous results. For lower levels of classification of risk, qualitative methods will often produce equally valid and acceptable results.

2.4.3 It will be noted that many of the hazards identified are acceptably mitigated by the application of existing Standards, regulations, procedures or practices.

2.4.4 Figure 2.3 illustrates a typical relationship between qualitative and quantitative probability of occurrence.

2.5 Determine Whether the Consequent Risk is Tolerable

2.5.1 Once the severity of a hazard has been assessed and the probability of it arising has been estimated, a judgment can be made on whether the consequent risk is acceptable or not.

2.5.2 Common sense dictates that a major consequence of an undesired event with a high probability of occurrence is unacceptable, however it may be tolerable if the probability of occurrence is very low although it may be undesirable.

2.5.3 The process of judging tolerability of risks and the results can be presented in tabular form as illustrated in Figure 2.4.

2.6 Actions to Reduce the Severity of the Hazard or the Probability of It Arising to Reduce the Risk to a Tolerable Level (Managing Risks)

2.6.1 Where the table indicates that the risk is currently unacceptable, action must be taken to reduce the probability of occurrence and/or the severity of the hazard. If neither mitigating measure is available, the system clearly does not satisfy the safety requirements.

2.6.2 In any process where judgment is applied there will be situations where the tolerability is not clearly defined. An issue which falls into this area of uncertainty, generally referred to as being 'as low as reasonably practicable' is likely to require the endorsement of the individual ultimately accountable for system safety before implementation.

Fig 2.1 Safety Criticality Classification (JAR 25)

Classification	Catastrophic	Hazardous	Major	Minor
Results in one or more of the following effects	• the loss of the aircraft • multiple fatalities	• a large reduction in safety margins • physical distress or a workload such that the flight crew cannot be relied upon to perform their tasks accurately or completely • serious injury or death of a relatively small proportion of the occupants	• a significant reduction in safety margins • a reduction in the ability of the flight crew to cope with adverse operating conditions as a result of increase in workload or as a result of conditions impairing their efficiency • injury to occupants	• nuisance • operating limitations: emergency procedures

NOTE: This table is included to illustrate one possible classification scheme. The actual classification used in a safety assessment must be indicated in the safety assurance document

Fig 2.2 Safety Criticality Classification expanded for the ATS environment

Classification	Catastrophic*	Hazardous	Major	Minor	Negligible
Results in one or more of the following effects	• ATC issues instruction or information which can be expected to cause loss of one or more aircraft (no reasonable and reliable means exists for the aircrew to check the information or mitigate against the hazards) • continued safe flight or landing prevented	• the ATC separation service provided to aircraft that are airborne or are inside a runway protected area in one or more sectors is suddenly, and for a significant period of time, completely unavailable • provision of instructions or information which may result in a critical near mid-air collision or a critical near collision with the ground • many losses of acceptable separation possible	• the ATC separation service provided to aircraft that are airborne or are inside a runway protected area in one or more sectors is suddenly, and for a significant period of time, severely degraded or compromised (e.g. contingency measures required or controller workload significantly increased such that the probability of human error is increased) • the ATC separation service provided to aircraft on the ground outside a runway protected area is suddenly, and for a significant period of time, completely unavailable • provision of instructions or information which may result in the separation between aircraft or aircraft and the ground being reduced below normal standards • No ATS action possible to support aircraft emergency	• the ATC separation service provided to aircraft that are airborne or are inside a runway protected area in one or more sectors is suddenly, and for a significant period of time, impaired • the ATC separation service provided to aircraft on the ground outside a runway protected area is suddenly, and for a significant period of time, severely degraded • ATS emergency support ability severely degraded	• no effect on ATC separation service provided to aircraft • Minimal effect on ATC separation service provided to aircraft on the ground outside a runway protected area • Minimal effect on ATS emergency support ability

* It is not obvious that such a severe failure mode exists with the current UK ATC practices and systems but it may be possible in the future

NOTE: This table is included to illustrate one possible classification scheme. The actual classification used in a safety assessment must be indicated in the safety assurance document.

Fig 2.3 Probability of occurrence definitions

Probability of Occurrence classification	Extremely improbable	Extremely remote	Remote	Reasonably probable	Frequent
Qualitative definition	Should virtually never occur in the whole fleet life	Unlikely to occur when considering several systems of the same type, but nevertheless, has to be considered as being possible	Unlikely to occur during total operational life of each system but may occur several times when considering several systems of the same type	May occur once during total operational life of a single system	May occur once or several times during operational life
Quantitative definition	$<10^{-9}$ per flight hour	10^{-7} to 10^{-9} per flight hour	10^{-5} to 10^{-7} per flight hour	10^{-3} to 10^{-5} per flight hour	1 to 10^{-3} per flight hour

The table above is reproduced from JAR 25 and is specifically related to the probability of an event occurring during flight. It is considered that the definitions are equally valid for aircraft movements at an aerodrome or aircraft flights through an ATC airspace sector.

NOTE: This table is included to illustrate one possible classification scheme. The actual classification used in a safety assessment must be indicated in the safety assurance document.

Fig 2.4 Example Tolerability Matrix

Severity					
Catastrophic	Review	Unacceptable	Unacceptable	Unacceptable	Unacceptable
Hazardous	Review	Review	Unacceptable	Unacceptable	Unacceptable
Major	Acceptable	Review	Review	Review	Review
Minor	Acceptable	Acceptable	Acceptable	Acceptable	Review
	Extremely improbable	Extremely Remote	Remote	Reasonably probable	Frequent

NOTE: This table is included to illustrate one possible classification scheme. The actual classification used in a safety assessment must be indicated in the safety assurance document.

APP 02 Approval of Maintenance Arrangements (AMA)

1 Introduction

Under the terms of Article 88 (1) of the Air Navigation Order, an Air Traffic Control Service is required to have CAA approval which includes consideration of maintenance and other arrangements as specified in Article 88 (2).

2 Safety Objective

That equipment maintenance arrangements are adequately safe to ensure ATM facilities remain fit for purpose (1685).

3 Acceptable means of compliance

3.1 The ATS Provider should detail the maintenance arrangements employed at the ATS facility (1686).

3.2 Acceptance of the detail will facilitate Approval of the maintenance arrangements.

3.3 The detail could be presented as part of the SMS, any approval being included in the ATS Unit approval or as an Exposition leading to the granting of a dedicated approval certificate.

NOTE: The term 'maintenance' includes the operation, regular maintenance, repair, modification, overhaul and decommissioning of ATS equipment.

3.4 The responsibility for the safety adequacy lies with the person in charge of the ATS facility (1687). Where any or all maintenance is carried out by subcontractors on behalf of the person in charge, any safety argument written by the subcontractor shall be considered as if endorsed by the person in charge (1688).

4 Person responsible for the Safety adequacy of Maintenance Arrangements

4.1 To ensure compliance with the safety objective, the person in charge shall consider the safety implications of the organisation structure and its maintenance tasks (1689).

4.2 The person in charge is defined as the person who meets the following criteria:

a) Is a legal entity in charge of the equipment being maintained.

b) Has the technical competence to understand the maintenance arrangements issues.

c) Has the authority to act should changes be necessary to any of the maintenance arrangements.

4.3 The equipment or systems of interest are only those relating to ATM facilities.

5 Typical aspects for which Safety Adequacy should be considered

5.1 Formal Control of Documentation

The person in charge should consider whether documents are traceable and endorsed by the organisation (1690). Typical methods of ensuring this cover inclusion of:

a) Organisation Name and Business Address.

b) Document Title.

c) Date.

d) Signed authorisation of document by person in charge.

e) Reference Number.

f) Amendment record.

5.2 General Organisational Aspects

Statements on safety adequacy should include the following subjects (1691):

a) Organisation Chart (incl. interfaces and aerodrome licence holder).

b) Key personnel:

  i) Terms of reference.

  ii) Responsibilities (including responsibility to consider safety aspects of organisational changes).

  iii) Authority to act.

c) Description of method for considering safety aspects for additional equipment or changes to existing equipment.

5.3 Documentation Arrangements

Statements on safety adequacy should include the following subjects/documents (1692):

a) Responsibility for control of documentation, including amendments and out of date versions.

b) Reference documents held or readily available, e.g.CAP 393 (the ANO), CAP 670, ICAO Annexes.

c) Local documents in use, e.g.

  i) Log books.

  ii) Maintenance programme.

  iii) Maintenance schedules.

  iv) Modification records.

  v) Equipment handbooks.

d) Staff instructions:

Safety adequacy of the arrangements or procedure for:

i) taking equipment out of service.

ii) returning equipment to service.

iii) issuing a NOTAM.

iv) the control of removable archival media (CAP 670, part C, Com 01 refers).

v) the action to take in the event of an aircraft accident.

vi) the conduct of flight checks.

vii) the control of access to sites established for the purpose of ATS provision.

e) Documentation for software version control.

viii)

5.4 Maintenance Arrangements

The safety adequacy of the following arrangements should be considered (1693):

a) Assurance that all Safety related ATM facilities are covered, including:

i) Organisation responsible for each level of maintenance.

ii) Frequency of maintenance for each equipment, i.e. daily, weekly etc.

b) Level of maintenance.

c) Selection and control of contractors/subcontractors, including declaration on disclosure of information obtained during inspections or audits by SRG to the person in charge. It is the responsibility of the person in charge to ensure that the subcontractor is capable of carrying out the maintenance to a satisfactory standard and where appropriate of providing the necessary ongoing support.

d) Programme of preventative maintenance.

e) Flight checking arrangements, including:

i) Person responsible for the control of flight checking.

ii) Equipment subject to regular flight calibration checks.

iii) External agency carrying out flight checks.

iv) Programme of checks applicable.

v) Instructions to staff for the conduct of flight checks and analysis of the results.

vi) Person responsible for notifying SRG of delays or failures of flight checks.

f) Description of records of preventative maintenance, faults, repairs and modifications.

g) Use of maintenance schedules.

h) Records of readings produced.

i) The production of commissioning (baseline/red) figures and the need to notify SRG of changes to these figures, particularly ILS monitor parameters.

j) Modification control and authorisation, and approval.

k) Engineering on call and call out arrangements.

5.5 Maintenance Support Arrangements

The safety adequacy of the following arrangements should be considered (1696):

a) Service Agreement with any third party providing maintenance or installation services.

b) Definition and control of any pertinent critical and sensitive areas.

c) Spares policy; where necessary expand for individual systems or equipment.

d) Spares storage.

e) Test equipment policy, provision, control, calibration and review.

f) Equipment and System configuration control; build state, modular serial number and modification status.

g) Physical and technical safeguarding of radio installations.

h) Radio sites protection from electrical interference.

i) Workshop facilities.

j) Service level agreements for external services.

5.6 Competency of Personnel

The safety adequacy of the following arrangements should be considered (1697):

a) Number of staff committed to maintenance and repair programme.

b) Staff certification schemes and policy.

c) Staff qualification, competence, specialisation and recency.

d) Staff training policy and plans.

e) Staff training and competency records.

f) Supervision of ATS contracted staff.

6 Personal Technical Certificates

In the absence of an alternate and accepted competency scheme the Personal Technical Certificate scheme will apply (1698).

6.1 Personal Technical Certificates (PTCs) are issued to appropriate engineering personnel (1699).

6.2 **Group Rating**

The certificates specify the equipment that an individual is qualified to maintain (1700). The certificates are authorised by the Regional Inspector based on an individual's training and experience.

Table of Group Types

R/T Comms and/or Ground-Ground Comms
Data Comms
Recorder Systems R/T
Recorder Systems Radar
ILS
MLS
DVOR/VOR
NDB
DF
DME
IRVR
Primary Radar Sensor
Secondary Radar Sensor
Radar Displays and Processing
General Data Processing and Computer Techniques
CCTV

6.3 **Type Rating**

6.3.1 The certificates also detail specific equipment types an individual is competent to maintain. It is the responsibility of the senior engineer at a particular location to assess and certify competence on specific equipment. Where staffing may be at the level of one individual, the Regional Inspector may certify competence.

6.3.2 Specific equipment ratings also include the maintenance actions an individual is competent to perform. The following maintenance levels will be specified (1701):

Level 1 Front panel maintenance including switching and lamp or fuse changing.

Level 2 In depth preventative maintenance, problem solving and repair and authority to return to service.

Level 3 Major overhaul and refurbishment.

6.3.3 Specific equipment type ratings are location dependent.

6.4 **Proficiency Record**

Provision is made in the certificates for a record of an individual's proficiency. This may be used to record how often an individual performs maintenance duties on specific equipment and / or lapses in competency on specific equipment.

7 Inspections and Audits

The Adequacy of Maintenance Arrangements will be subject to audit by ATSSD representatives from the Regional Office or the En-Route Regulation section as appropriate (1702).

APP 03 The Approval of an Air Traffic Control Unit

1 Air Traffic Service Facility Approvals

1.1 Prior relevant Approval for any Air Traffic Service supporting infrastructure shall be obtained before Approval under Article 88 is granted (78).

1.2 The Provider must be prepared to comply with Article 105 in respect of aeronautical radio station records prior to applying to the CAA for Approval under Article 88.

2 Nomination of Provider and Provider's Representative

2.1 The aerodrome or other authority shall nominate a Provider of the Air Traffic Control service (79). Within the Provider's organisation a post and post-holder who will act as the Provider's Representative shall be identified to the CAA (80).

NOTE: Three examples may help to clarify this:

a) An Aerodrome Authority may nominate a contractor as Provider (the legal person) and the Representative (an individual) who may be the contractor's General Manager, the SATCO or Manager ATC depending on the size of the operation.

b) An alternative may be that the Aerodrome Authority employs the ATC staff directly. In this case the Aerodrome Authority's company is the Provider and the Representative would probably be the person in charge of the ATC unit.

c) The provider of an Area Control Centre should nominate the ACC General Manager.

2.2 The approval document will be sent to the Representative.

3 Initial Approval of an Air Traffic Control Unit

3.1 A potential Provider seeking Approval for the provision of an Air Traffic Control Service shall apply to the CAA for assessment (81). A minimum of 60 days notice is required (82). Where appropriate the applicant should cross refer to any pertinent Safety Assurance Documentation that exists as part of the applicant's SMS (83).

3.2 A potential Provider shall identify to the CAA those areas where his unit cannot comply with CAP 670 Air Traffic Services Safety Requirements and CAP 493 Manual of Air Traffic Services Part 1 (84). Arguments should be presented in mitigation of the deficient areas (85).

3.3 Following application for Approval there will be a period of consultation during which information may be provided by the CAA to assist the smooth passage of the Approval. Visits may be made by CAA staff. A timetable of Inspections will be arranged. These inspections must be satisfactorily completed before an Air Traffic Control Service may be provided (86). The purpose of the inspections is to enable the potential Provider to demonstrate to the CAA that the unit meets the required standards.

3.4 Following a successful application the Provider will be granted an Approval to operate. This Approval may specify conditions.

3.5 Following an unsuccessful application the CAA will indicate the areas which require improvement before Approval can be granted.

4 Maintaining Air Traffic Control Unit Approval

4.1 The Provider shall inform the CAA immediately, in writing, when he considers he is unable to meet the terms of the Approval, if the Air Traffic Control Service is being terminated or if the Approval is no longer required (87).

4.2 If a unit does not meet the required standards the Approval may be varied, suspended or revoked. The variation may specify conditions which will place restrictions on the operation of the Air Traffic Control unit. Any conditions will be removed when the required standards are achieved.

5 ATSSD Regional Office and En-Route Regulation Responsibilities

5.1 The Regional Offices are responsible for overseeing the standards of civil units at aerodromes in the UK. En-Route Regulation is responsible for overseeing the standards of civil En-Route Units and Facilities. Included in this task are ATS licensing aspects, for example certification of competency, inspection and auditing of ATS units and the approval of equipment and procedures used in the provision of an ATC service.

5.2 The Regional Offices (RO) are based in three areas: Southern RO at Gatwick, Central RO at Manchester, and the Northern RO at Stirling, with En-Route Regulation (ERR) located at Aviation House, Gatwick.

5.3 ATSSD will become involved at an early stage in any application to establish an Air Traffic Control unit. This involvement will continue throughout the life of the unit.

6 Additional Information

6.1 A Provider of Air Traffic Control Services who objects to any decision by the CAA to refuse an application, to grant it in terms other than those requested by the applicant or to vary, suspend or revoke an Approval may, under Regulation 6 of the Civil Aviation CAA Regulations 1991, request that the case be decided by the CAA.

6.2 Nothing in this document exempts any person from complying with any other relevant legislation (such as the Health and Safety at Work Act, Building and Planning Regulations) pertaining to the provision of facilities or the installation of equipment.

6.3 The CAA reserves the right to require a Provider to install any equipment or facilities or to apply any conditions or procedures not specifically mentioned in this publication.

APP 04 Temporary ATC Units

1 Introduction

1.1 This document takes into account the following:

a) The short-term nature of the need.

b) The requirement for flexibility. It is recognised that some special events comprise helicopter operations only, others comprise fixed wing operations only and some are a combination of both.

c) The need to achieve suitable levels of safety at reasonable cost.

1.2 All Air Traffic Controllers are to be appropriately licensed and validated (88).

1.3 This document must be read in conjunction with CAP 670 Part B, Section 1 document APP 03. Only those areas where it has been necessary to make modifications to standard requirements have been mentioned and all other requirements remain.

1.4 In this document it is assumed that there will be no night operations. If the applicant expects that there may be night operations then this must be clearly indicated on the initial application (89). The CAA will indicate any extra requirements after due consideration.

1.5 Exceptionally, the CAA may grant one Approval to cover a number of events at the same location throughout the year, e.g. a racecourse. Any contractual arrangements between the applicant and the organiser(s) of the events must have been concluded at the time of application. When one Approval has been granted to cover all the events at a single venue for the year a Condition will be that the same Provider, location of the VCR, facilities etc are used on each occasion.

2 General

2.1 A person seeking approval for the temporary provision of an Air Traffic Control Service must give a minimum of 90 days notice (90).

2.2 Applicants must clearly identify on initial application any areas where they believe they will be unable to comply with the provisions of CAP 670 Part B, Section 1 document APP 03 (91).

2.3 This document defines the requirements of the Air Traffic Services Standards Department of the Civil Aviation Authority. Further information regarding the conduct of special events may be obtained from the following documents:

a) Flying Displays – A Guide to Safety & Administrative Arrangements (CAP 403).

b) Aeronautical Information Circular published prior to the commencement of each season.

c) Licensing of Aerodromes (CAP 168).

d) Air Traffic Control Licensing (CAP 670 Part D Human Resources).

3 Staffing Requirements – Ref: CAP 670 Part D, Annex B

Applicants are urged to enter into early discussions with the relevant Principal Inspector of Air Traffic Services for information and guidance, particularly if they consider they will be unable to comply with any aspects of the Scheme for the Regulation of the hours of civil ATCOs in the UK.

4 Communication – Ref: CAP 670 Part C, Section 1

The CAA will consider such factors as the ambient noise levels affecting the Air Traffic Control unit and the complexities of the task. Applicants should pay particular attention to the following:

a) The proximity of aircraft operations and especially helicopter operations.

b) The noise caused by air conditioning units.

c) The establishment of 'commentary positions' within the ATC unit.

d) The use of the ATC unit for other tasks such as collection of landing fees, pilot briefing etc.

5 Surface Wind Indication – Ref: CAP 670 Part C, Section 3

5.1 Proof will be required that the displays have been calibrated recently by a person competent to perform the calibration.

5.2 Sensors: The sensor(s) should be located to comply with the CAA's current siting and exposure requirements as described in CAP 670, Part C, Section 3 document MET 04, and Annex A to document ATC 01 in Part B Section 2 (92).

5.3 A less stringent requirement employing sensors and well-positioned windsleeve(s) may be acceptable. Windsleeves should be positioned on the aerodrome so as to be visible from all directions (93), they should be free from the effects of any disturbances caused by nearby objects (94) and they should be sited so that at least one sleeve is visible from each take-off position (95). Windsleeves must meet the requirements of CAP168, Licensing of Aerodromes (96). The applicant must submit diagrams showing the layout of sensors/windsleeves on the aerodrome (97).

6 Pressure Setting Information – Ref: CAP 670 Part C Section 3

The stated accuracy levels may be relaxed for special events. Proof will be required that the equipment has been calibrated together with any correction table by a person competent to perform the task.

7 Visual Control Room – Ref: CAP 670 Part B, Section 2, ATC 01

Some mobile and temporary VCR windows are prone to problems associated with reflections and condensation. Applicants should pay particular attention to the avoidance of such problems (98).

8 Manual of Air Traffic Services Part 2 – Ref: CAP 670 Part B, Section 2, ATC 02

8.1 A Manual of Air Traffic Services (MATS) Part 2 containing local instructions is to be prepared (99). All such instructions shall be clear, unambiguous and in a logical order (100).

8.2 A title page shall be used to identify clearly the unit, location and event to which the instructions relate (101).

8.3 A contents page is required (102). Section dividers are to be provided to emphasise different groups of information for quick reference (103).

8.4 The Provider is required to lodge a copy of the unit's MATS Part 2 with the CAA (104) together with the application for Approval (105).

8.5 The Provider shall ensure that the MATS Part 2 is current and accurately reflects the procedures at that unit for that particular event (106).

8.6 If the MATS Part 2 differs in any way from previous submissions the Provider is to indicate clearly the variations and the reasons for them (107).

8.7 Any charts, diagrams, maps or schematics included in the MATS Part 2 shall be identical to those submitted to aircrew as part of their briefing documents (108).

8.8 Any letters of agreement applicable to the event shall be included in a separate section marked 'Letters of Agreement' (109).

8.9 Blank pages are to be marked 'Intentionally Blank' (110).

8.10 Particular care should be taken to ensure the correctness of any telephone numbers connected with a particular event. In the interests of easy and effective amendment the applicant may deem it appropriate to place relevant telephone numbers on a clipboard as well as in the MATS Part 2.

8.11 Instructions applicable to any 'feeder sites' which are associated with the event shall be submitted as part of the unit MATS Part 2 (111). If any such site is positioned at an airfield which already has an approved ATC unit the Temporary Operating Instruction for the 'feeder site' unit's MATS Part 2 shall also be forwarded simultaneously with the Special Event unit's instructions (112).

9 Watch Log – Ref: CAP 670 Part B, Section 2, ATC 02

An Air Traffic Control watch log shall be maintained in accordance with MATS Part 1 (113).

10 Other Documents – Ref: CAP 670 Part B, Section 2, ATC 02

In addition to the MATS Part 2 the minimum further documents to be held on the unit are as follows:

a) Manual of Air Traffic Services Part 1 (CAP493) (114).

b) Approval of Air Traffic Control Units (CAP 670 Part B, Section 1, document APP 03) (845).

c) Flying Displays – A Guide to Safety & Administrative Arrangements (CAP403) (846).

d) NOTAM and Aeronautical Information Circulars pertinent to the unit and its operation (847).

e) Any briefing material supplied to participating pilots/aircrew (848).

f) Any other document required by the CAA or by another relevant authority or body, as directed (849).

11 Other Records

The initial application must give an estimate of the total number of proposed aircraft movements for the event including an approximate breakdown according to type (i.e. fixed wing, rotary wing, balloon etc) (115). Within 90 days after the event the actual number of aircraft movements by day and type is to be forwarded to the CAA (116).

Part B, Section 2, Air Traffic Control

ATC 01 ATC Support Systems and Facilities

NOTE: This document should be read in conjunction with document COM 05 Information and Alerting Systems (Part C Section 1. Communication).

1 Operations Rooms

1.1 Operational Positions

1.1.1 The Air Traffic Control operational requirement will dictate which, and how many, operational Air Traffic Control positions are required to enable a unit to provide a service for the safe and efficient conduct of flight. The CAA must be satisfied that the type and number of operating positions is adequate. Providers of Air Traffic Control services will have to take into consideration the requirements of the Regulations of Controllers' Hours.

1.1.2 The volume of traffic to be handled and the complexity of operations will determine the number of control positions appropriate for the unit.

1.1.3 The equipment and layout of operations rooms must be ergonomically designed to assist the staff in their task (8). Undue twisting or stretching can detract from the primary task.

1.1.4 Positioning of Visual Display Units should take into account any reflection or glare which is likely to affect the operation of the equipment (9).

1.1.5 Operational support equipment is any equipment or facility used by a controller in the course of his operational duties. Examples of such equipment are aerodrome lighting control panels, data displays, surface wind/IRVR/met displays. Providers shall notify the CAA when operational support equipment is installed, modified or removed (10). This action is to be taken whether or not the facilities require Approval under other Articles of the Order (11).

2 Information Systems

2.1 Meteorological Information

A display clearly showing current and relevant meteorological information shall be provided (12).

2.2 Surface Wind Indication

Displays

a) Control positions are to be equipped with surface wind indicator(s) simultaneously showing speed and direction (13).

b) At aerodromes supporting scheduled journeys (as defined in the Air Navigation Order, Article 129) by aircraft whose maximum total weight authorised exceeds 5,700 kg and such other aerodromes as the CAA may direct, control positions are to be equipped with a surface wind indicator capable of giving surface wind information in accordance with ICAO Annex 3, Meteorological Service For International Air Navigation (see Annex A) (14).

c) Where control positions are adjacent it may be possible to share displays.

2.3 **Sensors**

Surface wind sensors are to be located on the manoeuvring area in compliance with the CAA's current siting and exposure requirements as described in Annex B (15).

2.4 **Pressure Setting Information**

A barometer, or a method of obtaining pressure setting (for example from the aerodrome Meteorological Office) (16), and a pressure setting indicator is to be provided (17). The required accuracy of measurement or observation shall be ± 0.5 mb (hPa) (18). Detailed information can be obtained from ICAO Annex 3. Additional requirements may be specified for equipment used in the production of METARS. Suitable training in the use of meteorological equipment must be provided (19).

2.5 **Serviceability Indicators**

There must be either:

a) An indicator showing the serviceability status of any navigation or approach aid provided for the use of aircraft flying to or from the aerodrome (20), or

b) A method of communicating with the engineer responsible for the serviceability of such equipment (21). This method of communication is to be detailed in the MATS Part 2 (22).

3 Visual Control Room (VCR)

3.1 The Visual Control Room shall be sited so as to permit the controller to survey those portions of the aerodrome and its vicinity over which he exercises control (23). The most significant factors contributing to adequate visual surveillance are the siting of the tower and the height above ground of the Visual Control Room.

3.2 Providers should consider the impact of control tower building developments on other CAA requirements such as those of the aerodrome licence (e.g. safeguarding).

3.3 Providers must safeguard the view from an existing Visual Control Room from obstruction (24). The view from an existing Visual Control Room might be obstructed because of poor site selection, an extension of the manoeuvring area or by the construction of buildings close to the control tower.

3.4 When informed of proposals which may affect the view from the control positions the Provider shall identify operational and functional requirements. From these, safety requirements can be drawn up which will ensure the controllers' view remains unhindered as described above. In setting these safety requirements Providers should consider such things as:

- sight lines from the VCR following the proposed changes.
- the ability of controllers to observe crucial areas of operations such as the runways, taxiways, approaches and circuits.
- the ability to observe the smallest size of aircraft commonly using the aerodrome.
- the ability to observe unusual circumstances or emergencies eg wheel fires.

3.5 The use of electronic aids such as SMR or Closed Circuit Television (CCTV) to enhance the view from the VCR will only be considered for approval in exceptional circumstances.

3.6 Reflections in the Visual Control Room glass and sun or lamp glare through the windows are to be kept to a minimum (25).

3.7 Positioning of Visual Display Units should take into account any reflection or glare which is likely to affect the operation of the equipment (26). This is particularly important in the Visual Control Room.

3.8 Glare-proof shades or blinds which can be raised or lowered may be required for windows.

3.9 Visual Control Room operating positions must permit optimum visibility of ground and air operations' azimuth and elevation (27) whilst allowing the controller to refer easily to all the information on display (28).

3.10 Siting of working positions within the Visual Control Room will primarily be determined by the location of the tower in relation to the manoeuvring area, the most frequently used runway and the approach direction. Secondary considerations are simultaneously occupied operating positions and their functions (control of arriving and departing traffic against ground movements, the clearance delivery position, operation of the lighting panel, etc).

3.11 A pair of binoculars is required (29). Additional pairs may be required for other operational positions in the Visual Control Room.

4 Furniture

4.1 Control room layout should be such that controllers at operational positions are able to operate without distracting one another (30). Staff should be able to use a normal speaking voice when talking to one another, using RTF or telephones irrespective of aircraft or other noise (31).

4.2 Desks and equipment should provide satisfactory working conditions for each controller and assistant and facilitate liaison between them (32).

4.3 Facilities to accommodate manuals and documents, and display information such as NOTAM, weather and royal flights are to be provided (33). Information of a more permanent nature such as instrument approach procedures, topographical maps, telephone and emergency check-lists is to be conveniently located about the position (34).

5 Noise

Ambient noise levels within operations rooms should equate to the 'quiet office' environment (35) (approximately 50 dB(A) – source 'Noise Abatement' by C.Duerden,1972; Butterworth).

6 Lighting

6.1 Suitable minimum or non-glare lighting shall be provided to allow the controller to read and record information (36).

6.2 Lighting in the Visual Control Room must be arranged so that it does not diminish the ability of the controller to survey the aerodrome and its vicinity at night (37).

6.3 Operational lighting should be variable in intensity and direction for maximum flexibility (38).

6.4 Ambient lighting in operations rooms and Visual Control Rooms should be kept to a level consistent with good working conditions and with reflections reduced as much as possible (39). Door openings to lighted adjacent spaces should be screened so that light will not interfere with a controller's vision when doors are opened (40).

6.5 Emergency lighting shall be provided in operational areas in order that controllers will have sufficient light to be able to continue a service in the event of a mains power failure (41).

7 Heating and Air Conditioning

7.1 Air circulation must be sufficiently adequate to ensure that windows in Visual Control Rooms can be and will remain demisted (43); it shall also allow satisfactory ambient working conditions in operations rooms (44).

7.2 A Visual Control Room is normally very exposed to changes in atmospheric conditions and therefore experiences a wide variation of temperatures. Where heated/cooled air is provided it should be kept equally distributed around the Visual Control Room perimeter (45) and operated so as to provide a stable environment (46) and keep windows free from condensation (47).

7.3 It is desirable to provide separate air conditioning for personnel and electrical equipment requiring cooling.

8 Rest Facilities

8.1 Controllers are required to take breaks from operational duty, therefore, adequate rest facilities must be provided (48).

8.2 For low activity Air Traffic Control Units it may be acceptable to provide rest facilities in the Visual Control Room although generally this is not recommended.

8.3 ICAO Doc 9426, the ATS Planning Manual gives much useful guidance on the size, layout and facilities to be provided in rest areas.

Annex A to ATC 01

NOTE: This annex should be read in conjunction with document MET 04 Engineering Requirements for Surface Wind Speed and Direction (Part C Section 3 Surveillance).

1 Surface Wind Indication

1.1 Wind indicators at air traffic control units are to give the best practical indication of the winds which an aircraft will encounter during take-off and landing (49).

1.2 The CAA has accepted the ICAO recommendations in Annex 3 and will, in due course, require compliance at all aerodromes.

1.3 Aerodromes supporting scheduled journeys (as defined in the Air Navigation Order, Article 129) by aircraft whose maximum total weight authorised exceeds 5,700 kg and such other aerodromes as the CAA may direct are required to comply (50).

1.4 The requirements are as follows:

1.4.1 The mean direction and the mean speed of the surface wind is to be measured (51), as well as significant variations of the wind direction and speed (52). Since, in practice, it is difficult to measure the surface wind directly on the runway, surface wind observations for take-off and landing should be the best practicable indication of the winds which an aircraft will encounter during take-off and landing (53).

1.4.2 For reports for take-off, the surface wind observations are to be representative of conditions along the runway (54), and for reports for landing the observations are to be representative of the touchdown zone (55). Surface wind information for take-off and landing is to be representative of conditions at a height of 6 to 10m (20-30ft) above the runway (56). Surface wind observations made for reports disseminated beyond the aerodrome are to be representative of conditions at a height of 6 to 10m (20-30ft) above the whole runway where there is only one runway and the whole runway complex where there is more than one runway (57).

1.4.3 Representative surface wind observations are to be obtained by the use of sensors appropriately sited as determined by local conditions (58). Sensors for surface wind observations for reports for take-off and landing are to be sited to give the best practicable indication of conditions along the runway (eg lift-off and touchdown zones) (59). At aerodromes where topography or prevalent weather conditions cause significant differences in surface wind at various sections of the runway, additional sensors are to be provided (60).

1.4.4 Surface wind indicators relating to each sensor shall be located in the appropriate air traffic services unit (61). Where separate sensors are required as specified above the indicators shall be clearly marked to identify the runway and section of runway monitored by each sensor (62).

1.4.5 The sensor giving the best practicable indication of the surface wind at the touchdown point shall be used for all reports for take-off and landing (63). If this sensor does not give representative winds along the whole length of the runway then the indications from other sensors may be passed when requested by the pilot or when considered appropriate by the controller. Providers are to determine which sensors should be used for each runway or runway section (64).

1.4.6 The averaging period for wind observations shall be:

a) 2 minutes for reports used at the aerodrome for take-off and landing and for wind indicators in air traffic service units (65). The instantaneous surface wind should be available to be given to pilots on request particularly at aerodromes supporting primarily the operations of aircraft whose maximum total weight authorised is 5,700 kg or less (66).

b) 10 minutes for reports disseminated beyond the aerodrome except that when the 10-minute period includes a marked discontinuity in the wind direction and/or speed, only data occurring since the discontinuity is to be used for obtaining mean values, hence the time interval in these circumstances are to be correspondingly reduced (67).

NOTE: A marked discontinuity occurs when there is an abrupt and sustained change in wind direction of 30° or more, with a wind speed of 20 km/h (10 kt) or more, lasting at least 2 minutes.

1.4.7 In reports for take-off and landing, variations in the wind direction shall be given when the total variation is 60° or more with mean speeds above 6 km/h (3 kt) (68); such directional variations shall be expressed as the two extreme directions between which the wind has varied during the past 10 minutes (69). Variations from the mean wind speed (gusts) during the past 10 minutes shall be reported only when the variation from the mean speed has exceeded 20 km/h (10kt) (70); such speed variations (gusts) shall be expressed as the maximum and minimum speeds attained (71). When the 10-minute period includes a marked discontinuity in the wind direction and/or speed, only variations in the direction and speed occurring since the discontinuity are to be reported (72). The variations in direction and speed are to be derived:

a) For non-automated systems from the wind direction and speed indicators or from the anemograph recorder trace if available (73); and/or

b) For automated systems from the actual measured values of wind direction and speed, and not from the 2-minute and 10-minute running averages required under 1.4.6 (74).

1.4.8 In reports for take-off, surface winds of 6 km/h (3 kt) or less shall include a range of wind directions, whenever possible (75).

NOTE: A marked discontinuity occurs when there is an abrupt and sustained change in wind direction of 30° or more, with a wind speed of 20 km/h (10 kt) or more, lasting at least 2 minutes.

1.4.9 Where multiple sensors are installed, the 2-minute time averages of and significant variations in the surface wind direction and speed for each sensor used in reports for take-off and landing are to be monitored by automatic equipment (76).

ATC 02 ATC Documentation

1 Manual of Air Traffic Services Part 2 (MATS Part 2)

1.1 General

1.1.1 Local instructions for each Air Traffic Control unit are to be prepared and should be in the format described below (117). The sections to be included are shown at Annex A (118). These instructions are to be referred to as the Manual of Air Traffic Services Part 2 (MATS Part 2) (119).

1.1.2 A Provider (as defined in CAP 670 Part B, Section 1 document APP 03) is required to maintain a copy of his unit's MATS Part 2 with the CAA (120). All Amendments, Temporary and Supplementary Instructions are to be sent to the appropriate Principal Inspector, Regional Manager ATS Safety Regulation, or the Head of En-Route Regulation, as appropriate (121).

1.1.3 At ATC units not yet working under an approved safety management system, changes to safety related procedures must be identified and approved prior to implementation (122). At ATC units working under an approved safety management system, changes to safety related procedures must be subjected to the provider's safety assessment process. Such changes include revised control procedures, changes to procedures affecting more than one Air Traffic Control unit, changes to the location of controllers or changes in the use or levels of equipment. Applications for approval of procedures must be received by the CAA at least 20 working days prior to the proposed implementation date (123). If Providers are in any doubt as to whether approval is required they should seek guidance from the CAA.

1.1.4 Responsibility for the detailed information provided in MATS Part 2 and other manuals rests with the Provider. This person should be identified to the CAA as one of the Air Traffic service facility key personnel (124).

1.2 Purpose and Content

1.2.1 There should be a policy and arrangements addressing responsibilities, authorities and mechanisms for ensuring that changes to MATS Part 1 are assessed for implications in MATS Part 2 and vice versa (125) and that any non-compliances with MATS Part 1 are alerted to ATSSD (126).

1.2.2 The MATS Part 2 is to provide information which amplifies and interprets at local level the instructions in MATS Part 1 (127). It shall contain all such information and instructions as may be necessary to enable controllers to perform their duties (128). It should not normally repeat instructions already contained in Part 1 but it may be necessary to emphasise a point which has particular local relevance (129).

1.2.3 MATS Part 2 must contain full details of the operations at the unit (130). These include such things as operational procedures, co-ordination requirements, variations to standard separation and details of personnel responsibilities (see MATS Part 1).

1.2.4 MATS Part 2 shall contain the procedures for Message handling from phones, direct lines, teleprinter, fax etc (131).

NOTE: The responsibilities, authority and mechanisms for raising, responding to and distributing the message should be adequately defined.

1.2.5 MATS Part 2 must contain the ATC actions necessary during periods of equipment or operational deficiency (132).

NOTE: This includes:

a) Periods of reduced redundancy.

b) Periods of use of non-preferred Radar or Comms services.

c) Limitations of emergency Radar or Comms services.

d) Taking over tasks from other units.

1.2.6 In addition, the Provider should add any other information which is considered necessary for the safe operation of aircraft under the jurisdiction of the unit (133).

1.3 **Arrangement of Material**

1.3.1 The following paragraphs describe how the MATS Part 2 shall be compiled (134). The section format has proved effective and, in order to maintain a consistent approach, is described in Annex A. Therefore, the section numbers and headings shall be adopted (135) and, where a section is not applicable, the contents page shall be annotated 'not issued' (136).

1.3.2 A list of contents by section and paragraph which, although not exhaustive, covers the requirements of most units is shown at Annex A. The headings should be used as chapter titles but can be arranged and numbered in an order logical to the unit with the insertion of additional subjects as necessary (137). Where entries are made in more than one place then each entry should be cross-referenced to the others (138).

1.3.3 A check-list of pages and a contents page are to be provided similar to MATS Part 1 (139).

1.3.4 Sections, chapters, paragraphs and sub-paragraphs should be numbered (140). This assists the author in structuring the text in a logical manner and aids indexing and cross-referencing.

1.3.5 Every page in the MATS Part 2 is to be headed and numbered (141). If there is no text on a page then that page is to be marked 'Intentionally Blank' (142).

1.3.6 Each copy of a MATS Part 2 should normally bear a serial number and a list of holders should be maintained by the person responsible for issuing amendments (143). Where this system is not used a Provider should have satisfactory alternative arrangements for controlling the issue and amendments of manuals (144).

1.3.7 The Provider shall ensure that the MATS Part 2 is current (145) and reflects accurately the procedures at the unit (146).

1.3.8 Changes, additions and deletions are to be incorporated by the issue of new or additional pages (147). A number of methods can be used to draw attention to changes (coloured paper, briefing notices etc.). New pages are to be dated with the effective date of the new or altered instruction (148). Arrows or a similar system must clearly indicate the changes (149). A system of control should be implemented so that any changes or modifications cannot be inadvertently lost (150) and an accurate historical record is maintained (151).

1.3.9 Supplementary Instructions (S.I.) should be issued:

a) To introduce a change to existing instructions where an explanation or historical background to the subject would be helpful to the reader (152).

b) To cover changes of a permanent nature (153).

c) When an urgent amendment is required between routine amendments (154).

d) To re-emphasise an existing instruction (155).

The Supplementary Instruction should be dated (156) and contain the reprinted pages which can be incorporated into the MATS Part 2 with the minimum of delay (157).

1.3.10 Temporary Operating Instructions (TOI) should be used to notify changes of a short-term nature and NOT for changes to actual procedures (158). For example a TOI would be issued to promulgate the non-availability of a piece of Air Traffic Control equipment. Temporary Operating Instructions should be dated (159).

1.4 Format

The main features of a MATS Part 2 should be:

a) Paper size A4 (160).

b) Hard cover loose leaf binder (161).

c) Divider cards with protruding tabs between sections for quick reference (162).

d) A secure page numbering system (163).

e) The effective date at foot of the page (164).

f) The name of the unit on each page (165).

g) Blank pages to be marked 'Intentionally blank' (166).

h) Text is not to be hand-written (167).

i) A logical paragraph numbering system (168).

j) An Amendment Page showing the amendment status of the document (169).

k) A List of Contents or an Index (170).

1.5 New Air Traffic Control Units

Applicants at units seeking approval are to prepare a MATS Part 2 in accordance with the guidance in this document (171). It shall follow, wherever possible, the contents and format described in the following pages (172).

2 Letters of Agreement

2.1 A Letter of Agreement is a means of formalising matters of operational significance between neighbouring Air Traffic Service units or other interested parties. It should take the form of a bilateral or multilateral agreement concerning procedures which apply only to those party to the agreement (173). An example of a letter of agreement is shown in ICAO Doc 9426, the ATS Planning Manual.

2.2 The procedures which are the subject of the Letter of Agreement are to be approved by the CAA (174) and detailed in the MATS Part 2 (175). To facilitate the approval a copy of the Letter of Agreement is to accompany the application (176). The originals of the Letters of Agreement are to be retained by each of the parties concerned (177).

3 Watch Log

An Air Traffic Control watch log shall be maintained in accordance with MATS Part 1 (178). One log is to be maintained in each operations room where they are not adjacent (179).

4 Retention of Records

ATS records and log books must be retained and disposed of as detailed in MATS Part 1 (180).

5 Other Documents

5.1 In addition to the documents required to be available at operational positions (described in the Manual of Air Traffic Services Part 1, Section 8, Chapter 1, Administration and Licensing Paragraph 7 Publications), the following documents shall be available at an ATC unit:

a) CAP 670 ATS Safety Requirement (181)

b) ICAO Doc 7030/4 Regional Supplementary Procedures (182)

c) ICAO Doc 4444 PANS-RAC (183)

d) ATS Information Notices applicable to ATC units (184)

e) any other document, including safety management system documentation, as required by the CAA (185). Any document so required will normally be specified in the Approval document (186).

5.2 A method of ensuring that all documents required to be held at an ATC unit are correctly amended shall be established (187).

5.3 ATC units approved under Article 88 of the ANO and located at military aerodromes shall hold the following additional documents:

JSP 318 (188)
JSP 318A (189)
Relevant RAF FLIPs (190)
Relevant documents from the RAF ATCEB list (191)

With the agreement of the Regional Manager ATS Safety Regulation, and provided that they are either not relevant to the operational task or a suitable RAF issued equivalent is available, the following documents shall not be required:

Rules of the Air Regulations
Air Navigation (General) Regulations
CAP 168 Licensing of Aerodromes
CAP 680 Aerodrome Bird Control
ICAO Doc 7910 Location Indicators
ICAO Doc 8126 Aeronautical Information Services Manual
ICAO Doc 8400 Abbreviations and Codes
ICAO Doc 8585 Abbreviations of Aeronautical Authorities
ICAO Doc 8643 Aircraft Type Designators
ICAO Doc 7030 Regional Supplementary Procedures (192)

5.4 Military units employing civil ATCOs are to hold documents listed in column (a) of the following table, and hold documents as required by the operational role of the unit listed in column (b) as agreed between the unit and the Regional Manager ATS Safety Regulation (193).

REQUIRED DOCUMENTS (a)	OPTIONAL DOCUMENTS (b)
JSP 318	CAP 168
JSP 318A	CAP 680
RAF FLIPs	ICAO Doc 8126
MATS Pt 1	ICAO Doc 7910
MATS Pt 2	ICAO Doc 8400
ANO	ICAO Doc 8585
UK Integrated AIP	ICAO Doc 8643
AICs	ICAO Doc 7030
NOTAM	Plus Selected documents from RAF ATCEB list
CAP 670	
CAP 413	
ICAO Doc 4444	

Annex A to ATC 02 Manual of Air Traffic Services Part 2

List of Contents by Section

SECTION 1 UNIT GENERAL OPERATING INSTRUCTIONS

CHAPTER 1 ALTIMETER SETTING PROCEDURES

Locally based light aircraft.

Transit aircraft.

QFE Threshold.

Transition Altitude.

Transition Levels.

Minimum Flight Levels.

ASRs.

CHAPTER 2 LIGHT AIRCRAFT AND HELICOPTER PROCEDURES

Responsibilities (ADC or APC).

Entry/Exit Lanes.

Other Routes or Tracks.

Radio Failure Procedures.

Fanstop Procedures.

Rejoin Procedures.

Non Radio aircraft.

CHAPTER 3 INSTRUMENT RATING TESTS AND TRAINING

CHAPTER 4 FLOW REGULATION

As stipulated by parent ACC or adjacent airfields.

CHAPTER 5 NOISE ABATEMENT

MNRs.

Procedures for Aircraft and Air Traffic Control.

Noise complaints – action.

CHAPTER 6 AIRCRAFT DIVERSION PROCEDURES – AIR TRANSPORT

Action by Air Traffic Control.

CHAPTER 7 METEOROLOGICAL INFORMATION

Sources of reports and forecasts.

Local observations by qualified and non accredited observers.

Supply of Special Reports for incidents/accidents.

CHAPTER 8 FLIGHT PLANS

Addressing requirements.

Stored flight plans.

Filed flight plans.

AFTN arrangements.

CHAPTER 9 TRAFFIC DATA DISPLAY

Local flights.

SIDs and radar releases.

Recording of persons on board.

FPS marking.

RWY Blocked indication.

CHAPTER 10 SPECIAL CATEGORIES OF FLIGHT

Responsibility for authorisations.

Small free balloons.

Action when a captive balloon breaks free.

Gliding sites.

Microlites and radio controlled aircraft.

Parachute dropping.

Banner towing.

Helicopter activity.

Royal Flights including safeguarding.

Safeguard aerodromes.

Ambulance flights.

CHAPTER 11 WATCH ADMINISTRATION

Logs and Records.

SRA runs.

Checks, equipment maintenance and serviceability.

Testing of fire alarms and back up communications and logging same.

Vehicles.

Approval of visitors.

CHAPTER 12 LIAISON WITH AIRPORT MANAGEMENT

Airport security.

Customs and Immigration.

Phraseology for detaining aircraft.

CHAPTER 13 EXTENSION OF HOURS

Aerodrome availability.

Liaison with other sections.

CHAPTER 14 NOTAM

Procedure for issue.

CHAPTER 15 ALL WEATHER OPERATIONS

Runway Visual Range.

Maximum Values.

General local instructions.

CAT II/III operations.

Ground power supply system.

Met Information.

Air Traffic Control Procedures.

Air Traffic Control Separations.

GMC.

Records.

Facilities.

CHAPTER 16 CO-ORDINATION WITH ADJACENT AERODROMES

SECTION 2 LOCAL SEPARATION STANDARDS

CHAPTER 1 SPECIAL SEPARATION STANDARDS IFR

Increased longitudinal separations.

Holding patterns.

En route and departing traffic.

Descent procedures in relation to adjacent airways etc.

Wake vortex spacing.

Reduction of IFR separation in vicinity of an aerodrome.

CHAPTER 2 SPECIAL SEPARATION STANDARDS – SPECIAL VFR

Entry/Exit lanes.

SVFR Separation standards.

Weather limitations.

SECTION 3 AERODROME CONTROL

CHAPTER 1 AERODROME CONTROL

Daily checks.

General responsibilities.

Delegated responsibilities.

Selection of runway in use.

Preferential R/W.

Description of airfield eg. runways, taxiways, obstructions, diagram etc.

Use of ATM.

CHAPTER 2 AERODROME OPERATIONS

Co-ordination between Aerodrome/Approach Control and/or parent ACC.

Circuit procedures.

Start up clearances.

Departure clearances.

SIDs.

Land after procedures.

Separation of circuit traffic from IFR approaches.

Training aircraft.

Glider operations on airfield.

Turbulence/wind shear warnings.

Procedures for different or dual runway operations.

Late landing clearances inside 2NM.

CHAPTER 3 AERODROME SURFACE OPERATIONS

Marshalling and manoeuvring areas and a/c parking arrangements.

Airfield surface and lighting inspections.

Abandoned take-off.

Notification of Snow and Ice conditions.

Work in Progress and Grass Cutting briefings, work authorisation permits.

Compass swing.

Engine run-up areas.

ILS calibration – effect of aircraft or vehicles near transmitters.

Control of vehicular traffic and traffic lights on and off airfield and crossing runways.

Snow clearance.

Snowtams.

Tels restricted areas.

SMR.

CHAPTER 4 MEASUREMENT AND NOTIFICATION OF WHEEL BRAKING ACTION

Operation of mu-meter.

Requirement for checks.

Reporting of results.

Records.

Snow, ice and slush tables.

CHAPTER 5 RUNWAY CONTROL UNIT

Responsibilities.

CHAPTER 6 BIRD SCARING AND DISPERSAL

General.

Air Traffic Control procedures.

Bird Inspection.

CHAPTER 7 AERODROME AND OBSTRUCTION LIGHTING

Services available and when used.

PAPI/VASI.

Lighting inspections.

Emergency/standby equipment.

Obstruction lighting.

Light intensity settings and selections.

Contingency arrangements.

CHAPTER 8 AERODROME RESCUE AND FIRE SERVICE

Services available.

Categories of fire cover and examples of largest aircraft type allowed.

Radius of action.

Reduction of available cover.

Action by Air Traffic Control.

Weather standbys.

Communications between RFFS/ADC/Aircraft.

Training Exercises.

SECTION 4 APPROACH CONTROL AND APPROACH RADAR

CHAPTER 1 APPROACH CONTROL

Responsibilities

Liaison with Aerodrome Control.

CHAPTER 2 PROCEDURES FOR IFR TRAFFIC

Information to arriving aircraft.

Non public transport minima, if applicable.

Inbound routes.

Allocation of levels.

Release procedures.

Expected approach times.

Holding and approach patterns.

OCLs.

Missed approach procedures.

Clearance to enter controlled airspace.

Departure clearances.

SIDs.

Speed limits.

CHAPTER 3 CO-ORDINATION

With parent ACC.

Sector responsibility.

With adjacent airfields.

Liaison.

Passing of SSR codes for benefit of another ATSU.

CHAPTER 4 APPROACH RADAR CONTROL

Services and responsibilities.

Delegated responsibilities.

Radar separation minima.

Terrain clearance.

Danger areas. Controlling authority / how to contact in emergency.

Surveillance radar approaches – minimum number per month and logged.

Co-ordination with APC/ADC/ACC.

Radar vectoring area.

Radio and radar failure procedures.

Standby equipment.

CHAPTER 5 AREA CONTROL

Local Procedures.

Co-ordination with appropriate units.

SECTION 5 TELECOMMUNICATIONS

CHAPTER 1 RADIO AIDS AND RTF

Serviceability and maintenance.

R/T procedures.

Recordings and action in event of U/S.

Aircraft radio flight tests.

Vehicle callsigns.

Power supplies and standby equipment.

D/F.

CHAPTER 2 TELEPHONES

Equipment serviceability.

Telephone procedures. Identifying position or person.

Limitation of 'outside' calls.

Press queries etc.

'Off airfield' emergency telephone procedures.

SECTION 6 RADAR TECHNICAL

CHAPTER 1 EQUIPMENT DESCRIPTION AND DATA

General.

Technical description – PSR and SSR.

Controls.

Setting up procedures.

Permanent echoes.

Periodic checks.

Closing down.

Coverage (including diagrams).

Technical specification.

Aerodrome Traffic Monitor.

Surface Movement Radar.

CHAPTER 2 RADAR MAINTENANCE AND UNSERVICEABILITY

Maintenance.

Unserviceabilities.

NOTAM action.

Reasons for fade.

SECTION 7 EMERGENCIES

CHAPTER 1 EMERGENCY SERVICES

General.

Aerodrome grid reference map.

Local area map.

Areas of poor R/T coverage.

Radius of action.

Immediate actions.

Responsibilities of key personnel.

Accidents outside radius of action.

Alerting procedures – emergency categories.

Emergency services access.

Rendezvous points.

Logbook entries.

Meteorological special reports.

Tape impound requirements.

Runway/aerodrome inspection.

Stand down of emergency services.

CHAPTER 2 REPORTING ACTION

General.

Local reporting procedures.

ACC reporting.

Follow up actions.

Other incident reporting actions – AIRPROX, MOR, breaches of regulations, etc.

Oil slick reports.

CHAPTER 3 DEPLETION OF EMERGENCY SERVICES

General.

Reduced coverage.

Notification by emergency services.

Action by ATC.

CHAPTER 4 TRAINING AND TESTING

General.

Routine testing of emergency alarms and communications.

Emergency exercises.

CHAPTER 5 SEARCH AND RESCUE

General.

Local procedures.

Liaison with local services, coastguard etc.

Parent ACC.

Use of emergency frequencies.

CHAPTER 6 HIJACKING

General.

Notification.

Action to be taken.

CHAPTER 7 BOMB WARNINGS

General.

Notification.

Warning whilst aircraft in-flight.

Warning whilst aircraft on ground.

Action to be taken.

SECTION 8 DISRUPTION OF AIR TRAFFIC SERVICES

CHAPTER 1 EMERGENCY OPERATIONS

Bomb Warning/Threats.

Evacuation.

Resumption of ATC Watch.

SECTION 9 GENERAL ADMINISTRATION

CHAPTER 1 WATCH ROSTERS

ATC 03 Emergency or Contingency Facilities

1 Introduction

1.1 At some units, facilities exist to provide an ATC service from an alternative location.

1.2 In practice such an alternative facility is established

1.2.1 to enable an ATC service to be provided for a short time after the unexpected withdrawal of the main facility (the alternative facility may be known as an Emergency ATC unit), or

1.2.2 to enable an ATC service to continue to be provided for an extended period on a planned basis (the alternative facility may be known as a Contingency ATC unit).

1.3 This section provides guidance on the level of facilities to be provided in an Emergency or Contingency ATC unit.

1.4 It is recognised that where an Emergency/Contingency ATC unit is already in existence it may not meet these requirements. When changes are planned to an established facility, the Provider is expected to meet these requirements in respect of the equipment or procedures which are to be changed.

1.5 Where an established Emergency/Contingency unit exists the Provider is recommended to review the facilities provided with respect to the requirements described below and, where practicable, amend them to comply with the requirements.

2 General

2.1 The Provider shall provide to the CAA an operational requirement (OR) for an Emergency or Contingency ATC unit (194). The OR shall describe the maximum period of time for which the alternative facility is designed to be used together with other operational constraints (195).

NOTE: The level of equipment required will be dependant on the OR and will be determined by the period that the alternative facility is to be used and the level of ATC service that is to be provided.

2.2 An Emergency ATC unit shall be equipped with facilities to enable traffic already under the control of the ATC unit either to complete a landing or leave the area of responsibility of the unit in an orderly manner (196).

NOTE: Managers of units wishing to make significant physical or procedural changes to an existing Emergency/Contingency ATC unit or to establish such a facility are advised to enter into early discussions with their Regional Manager ATS Safety Regulation.

3 Documentation

3.1 The OR shall identify any requirements of CAP 670 ATS Safety Requirements that cannot be met from the Emergency/Contingency ATC unit (197). Application for dispensation must be supported by details of the proposed procedures that may mitigate the deficiency (198).

3.2 The OR shall identify any relevant procedures detailed in MATS Part 2 which cannot be achieved from the Emergency/Contingency ATC unit (199). The actions proposed to accommodate the absence of these procedures when operating from the Emergency/Contingency ATC unit shall be included in the OR (200).

NOTE: These actions might include a restriction to movement rates, limiting the number of aircraft taxiing on an area not visible to the controller or restricting certain types of activity to specific weather conditions.

3.3 Any significant variation to the procedures approved for use in the Emergency/ Contingency ATC unit from those used in the main location shall be included in MATS Part 2 (201).

3.4 The procedures to be followed when transferring the provision of ATS from the normal location to the Emergency/Contingency ATC unit, either on a planned or unplanned basis, shall be included in MATS Part 2 (202).

3.5 The procedures to be followed when resuming normal operations shall be included in MATS Part 2 (203).

Part B, Section 3, Systems Engineering

SW 01 Regulatory Objectives for Software Safety Assurance in ATS Equipment

Part 1 Preliminary Material

1 Introduction

1.1 For the Authority to approve an ATS system (people, procedures and equipment) to enter service, arguments and evidence must be available to provide assurance that the system will perform all of its safety related behaviour within the system's defined integrity targets.

1.2 Where equipment is used to provide safety related functions there are three sources from which arguments and assurance evidence can be provided: the system lifecycle, the hardware lifecycle and the software lifecycle. This document defines the assurances to be made available, for the purposes of an approval, from the behaviour of the software and certain aspects of the way in which it has been developed.

1.3 This document assumes that software safety requirements have been derived from a full risk and safety analysis of the system. This will have established the overall safety requirements that have been refined and allocated in the design to software. This is a commonplace system safety process and is described in standards and guidelines such as IEC 61508 Part 1, ARP4754, and Def Stan 00-56.

1.4 This document does not prescribe how the assurance evidence is to be produced or its adequacy argued. International software assurance standards and guidelines, such as IEC 61508 Part 3, RTCA DO178-B/EUROCAE ED12-B, and Def Stan 00-55, when used in conjunction with this document may provide an effective way to produce timely and technically valid evidence to satisfy these assurance objectives.

2 Scope

2.1 This document applies to any ATS system where the Software is needed to fulfil a system safety requirement.

2.2 The objectives in this document only apply to those software requirements that have an impact on safety. These are called Software Safety Requirements in this document.

2.3 This document does not apply to electronic items such as application specific integrated circuits, programmable gate arrays, solid-state logic controllers or software requirements that can be demonstrated not to affect safety.

Part 2 Requirements

3 Safety Objectives

3.1 Prime Objectives

3.1.1 The prime software safety objective to be met for ATS systems that contain software is:

To ensure that the risks associated with deploying any software used in a safety related ATS system have been reduced to a tolerable level (1703).

3.1.2 To achieve this objective it is necessary:

For arguments and assurance evidence to be available which show that the risks associated with deploying any software used in a safety related ATS system are tolerable (1704).

3.2 Sub Objectives

Achievement of the prime software safety objective shall be demonstrated by providing credible arguments and evidence that the following five sub-objectives have been achieved:

A) To ensure that arguments and evidence are available which show that the Software Safety requirements correctly state what is necessary and sufficient to achieve tolerable safety, in the system context (1705).

NOTE 1: These requirements will include requirements to control hazards identified during implementation.

NOTE 2: It is assumed that the system-level safety requirements are derived from a hazard and risk analysis of the ATS environment in which the system is required to operate.

NOTE 3: It is assumed that a necessary and sufficient set of system-level safety requirements exist, which describe the functionality and performance required of the system in order to support a tolerably safe ATS.

NOTE 4: It is assumed that the failure modes which the software must detect and mitigate in order to meet the system safety requirements have been identified e.g. those failure modes associated with: other systems, system-system interactions, equipments, pre-existing software and all user-system interactions.

NOTE 5: It is assumed that the failure modes identified include generic failures relevant to the safety related ATS application, e.g. security threats, loss of communications, and loss of power.

NOTE 6: It is assumed that the failure modes identified (including human errors) are representative of the operational environment for the system and workload on the system operators.

NOTE 7: During the software development process, functions may be introduced which have repercussions on the safety of the ATS system. These will need to be assessed and if necessary, new or changed safety requirements will have to be generated.

NOTE 8: The set of software safety requirements includes all software safety requirements derived or changed during the requirements determination and design processes.

B) To ensure that arguments and evidence are available which show that the software satisfies its safety requirements (1706).

C) To ensure that arguments and evidence are available which show that all Safety Requirements can be traced to the same level of design at which their satisfaction is demonstrated (1707).

D) To ensure that functions implemented as a result of Software Safety Requirements are not interfered with by other functions implemented in the software (1708).

E) To ensure that the arguments and evidence, for the safety of the software in the system context, are from: a known executable version of the software and a known set of software products, data and descriptions that have been used in the production of that version (1709).

For a greater understanding of how the sub-objectives achieve the overall safety objective refer to their derivation provided in Appendix D.

Part 3 Guidance

4 Introduction

4.1 All material from this point is non-mandatory and should only be considered as guidance. This guidance has been included in this regulation for two purposes:

a) To assist Service Providers in evaluating the adequacy of the software assurances, provided by their Systems Integrators and/or Equipment Manufacturers, for the purpose of satisfying the safety objectives mandated by this regulation.

b) To assist Systems Integrators and/or Equipment Manufacturers in providing assurances, for the behaviour of software in their products, that are appropriate for demonstrating compliance to the safety objectives mandated by this regulation.

4.2 Service Providers and/or Equipment Manufacturers are free to propose and use alternative methods of evaluation with the agreement of the Civil Aviation Authority. This guidance is only provided for those Service Providers and/or Equipment Manufacturers that do not wish to propose their own methodology for demonstrating compliance with the safety objectives mandated by this regulation.

5 Guidance on Presenting Arguments and Evidence that the Assurance Objectives have been met

5.1 Credible arguments and evidence should be available to demonstrate the achievement of each of the five assurance sub-objectives defined in section 3. The credible limits and bounds of which are provided in sections 5 to 9 of this document.

5.2 To demonstrate the validity of the arguments and evidence it should be possible to show that:

a) A coherent and convincing argument with adequate supporting evidence is available to claim the achievement of each of the five assurance objectives defined in section 3.

b) For all claims, Direct and Backing evidence are combined into an argument that provides justification for the claim.

5.3 Appendix B defines the terms Direct Evidence and Backing Evidence and the principals and concepts upon which the arguments and evidence should be based.

5.4 This guidance uses the concept of Assurance Evidence Levels (AELs) to relate the criticality of the software safety requirement to the depth and strength (rigour) of evidence required for the assurance of its correct implementation. AELs are explained in detail in Appendix A.

6 Guidance On Credible Arguments And Evidence To Demonstrate Requirements Validity Relating to Objective A

6.1 Direct Evidence of Requirements Validity

To demonstrate the validity of software safety requirements, arguments and evidence should be available that show:

a) The software safety requirements are a valid sub-set of the system-level safety requirements.

b) The software safety requirements adequately specify the required safety behaviour of the software.

c) Each software safety requirement includes either:

   i) A specification for each of the Behavioural Attributes (see Appendix C), or

   ii) A valid argument that the attribute is not applicable

d) All hazardous failure modes of the software have been identified at the Software requirements (AELs 1,2,3,4 & 5), Software internal design (AELs 2,3,4 & 5) and Software source code levels (AELs 4 & 5).

e) All hazardous failure modes identified at each level in the software design or in the software implementation are traceable to a defence (i.e. to a safety requirement for software, hardware or operation) or to a justification that no defence is necessary.

f) The software safety requirements should be specified explicitly and should be set out in such a way as to be easily distinguishable from other requirements.

g) The software safety requirements should be specified in sufficient detail and clarity to allow the design and implementation to achieve the required level of safety.

6.2 **Backing Evidence of Requirements Validity**

To give confidence that the requirements are correct and complete, arguments and backing evidence should be available that demonstrate:

a) The specification notations are capable of supporting the identification of all modes of software failure that cause a system level hazard.

b) The analytic methods and techniques used are appropriate for the attributes of the software safety requirements.

c) The analysis notations are appropriate to the problem domain and representation and allow an adequate analysis of the design.

d) Adequately qualified and experienced staff have applied the analysis techniques.

NOTE: Staff are deemed to be appropriately qualified and experienced if they understand the design notations, and the analysis approach, are experienced in using them and understand the required software safety requirements attributes and the system context.

e) Any tools, used in the analysis processes, have been verified and validated to an appropriate level for the impact of the tool on the software safety requirement.

f) Any tools, used to derive and/or express the software safety requirements, have been verified and validated to an appropriate level for the impact of the tool on the software safety requirement.

g) A process that is independent of the means by which the requirements were derived in the first place has demonstrated the validity of the software safety requirement.

NOTE 1: More than one notation may be used at any given requirements or design level.

NOTE 2: Following the guidance in section 6 'Requirements Satisfaction' should highlight those requirements that are unverifiable. Consequently this section and section 6 may be used to demonstrate that software safety requirements are complete, are valid and their implementation has been verified.

7 Guidance on Credible Arguments and Evidence to Demonstrate Requirements Satisfaction Relating to Objective B

7.1 General Requirements for Evidence of Requirements Satisfaction

a) Arguments and evidence should be available to show that each and every software safety requirement has been satisfied completely and correctly.

b) This guidance only considers evidence made available from the following sources: testing, field service experience or analysis.

NOTE 1: Where field service experience fails to show, or any result of the analyses and tests fails to show, that assurance requirements are met, it should be regarded as evidence that the software is not safe to enter service (unless an argument with supporting evidence is available to justify the software entering service despite the assurance requirements not being met, e.g. architectural mitigation may be provided).

NOTE 2: Different sources of evidence of requirements satisfaction may be offered for different software safety requirements within a component of the application software, provided that it is valid to assess the requirements independently.

NOTE 3: The same evidence may be offered for different software safety requirements or attributes provided that it is valid to assess them collectively.

c) Arguments and evidence of software safety requirement satisfaction should comply with the generic requirements (i.e. for all attributes) of Section 6.2 and 6.3 and the attribute specific requirements of section 6.4 below.

NOTE: It is only necessary to provide evidence of requirements satisfaction for those attributes identified as being pertinent to the software safety requirement.

d) The tables at the start of each section 6.4.1 to 6.4.7 show acceptable sources of direct evidence for each software requirement attribute and AEL. The Primary argument should be based on the source of evidence that is shown CAPITALISED in the table. Where a Secondary argument is necessary it should be based on the source of evidence shown in Lower Case. For a greater understanding of Primary and Secondary arguments refer to Appendix B.

NOTE: Different sources of evidence may be offered for the same attribute of a software safety requirement provided that:

i) The acceptance criteria for each source, when combined, can be shown to satisfy the acceptance criteria for the attribute,

ii) It can be shown that the sources of evidence are independent.

The tables in section 6.4 indicate how this evidence wil be assessed. use multiple columns for a particular AEL (the value of an AEL is the row of the table).

e) Tables 1, 2 and 3 below show how evidence, that the software safety requirements have been implemented completely and correctly, can be collected to an appropriate level of rigour.

Table 1 Test Evidence

AEL	Rigour	
1	Statement -	selection of best practice guidance / standards / tools
	Statement -	all tests meet criteria/justification for failure to meet criteria
	Statement -	verification & validation of tools and procedures
2	Test criteria	
	Test specification	
	Test results	
	Report -	verification of use of standards/guidelines/tools
	Report -	analysis of tool and procedure errors
	Project specific test processes developed and justified	
	Use of formal metrics of test coverage	
3	Report -	verification of test criteria
	Report -	assessment of test results
	Report -	adequacy of test data (including justification for coverage)
	Report -	verification of use of project specific test processes
	Report -	verification & validation of tools and procedures
4	Test assessments performed by independent department	
5	Test assessments performed by independent organisation	

Table 2 Field Service Evidence

AEL	Rigour	
1	Statement -	field service records support claims
	Statement -	SW is relevant to Field service claims
	Statement -	operational environment is relevant to Field service claims
	Statement -	field service records are complete and correct
2	Field service records	
	DRACAS procedure	
	Report -	analysis of tool and procedure errors
3	Report -	analysis of Field service claims
	Report -	analysis of similarity of SW/Justification for differences
	Report -	Analysis of similarity of operating environment/ justification for differences
	Report -	verification of use of DRACAS & supporting tools
4	Assessment of analysis, justification and verification by an independent department	
5	Assessment of analysis, justification and verification by an independent organisation	

Table 3 Analytic Evidence

AEL	Rigour	
1	Statement -	selection of best practice guidance/standards/notations/ techniques/tools
	Statement -	analysis shows criteria are met for all attributes/ justification for failure to meet criteria
	Statement -	verification & validation of tools
2	Report -	analytic criteria including use of formal metrics for criteria coverage
	Results of analysis	
	Report -	verification of use of guidance/standards/notations/ techniques/tools
	Project specific development process developed and justified	
	Staff competency rules and justification	
	Report -	analysis of tool errors
3	Report -	verification of criteria
	Report -	assessment of results
	Report -	assessment of development process (all practicable measures have been taken to ensure the product is free of errors)
	Report -	adequacy of criteria (including justification for coverage)
	Report -	verification of use of project specific development process
	Report -	verification & validation of tools
	Report -	verification of staff competency
4	Assessments performed by independent department	
5	Assessments performed by independent organisation	

NOTE 1: The above items are cumulative; all items for lower AELs should be included with the items for higher AELs.

NOTE 2: Often standards and regulations concentrate on when a technique should be applied, making a decision that above a certain criticality technique A is required and below it is not. In this guidance the emphasis is on the rigour and extent of the activity not whether it should be done or not.

For example it is quite obvious that all systems should be tested, but it is the extent of the tests, their independence and the visibility of the associated test cases and results that vary. At low AELs a statement from a competent organisation that test criteria have been defined according to some systematic best practice is sufficient. At higher AELs the test criteria should be justified and documented with additional reports provided.

The tables above and in section 6.4 capture how the variation in the rigour of evidence with AEL might occur. However it is the demands of the argument being made and what is necessary to provide a convincing case that is the overriding factor. The tables therefore combine a number of different factors. There are changes in the role of 'testing' within the overall argument as other arguments (e.g. analytical ones) take a more prominent role (section 6.4). Also, there are variations in the strength of argument for the testing (e.g. provision of independent oversight) as well as changes to the details of the arguments being made in the tables above (e.g. test criteria are adequate because a certain type of coverage is desired and is being measured). These different factors can interact in a number of ways and it is the overarching need for a convincing and valid argument that should ultimately drive the rigour of the evidence provided.

f) If more than one source of direct evidence is supplied for the attribute of a software safety requirement, backing evidence should be available for each of the chosen sources.

g) Unless an argument can be made that the assurance can be achieved by other means:

   i) Test evidence should be available for each attribute.

   ii) Where Field service experience exists, it should be analysed and available as evidence.

   iii) If statistical testing or field experience is used in a Primary argument then this should be demonstrated at the 95% confidence level.

   iv) If systematic tests are used to demonstrate that a requirement is met, all tests must succeed.

h) Any evidence (e.g. from test, field service or analysis) that contradicts the demonstration of the software safety requirement should be explicitly identified. If the contradiction cannot be resolved, the software safety requirement should not be considered satisfied.

7.2 Direct Evidence for Requirements Satisfaction (all attributes)

For Direct evidence to be acceptable it must comply with the following requirements:

7.2.1 Direct Evidence from Testing

a) Arguments and evidence should be available that show:

   i) Tests were specified for all the relevant behavioural attributes of each safety requirement.

   ii) Testing was carried out to show that the acceptance criteria for each applicable attribute have been met.

   iii) The results of the testing show that the specified acceptance criteria for each applicable attribute for each software safety requirement has been met.

b) For direct evidence of testing to be credible it should include test specifications, test criteria, test results, an analysis of test results, and an analysis of faults discovered during testing.

7.2.2 Direct Evidence from Field Service Experience

a) Arguments and evidence should be available that show:

i) An analysis process, with pass/fail criteria, was specified for each attribute of the software safety requirement that is being justified from field experience.

ii) The analysis of the field service records shows that the criteria for each attribute of the software safety requirement being justified from field experience have been satisfied.

b) For direct evidence from field service experience to be credible, all of the details relevant to the argument being made (e.g. of length of service, history of modifications, list of users) should be included.

7.2.3 Direct Evidence from Design Analysis

a) Arguments and evidence should be available that show:

i) An analysis process, with pass/fail criteria, was specified for each attribute of the safety requirement that is being justified by analysis of design.

ii) The specified acceptance criteria for each attribute of the software safety requirement being justified by analysis of the design, have been satisfied.

NOTE: Analytic arguments usually rely on the source code and therefore, for high AELs, there should be a demonstration that the object code is a correct translation of the source code.

7.3 Backing Evidence for Requirements Satisfaction (all attributes)

For Backing evidence to be credible it should comply with the following:

7.3.1 Backing Evidence from Testing

Arguments and evidence should be available that show:

i) The test methods and techniques used are appropriate for the attributes of the software safety requirement under consideration.

ii) Procedures and tools used to support testing have been verified and validated to a level appropriate for the AEL.

iii) The tests are sufficiently thorough and are representative of the demands that will be made on the software when it is in service.

iv) The test criteria are a complete and correct interpretation of the software safety requirements.

v) The test cases provide adequate coverage of the input domain.

vi) Testing was performed independently from design, e.g. independent generation of test requirements and independent performance of test specifications. The extent of independence is shown in Table 1 of section 6.1.

vii) Any tools used to support testing maintain the integrity of the results and the operational software.

viii) Procedures or tools were used to ensure that testing was carried out as required in the test procedure and that the results satisfy the test criteria.

ix) Test guidance, procedures, standards and tools were defined and adhered to.

x) The test environment and procedures were recorded accurately.

xi) For AEL 1 to 3, any differences between the operational and test environments are identified, and the impact on test results assessed.

xii) For AEL 4 & 5, tests are made on a configuration identical to the operational system.

xiii) The complexity and input domain of a software safety requirement was analysed and used to support the selection of normal and abnormal test data.

xiv) The consequences of failing to meet a software safety requirement have been analysed and have been used to support the selection of normal and abnormal test data.

xv) All faults and their implied undiscovered faults, discovered during testing, have been analysed and that their existence does not adversely affect safety.

7.3.2 **Backing Evidence from Field Service Experience**

Arguments and evidence should be available that show:

i) The proposed software and the software for which the field service experience is available are identical or sufficiently similar.

ii) The proposed operational environment and the operational environment for which the field service experience is available are identical or sufficiently similar.

iii) The proposed hardware and the hardware for which the field service experience is available are identical or sufficiently similar.

iv) All attributes of the software safety requirements being justified from field experience have been exercised in the deployed software.

v) A Defect Reporting, Analysis and Corrective Action System (DRACAS) is in place for the deployed software, and is operated in a reliable manner, adequate to support the claims made for the software.

vi) The field service records are correct and complete.

vii) Procedures and tools were used to support the analysis of field service experience, to ensure that analysis has been carried out as required in the analysis procedure, and that the results satisfy the analysis criteria.

viii) The procedures and tools used to support the analysis of field service experience were verified and validated.

ix) Any tools used to support analysis maintain the integrity of the results and the operational software.

x) Sufficient experience exists to demonstrate that the acceptance criteria for each attribute of the software safety requirement have been met.

xi) For all reported failures of an attribute in the software component, the underlying fault has been corrected, or that the fault is not relevant because it has no safety impact.

xii) All field reports identifying failures of the attributes, of the software safety requirements being justified from field experience have been made available.

7.3.3 Backing Evidence from Design Analysis

Arguments and evidence should be available which show that:

i) The design notations are capable of supporting the identification of all attributes that are to be analysed.

ii) The analytic methods and techniques used are appropriate for the attributes of the software safety requirement.

iii) The analysis notations are appropriate to the problem domain and representation and allow an adequate analysis of the design.

iv) The analysis techniques have been applied by adequately qualified and experienced staff.

v) Assumptions used in the analysis (e.g. about the environment, hardware, operating system and other interfaces) have been validated.

vi) Models or other abstractions used in the analysis are an adequate representation of the software design.

vii) The formal proofs or arguments submitted are logically correct. This may be shown either by manual inspection or by tool-based checking,

viii) Procedures or tools have been used to ensure that the analyses are carried out adequately.

ix) Any procedures and tools used to support analysis, analysis of testing and the analysis of field service experience have been verified and validated.

x) Any tools used to support analysis, maintain the integrity of the results and the operational software.

xi) Where analysis has been carried out on source code, the object code is a correct translation of that source code.

NOTE 1: Staff are deemed to be appropriately qualified and experienced if they understand the design notations, are experienced in using them, and understand the analysis approach, the required attributes and the system context.

NOTE 2: More than one notation may be used at any given design level.

7.4 Evidence for Requirements Satisfaction (by attribute)

This section offers guidance on assessing the behavioural attributes of a software safety requirement in addition to the generic guidance specified in sections 6.1 to 6.3.

7.4.1 Specific Requirements for Evidence of Functional Properties

It is expected that an appropriate form of direct evidence will be selected from the following table in order to demonstrate that the specified functional properties have been correctly implemented.

	Acceptable Sources of Evidence: Functional Properties (Choose 1 column only from the appropriate row)		
AEL 1	TESTING	FIELD SERVICE EXPERIENCE & Testing	ANALYSIS & Testing
AEL 2	TESTING	FIELD SERVICE EXPERIENCE & Testing	ANALYSIS & Testing
AEL 3	ANALYSIS & Testing	ANALYSIS & Testing & Field Service Experience	
AEL 4	ANALYSIS & Testing	ANALYSIS & Testing & Field Service Experience	
AEL 5	ANALYSIS & Testing		

7.4.1.1 Direct Evidence of Analysis of Functional Properties

Arguments and evidence should be available that show:

a) The source code contains a correct implementation of the functional properties of the software safety requirement, either directly or by means of intermediate design notations or stages. This includes those functional properties that have been derived from non-functional software safety requirements.

b) All parameters and constants used in conjunction with the software system have been checked for correctness and internal consistency.

7.4.2 Specific Requirements for Evidence of Timing Properties

It is expected that an appropriate form of direct evidence will be selected from the following table in order to demonstrate that the specified timing properties have been satisfied.

	Acceptable Sources of Evidence: Timing Properties (Choose 1 column only from the appropriate row)		
AEL 1	TESTING	TESTING & Field service experience	ANALYSIS & Testing
AEL 2	TESTING	TESTING & Field service experience	ANALYSIS & Testing
AEL 3	ANALYSIS & Testing	ANALYSIS & Testing & Field Service Experience	
AEL 4	ANALYSIS & Testing	ANALYSIS & Testing & Field Service Experience	
AEL 5	ANALYSIS & Testing		

7.4.2.1 **Direct Evidence from Testing of Timing Properties**

Arguments and evidence should be available which show that:

a) Specified response times for the software safety requirement have been met under minimum or no load conditions, normal and maximum planned load conditions.

b) Specified throughputs for the software safety requirement have been met under minimum or no load conditions, normal and maximum planned load conditions.

7.4.2.2 **Backing Evidence of Testing of Timing Properties**

Arguments and evidence should be available which show that the minimum, normal and worst case load conditions used in testing are representative of actual operation.

7.4.2.3 **Direct Evidence from Analysis of Timing Properties**

Arguments and evidence should be available which show that:

a) The results of a worst-case timing analysis prove that the specified time response for the software safety requirement has been met.

NOTE: For simple software designs (e.g. using fixed loops and cyclic scheduling) design arguments and supporting evidence may be used to demonstrate that response times and throughput are invariant. This evidence may be used in conjunction with explicit timing and throughput measurements to show that the timing constraints are met.

b) For complex software designs, the worst-case timing path through the software has been determined by analysis.

c) For complex scheduling, all safety related components that implement safety requirements meet their timing and throughput requirements (e.g. using queue simulation models).

d) For AEL 3, 4 & 5, all practicable measures have been taken to ensure that no timing anomalies exist.

e) For AEL 4, rigorous arguments were used to ensure timing correctness.

f) For AEL 5, proof was used to ensure timing correctness for the safety properties.

7.4.2.4 **Backing for Analysis of Timing Properties**

Arguments and evidence should be available which show that the modelling assumptions are applicable and take into account the speed of the hardware on which it will be implemented and any associated input-output devices.

7.4.3 Specific Requirements for Evidence of Robustness

It is expected that an appropriate form of direct evidence will be selected from the following table in order to demonstrate that the specified robustness properties have been satisfied.

	Acceptable Sources of Evidence: Robustness (Choose 1 column only from the appropriate row)		
AEL 1	TESTING	TESTING & Field service experience	ANALYSIS & Testing
AEL 2	TESTING	TESTING & Field service experience	ANALYSIS & Testing
AEL 3	ANALYSIS & Testing	ANALYSIS & Testing & Field Service Experience	
AEL 4	ANALYSIS & Testing	ANALYSIS & Testing & Field Service Experience	
AEL 5	ANALYSIS & Testing		

7.4.3.1 Direct Evidence from Testing for Robustness

Arguments and evidence should be available which show that all credible modes of failure have been covered, including software failures, interface failures, power-loss and restoration, failures of linked equipment, and breaks in communication links.

7.4.3.2 Backing for Testing of Robustness

Arguments and evidence should be available which show that:

a) The test cases cover a complete credible set of environmental failure modes.

b) Credible sequences of environmental failures are covered by the test cases.

7.4.3.3 Direct Evidence from Analysis for Robustness

Arguments and evidence should be available which show that:

a) The software design has features that make it robust to internal and external failures. The analysis should identify the failure modes considered and the design strategy used to recover from or mitigate the failures.

NOTE: These failures typically include failures of concurrent software processes, the scheduler, input-output interfaces and file storage.

b) Failures of non-safety related components within the same computer do not affect the functioning of safety-related components (i.e. there is adequate segregation of resources).

c) For AEL 3 and above, source code cannot lead to run-time exceptions.

NOTE: This does not imply that exception-handling code should not be provided. Exceptions may still arise from transient or permanent hardware failures, or where errors have been made in the demonstration that the source code cannot raise exceptions.

d) For AEL 4, rigorous argument was used to ensure that failures in the environment will not result in failure to meet the software safety requirements.

e) For AEL 5, proof of correctness for the robustness attributes of the safety properties carried out.

7.4.3.4 **Backing for Analysis of Robustness**

Arguments and evidence should be available which show that:

a) Fault detection mechanisms used to detect failure are sufficient to detect a high proportion of the failures. This proportion should be defined and justified.

b) Modelling assumptions are applicable and take into account the hardware on which it will be implemented and any associated input-output devices.

7.4.4 **Specific Requirements for Evidence of Reliability**

Where feasible, software safety requirements should be stated in probabilistic terms involving time (i.e. that a given failure rate must not be exceeded), and testing or field service experience is to be used to obtain direct evidence of requirements satisfaction. For this evidence to be compelling a statistical confidence of at least 95% should be achieved.

It is expected that an appropriate form of direct evidence will be selected from the following table in order to demonstrate that the specified reliability properties have been satisfied.

	Acceptable Sources of Evidence: Reliability (Choose 1 column only from the appropriate row)			
AEL 1	TESTING	FIELD SERVICE EXPERIENCE & Testing	ANALYSIS & Testing	ANALYSIS & Field Service Experience & Testing
AEL 2	TESTING	FIELD SERVICE EXPERIENCE & Testing	ANALYSIS & Testing	ANALYSIS & Field Service Experience & Testing
AEL 3	FIELD SERVICE EXPERIENCE & Testing	ANALYSIS & Testing	ANALYSIS & Testing & Field Service Experience	
AEL 4	ANALYSIS & Testing		ANALYSIS & Field Service Experience & Testing	
AEL 5	ANALYSIS & Field Service Experience & Testing			

7.4.4.1 **Direct Evidence from Testing for Reliability**

Arguments and evidence should be available which show that:

a) The demands placed on the software were representative of normal operation.

b) The tests were sufficient to demonstrate that the reliability attribute of the software safety requirement is met to a confidence of 95%.

7.4.4.2 **Direct Evidence from Field Service Experience for Reliability**

Arguments and evidence should be available which show that the failure rate for all safety related failures, observed in field service should not be greater than the allowed failure rates stated in the software safety requirements, to a 95% confidence level.

7.4.4.3 **Direct Evidence from Analysis for Reliability**

Arguments and evidence should be available which show that there is a low probability of residual faults in the software.

7.4.4.4 **Backing Evidence from Analysis of Reliability**

Arguments and evidence should be available which show that:

a) The fault density figures are credible when compared with other projects using a similar development approach.

b) Design and programming standards were in place to:

   i) Minimise the risk of residual errors remaining in the software (for example, from the use of constructs which are open to misinterpretation, are obscure in meaning, or may lead to programs which are difficult to analyse).

   ii) Ensure that the clarity and readability of the software design and code are adequate, as appropriate to the design notations and languages used.

c) The design and programming standards were adhered to.

d) Mechanisms were in place to detect software faults at each stage of development.

e) The fault-detection mechanisms were effective at each stage of development.

7.4.5 **Specific Requirements for Evidence of Accuracy**

It is expected that an appropriate form of direct evidence will be selected from the following table in order to demonstrate that the specified accuracy properties have been satisfied.

<table>
<tr><th></th><th colspan="4">Acceptable Sources of Evidence: Accuracy
(Choose 1 column only from the appropriate row)</th></tr>
<tr><td>AEL 1</td><td>TESTING</td><td>FIELD SERVICE EXPERIENCE & Analysis & Testing</td><td>ANALYSIS & Testing</td><td>ANALYSIS & Field Service Experience & Testing</td></tr>
<tr><td>AEL 2</td><td>TESTING & Analysis</td><td colspan="2">ANALYSIS & Field Service Experience & Testing</td><td>ANALYSIS & Testing</td></tr>
<tr><td>AEL 3</td><td colspan="2">ANALYSIS & Testing</td><td colspan="2">ANALYSIS & Field Service Experience & Testing</td></tr>
<tr><td>AEL 4</td><td colspan="4">ANALYSIS & Testing</td></tr>
<tr><td>AEL 5</td><td colspan="4">ANALYSIS & Testing</td></tr>
</table>

7.4.5.1 **Direct Evidence from Testing for Accuracy**

Arguments and evidence should be available which show that the required computational precision is demonstrated under worst-case input conditions.

7.4.5.2 **Direct Evidence from Analysis for Accuracy**

Arguments and evidence should be available which show that:

a) The sources of error for all computations associated with the software safety requirement have been identified and the worst-case errors are within the specified bounds.

b) All parameters and constants used in conjunction with the software system have been checked for correctness and internal consistency.

c) For AEL 4, the use of rigorous arguments of computational accuracy and stability have been made

d) For AEL 4 & 5, the object code is a correct translation of the source code, i.e. that as far as is reasonably practicable no additional computational inaccuracies are introduced by the translation into object code.

e) For AEL 5, there is proof that the implementation meets the software safety requirements for computational accuracy and stability.

NOTE: Typical sources of error are numerically unstable algorithms, floating-point truncation (e.g. small numbers added to large numbers), and numerical overflow. Good algorithm design can reduce the errors to tolerable levels.

7.4.5.3 **Backing Evidence from Analysis of Accuracy**

Arguments and evidence should be available which show that:

a) The error analysis is based on worst-case input values.

b) Good design practice is used to minimise errors in complex algorithms.

7.4.6 **Specific Requirements for Evidence of Resource Usage**

It is expected that an appropriate form of direct evidence will be selected from the following table in order to demonstrate that the specified resource-usage properties have been satisfied.

<table>
<tr><th></th><th colspan="4">Acceptable Sources of Evidence: Resource Usage
(Choose 1 column only from the appropriate row)</th></tr>
<tr><td>AEL 1</td><td>TESTING</td><td>FIELD SERVICE EXPERIENCE & Analysis & Testing</td><td>ANALYSIS & Testing</td><td>ANALYSIS & Field Service Experience & Testing</td></tr>
<tr><td>AEL 2</td><td>TESTING & Analysis</td><td colspan="2">ANALYSIS & Field Service Experience & Testing</td><td>ANALYSIS & Testing</td></tr>
<tr><td>AEL 3</td><td colspan="2">ANALYSIS & Testing</td><td colspan="2">ANALYSIS & Field Service Experience & Testing</td></tr>
<tr><td>AEL 4</td><td colspan="4">ANALYSIS & Testing</td></tr>
<tr><td>AEL 5</td><td colspan="4">ANALYSIS & Testing</td></tr>
</table>

7.4.6.1 **Direct Evidence from Testing of Resource Usage**

Arguments and evidence should be available which show that Resource usage does not exceed the specified resource constraints and has been demonstrated under worst-case conditions.

Typically these resources include: disc storage, main memory, input/output bandwidth, communications bandwidth, and processor time.

7.4.6.2 **Direct Evidence From Analysis of Resource Usage**

Arguments and evidence should be available which show that:

a) The resource usage of the software does not exceed the specified resource constraints.

NOTE: This may be based on design evidence if resources are statically assigned, or by a worst-case resource-use analysis if the resources are assigned dynamically.

b) For AEL 4 & 5, use of rigorous arguments of resource usage has been made.

7.4.6.3 **Backing Evidence for Analysis of Resource Usage**

Arguments and evidence should be available which show that:

a) The resource usage analysis is based on worst-case input values.

b) The worst-case conditions are credible under worst-case operational conditions.

7.4.7 **Specific Requirements for Evidence of Overload Tolerance**

Arguments may be made that design features are not required if the overload conditions are impossible.

Such overloads typically include: Excessive input-output data rates, Excessive processor usage, Disk storage overflows, Buffer overflows, and Virtual Storage overflows.

Arguments and evidence should justify that any claims about the impossibility of overload still apply under failure conditions.

It is expected that an appropriate form of direct evidence will be selected from the following table in order to demonstrate that the specified overload tolerance properties have been satisfied.

<table>
<tr><th></th><th colspan="4">Acceptable Sources of Evidence: Overload Tolerance
(Choose 1 column only from the appropriate row)</th></tr>
<tr><td>AEL 1</td><td>TESTING</td><td>FIELD SERVICE EXPERIENCE & Analysis & Testing</td><td>ANALYSIS & Testing</td><td>ANALYSIS & Field Service Experience & Testing</td></tr>
<tr><td>AEL 2</td><td>TESTING & Analysis</td><td colspan="2">ANALYSIS & Field Service Experience & Testing</td><td>ANALYSIS & Testing</td></tr>
<tr><td>AEL 3</td><td>TESTING & Analysis</td><td colspan="2">ANALYSIS & Field Service Experience & Testing</td><td>ANALYSIS & Testing</td></tr>
<tr><td>AEL 4</td><td colspan="2">ANALYSIS & Testing
(Deterministic overload design)</td><td colspan="2">TESTING & Analysis
(Non deterministic overload design)</td></tr>
<tr><td>AEL 5</td><td colspan="2">ANALYSIS & Testing
(Deterministic overload design)</td><td colspan="2">TESTING & Analysis
(Non deterministic overload design)</td></tr>
</table>

7.4.7.1 **Direct Evidence from Analysis for Overload Tolerance**

Arguments and evidence should be available which show that:

a) The design is capable of degrading gracefully under overload conditions so that software safety requirements are still met.

b) For AEL 4 & 5, the use of rigorous arguments of overload have been made.

NOTE: Where the design does not allow the loading to be determined analytically then at AELs 4 & 5 such evidence of overload tolerance will not be compelling. The arguments presented in this case will support testing by providing analysis of the test cases.

7.4.7.2 **Backing Evidence for Analysis of Overload Tolerance**

Arguments and evidence should be available which show that the overload analysis is credible under worst-case operational conditions.

8 Guidance on Credible Arguments and Evidence to Demonstrate Requirements Traceability Relating to Objective C

8.1 **Direct Evidence for Requirements Traceability**

Arguments and direct evidence of software safety requirements traceability should be available that demonstrate:

a) Each requirement introduced at each level in the design has been traced to the same level of design at which its satisfaction is demonstrated.

b) Each requirement introduced at each level in the design has been traced to a system safety requirement.

8.2 **Backing Evidence of Requirements Traceability**

To give confidence that the traceability records are correct and complete, arguments and backing evidence should be available that demonstrate:

a) The notation for tracing the software safety requirements is unambiguous and has been used consistently.

NOTE: Traceability encompasses all pre-existing software items included in or called from the application.

b) The notation for tracing software safety requirements supports both forward and backward traceability.

c) Any tools used to support traceability did not corrupt the traceability structures and records.

d) Procedures or tools have been used to ensure that any loss of traceability or incorrect traceability is detected and corrected.

e) Any tools used to construct or maintain traceability have been verified and validated to an appropriate level for the impact of the tool on the design.

9 Guidance on Credible Arguments and Evidence to Demonstrate Freedom from Interference by Non Safety Functions Relating to Objective D

9.1 Direct Evidence of Freedom from Interference

Arguments and direct evidence that the software safety requirements integrity is maintained should be available that demonstrate:

a) Any non-safety functions existing in the implementation cannot interfere with those functions resulting from software safety requirements.

9.2 Backing Evidence of Freedom from Interference

To give confidence that the software safety requirements integrity is maintained arguments and backing evidence should be available that demonstrate:

a) The notations used in the analysis of interference are capable of supporting the identification and correction of all relevant interference mechanisms.

b) The analytic methods and techniques used are appropriate for identifying and analysing interference mechanisms.

c) The analysis notations are appropriate to the problem domain and representation and allow an adequate analysis of the design.

d) The analysis techniques have been applied by adequately qualified and experienced staff.

e) Assumptions used in the analysis (e.g. about the environment, hardware, operating system and other interfaces) have been validated.

f) Models or other abstractions used in the analysis are an adequate representation of the software design.

g) Procedures or tools have been used to ensure that interference is detected and corrected.

h) Any tools used to support the detection or correction of interference did not corrupt the results or the operational software.

i) Any tools used to detect or correct interference have been verified and validated to an appropriate level for the impact of the tool on the code and analysis.

10 Guidance on Credible Arguments and Evidence to Demonstrate Configuration Consistency Relating to Objective E

10.1 Direct Evidence of Configuration Consistency

Arguments and evidence should be available that show:

a) All those artefacts, which are offered as a source of direct or backing evidence are produced by the development of, or related to, the known executable version of the software.

NOTE: Evidence that is not created during the development process of the known executable version of the software can be related to it. In this case arguments for the validity of the relationship should be made available.

b) The evidence was collected from the processes and products to which it relates.

c) Evidence has not been altered without the alterations and their justification being made visible.

d) The evidence is unambiguously and consistently identified.

NOTE: Artefacts commonly offered as sources of Direct and Backing Evidence are:

i) The object code;

ii) The source code;

iii) The requirements (System requirements, Software safety requirements, other Software requirements)

iv) Any data that has been used in conjunction with the known version of the source code;

v) All user manuals and other operating instructions for the software;

vi) All test specifications, test scripts, test harness programs and test results;

vii) Versions of all hardware used in the: generation of test data, stimulation of tests and recording of test results;

viii) Intermediate software design descriptions, either in natural language or formal or semi-formal notations;

ix) The results of hazard analysis undertaken on the system and software;

x) Requirements traceability records (where these are kept separately from the source code);

xi) The results of manual inspections and static analyses of various kinds;

xii) All safety arguments;

xiii) Versions of the compilation system and any other development tools, including the hardware upon which they operate.

10.2 **Backing Evidence of Configuration Consistency**

a) Arguments and evidence should be available that show:

i) Any tools used to support configuration consistency did not corrupt the configuration consistency structures.

ii) Any tools used to construct or maintain configuration consistency have been verified and validated to an appropriate level for the impact of the tool on the code.

b) A computer based change control and configuration management system should be used to maintain the consistency of all products of the development process.

Appendix A to SW 01 - Identification of AELs

1 Introduction

1.1 For the regulator to be satisfied that a software safety requirement has been implemented fully and correctly, the five objectives defined in Part 2 section 3 of SW01 (Requirements Validity, Requirements Satisfaction, Requirements Traceability, Requirements Integrity, Freedom from Interference and Configuration Consistency) must be achieved.

1.2 In order to demonstrate that the objectives have been achieved, arguments and assurance evidence must be made available to the regulator from the behaviour of the software and certain aspects of the way in which it has been developed. The strength and depth (rigour) of that assurance evidence is driven by the **safety criticality** of the software safety requirement.

1.3 The safety criticality of the software safety requirement is expressed as an index in the range 1 to 5. This index is referred to as the Assurance Evidence Level (AEL). The AEL determines the minimum set of assurance evidence that is required to be available to the regulator for a given software safety requirement for any system proposed for approval.

1.4 Since the AEL determines the evidence to be available for approval of the system, it affects the products of the development process. Furthermore software safety requirements are dynamic in the sense that they can be created and altered by design decisions, as can their associated AELs. It is therefore extremely impractical for a regulator to either set or agree changes to each AEL as the associated software requirement changes during development. For this reason AELs are to be established by the service provider. The regulator will review them when the system is presented for approval.

1.5 This appendix provides the means whereby the service provider can establish the AEL of a software safety requirement.

2 Safety Criticality

2.1 There are a number of indicators of criticality; the dominant one is the worst-case consequence of the software safety requirement not being met. This is most conveniently expressed in terms of the impact of the failure on the continuation of the provision of an ATS rather than in terms of the consequences of any ensuing accident. These worst-case consequences can also be characterised by the need for any mandatory reporting of accident or incidents as defined in CAP382.

2.2 Where architectural and operational defences have been taken against the worst-case consequences, they need to be taken into account when judging the criticality of the software safety requirement. Just assessing the AEL on the basis of the worst credible event in the wider system is likely to result in an unduly high AEL for the software safety requirement.

2.3 Architectural and operational defences may be accounted for in one of two ways. First, by considering, the tolerable failure rate of the software safety requirement which when combined with other failures will cause the worst-case credible consequence. Second, by considering the number and strength of defences to be penetrated before causing the worst-case credible consequence.

3 Calculation of AEL

3.1 An AEL should be assigned using tables 1 and 2 'AEL Safety Criticality' and 'AEL safety criticality modification due to Architectural and operational defences'.

3.2 The provisional assignment of AEL can be found from table 1 by relating the worst-case consequence of the failure to meet the requirement (the hazard) to one of the columns in the table. Three sets of guidewords are given: ATS severity categories (based on ESARR 4, Mandatory occurrence reporting categories (CAP 382) and UK Airprox risk categories). These may help in understanding the hazard.

3.3 The assessment of the worst-case consequence may already be documented in the system hazard analysis. When this is not the case, a hazard analysis should be undertaken to assess how the software requirements might lead to one of these system level hazards.

Table 1 AEL safety criticality

Characteristic	**1**	**2**	**3**	**4**	**5**
SRC Severity Classification scheme in ATM (ESARR 4)	No immediate effect on safety	Slight reduction in safety margins	Major reduction in safety margins	Large reduction in safety margins	Complete loss of safety margins
Relationship to the Mandatory Occurrence Reporting Scheme (CAP 382)	No effect on ATC workload	Increased ATC workload	Loss of separation Significant ATC overload Significant degradation of ground based system	Serious loss of separation Serious ATC overload Serious degradation of ground based system	A UK reportable accident Actual risk of collision
Relationship to the UK Airprox Board, Risk categories	N/A	N/A	C- No risk of collision	B - Safety not assured	A - Risk of collision

3.4 If it can be argued that defences in other parts of the system (including other parts of the software) mitigate against the consequences of the failure to meet the software safety requirement then the provisional assignment of AEL can be reduced by using table 2.

NOTE: This document assumes that software safety requirements have been derived from a full risk and safety analysis of the system. This will have established the overall safety requirements that have been refined and allocated in the design to software. This is a commonplace system safety process and is described in standards and guidelines such as IEC 61508 Part 1, ARP4754, Def Stan 00-56.

Table 2 AEL safety criticality modification due to Architectural and operational defences

Reduction of AEL / **Characteristic**	**-1**	**-2**	**-3**	**-4**
Number and strength of defensive layers	Requirement is monitored	Requirement is met independently in a redundant channel	At least two forms of mitigation which are not part of the requirement	Many forms of mitigation such that a failure of the requirement is extremely unlikely to result in the hazard.
The probability of the failure of all Architectural and operational defences	10-2/hr	10-3/hr	10-5/hr	10-7/hr

The provisional AEL from Table 1 is then added to the offset provided by Table 2.

4 Software Components

4.1 A software component is defined as the implementation of the smallest grouping of software safety requirements; which because no argument for the independence of their attributes from each other is being made, assume the same AEL.

NOTE 1: Independence may be physical or logical.

NOTE 2: A software component may be a single executable program, a number of programs operating together, or a part of a single program e.g. a concurrent process, depending on the system and software architecture.

NOTE 3: As software components become larger and/or more complex it becomes increasingly difficult to provide arguments and evidence that the ATS system will perform all of its safety related functions without failure. Independence may be used to minimise the size and complexity of software components to ease this difficulty.

4.2 The evidence required to support arguments of the adequacy of the independence between software components is determined by the AEL of the software safety requirement with the highest AEL of those requirements implemented in the components.

4.3 The AEL of all the software safety requirements implemented in a software component should be the highest AEL of the individual software safety requirements implemented in the software component.

4.4 Requirements derived from a software safety requirement cannot be assumed to have the same AEL as the originating requirement. They must be evaluated, as defined in section 3 Appendix A, in order to derive their correct AELs.

4.5 Design decisions must be evaluated at the system level in order to identify any new software safety requirements. These new software safety requirements must then be allocated an AEL, as defined in section 3 Appendix A.

NOTE: This document assumes that software safety requirements have been derived from a full risk and safety analysis of the system. This will have established the overall safety requirements that have been refined and allocated in the design to software. This is a commonplace system safety process and is described in standards and guidelines such as IEC 61508 Part 1, ARP4754, and Def Stan 00-56.

Appendix B to SW 01 - Argument and Evidence Concepts

1 Safety Arguments

1.1 SW01 Part 3 section 4 guides the service provider in preparing a coherent and convincing argument with adequate supporting evidence to assure the regulator that the prime software safety objective has been achieved:

1.2 To ensure that the risks associated with deploying any software used in a safety related ATS system have been reduced to a tolerable level.

1.3 SW01 provides an argument that assurance of achieving the prime software safety objective may be demonstrated by achieving each of the five assurance objectives elaborated in Part 3, i.e.:

a) Safety Requirements Validity (section 5);

b) Safety Requirements Satisfaction (section 6);

c) Safety Requirements Traceability (section 7);

d) Freedom from Interference by Non Safety Functions (section 8);

e) Configuration Consistency (section 9).

1.4 Thus SW01 provides the basic relationship between software safety and regulatory assurance and it is only necessary to demonstrate achievement of the four assurance objectives to the Authority.

1.5 The guidance in part 3 defines the bounds of arguments and the types of evidence that may be used to support a claim that an objective has been achieved. The service provider needs to provide the actual claim, arguments and supporting evidence. It is likely that sub-claims will be made by the service provider to support the claim that an objective has been achieved. Any argument and evidence must also justify the choice of sub-claims

2 Evidence

2.1 For the purposes of this document, evidence, to support an argument that a safety assurance objective has been met, can take one of two complementary forms, as follows:

a) Direct Evidence – that which is produced by an activity taking place or software behaviour occurring, which is directly related to the claim being made; and

b) Backing Evidence – that which shows that the Direct Evidence is both credible and soundly based.

NOTE 1: Backing is only required for direct evidence actually produced.

NOTE 2: For example:

For a situation where test specifications, test scripts, test harness programs and test results have been submitted as evidence to support claims that the requirements satisfaction objective (part 3 section 5) has been achieved. It would be necessary to make a sub-claim that the configuration consistency objective (part 3 section 9), for that evidence has also been achieved. To do this, requirement 9.1 for direct evidence and requirement 9.2 for backing evidence must be satisfied.

2.2 To substantiate a claim that this is true, the following statement could be made:

> 'The test specifications, test scripts, test harness programs and test results apply to the version of the source code being assessed **because** a unique numbering system is used, this is controlled by a configuration management system and has been checked by review.'

a) **The claim is:**

'The test specifications, test scripts, test harness programs and test results apply to a known version of the source code.'

b) **Direct evidence is:**

The unique numbers are present on all data submitted as evidence and they are controlled by a configuration management system that has been checked by review.

c) **Backing evidence is:**

Audit of numbers and reviews, evidence of CMS pedigree, etc.

To be able to claim achievement of the configuration consistency objective in full it would be necessary to:

- Put forward similar sub-claims for all other evidence submitted to support claims of achieving the other objectives;
- Argue that the set of sub-claims is complete.

3 Rigour of Arguments

The rigour (depth and strength) required of the arguments, that the assurance objectives have been met, increases with AEL. The increased rigour is introduced by requiring the arguments to be presented to a lower level of design.

4 Arguing Requirements Satisfaction

4.1 Structuring of Arguments

In arguing achievement of Safety Requirements Satisfaction objective at an AEL greater than 3 in particular, a single argument is considered to be insufficient to adequately demonstrate that the objective has been met. The concept of Primary and Secondary arguments has therefore been introduced, as follows.

4.1.1 Primary Arguments

Primary Arguments are, as the name suggests, the main arguments (using the Direct and associated Backing evidence) that the software safety requirement is satisfied.

4.1.2 **Secondary Arguments**

4.1.2.1 Secondary Arguments provide additional, independent arguments that the safety requirement is satisfied. They compensate for the possible lack of completeness and uncertainty in the Primary Argument.

4.1.2.2 Secondary Arguments need not demonstrate the claim completely, but the result should not contradict the result of the primary argument.

4.1.2.3 The Secondary argument might use a similar justification (same clauses as primary justification) by an independent team or an entirely different form of evidence, or both.

4.2 **Sources of Evidence for Requirements Satisfaction**

4.2.1 Evidence to support an argument that a software safety requirement has been met may be obtained from one or more of the following main sources:

a) Testing of the object code.

b) Field service experience of an identical, or sufficiently similar, system.

c) Analysis of an appropriate level of design.

Which of the three main sources of evidence is most appropriate will vary according to the attribute concerned and the required AEL, as indicated in Part 3 Section 6.

NOTE 1: In this context, source code is considered to be an aspect of design.

NOTE 2: Analysis can include evidence of the effective use of appropriate processes and techniques.

NOTE 3: For the other assurance objectives (Configuration consistency, Requirements traceability and Requirements validity) analytic evidence is expected.

4.2.2 The forms of evidence available for each attribute and each source of evidence are listed in Table 1.

NOTE: Table 1 is not exhaustive; other forms of evidence that support a claim that a given attribute is satisfied may be offered.

Table 1 Forms of Evidence: Satisfaction of Safety Requirements

Software attribute	Test evidence	Field experience	Analytic evidence
Functional properties	Functional testing	Analysis of known faults in a product	Formal proof of logical behaviour
Timing Properties	Response time tests. Maximum throughput tests	Analysis of known faults in a product	Worst case timing analysis. Performance modelling
Robustness	Fault injection testing (internal and i/o). Power failure and equipment failure tests	Evidence from incident reports on effectiveness of fault tolerance measures	Design evidence that internal and external failures can be detected, and appropriate action taken

Table 1 (Continued) Forms of Evidence: Satisfaction of Safety Requirements

Software attribute	Test evidence	Field experience	Analytic evidence
Reliability	Reliability testing (using expected operational profile) Evidence of high test coverage	Field reliability measurements (for a similar operational profile) Estimates based on residual faults and operating time (N/T)	Evidence of a low probability of residual faults (from analysis of the process and the product). E.g. Static analysis Compliance analysis Complexity metrics Inspection, Quality of support tools. Fault density in similar projects
Accuracy	Measuring error for known test cases	Analysis of known faults in a product	Numerical analysis Algorithm stability analysis
Resource usage	Worst case load tests (disc, memory, input/output, communications, processor)	Resource usage monitoring data from similar applications	Design evidence of static assignment of resources at start-up. Worst case resource analysis
Overload tolerance	Excess load tests	Analysis of known faults in a product	Design evidence that system will degrade gracefully in overload conditions

4.3 Rigour of Evidence

The rigour (depth and strength) of the evidence gathered (both direct and backing evidence) also increases with AEL. This is reflected in the requirements at section 6.1, which shows the evidence to be produced from each source of evidence for each AEL.

The requirements in each table are cumulative - i.e. at a given AEL, its requirements together with all requirements for lower AELs should be complied with.

5 Safety Cases

Insofar as SW01 deals only with the approval of software demonstration of the satisfaction of the requirements herein may be used in support of a system safety case.

Appendix C to SW 01 - Definitions and Abbreviations

The following terms are used in this document in addition to the general glossary of Definitions and Abbreviations.

Definitions

Accuracy	The required precision of the computed results.
Application	The whole system that provides the overall service to the user.
Application Software	The software part of the application, including data.
Assurance Evidence Level (AEL)	Assurance Evidence Levels (AELs) are allocated to software safety requirements to identify the type, depth and strength of evidence that must be made available from the software lifecycle for the equipment approval process.
Behavioural Attributes	Functional properties, Timing properties, Robustness, Reliability, Accuracy, Resource usage, Overload tolerance.
Correct	Free from fault. (Note: This does not mean mathematically proven. Where Formal proof of Correctness is required it is stated in the text.)
Design notation	Any notation that has well understood (although not necessarily a formally specified) semantics, which describes the structure or intended behaviour of some aspect of a software system, either by graphical or textual means, or both. Examples of design notations include data and control flow diagrams, state transition diagrams, MASCOT or HOOD diagrams, and decision tables. A high level programming language is regarded here as a particular kind of design notation, although with the special property that it can be compiled directly into executable code.
Function	A mode of action or activity by which software fulfils its purpose.
Functional Properties	The primary functional behaviour of the software.
Hazard Analysis	A systematic investigation of the hazards posed by a system, in terms of likely effects of system behaviour.
Operating System	A program that controls the execution of application software and acts as an interface to the underlying hardware platform.
Overload Tolerance	The behaviour of the system in the event of, and in particular its tolerance to, inputs occurring at a greater rate than expected during normal operation of the system.

Pre-existing software	Any software that is not written specifically for a given application but is obtained from other sources and is used either in source code or in object code form. Typical examples of pre-existing software include operating systems and database management systems. Commercial-off-the-shelf (COTS) software is by definition pre-existing, although other sources of pre-existing software exist, for example 'free' software published by various organisations.
Proof	Convincing evidence. (Note: This does not mean mathematically proven. Where Formal proof is required it is stated in the text.)
Reliability	The probability that the software will perform to a specified requirement for a specified period of time under specified conditions.
Report	A documentary justification of a claim.
Resource Usage	The amount of resources within the computer system that can be used by the application software. Resources may include main memory of various categories (such as static data, stack and heap), disc space and communications bandwidth, and may include internal software resources, such as the number of files which may be simultaneously open.
Rigorous Argument	A logically correct argument that is assumed to be mathematically provable, but has not been proven.
Rigorous Inspection	A careful examination of a design or program component to ensure that it meets its requirements, is internally consistent and well formed, and conforms to all necessary standards and procedures. The 'Fagan' technique is one well-known inspection technique that is noted for its rigour.
Robustness	The behaviour of the software in the event of spurious (unexpected) inputs, hardware faults and power supply interruptions, either in the computer system itself or in connected devices.
Safety Integrity (SI)	The probability of a safety-related system satisfactorily performing the required safety functions under all the stated conditions within a stated period of time.
Safety Lifecycle	The necessary activities involved in the implementation of safety-related systems, occurring during a period of time which starts at the concept phase of a project and finishes when none of the safety-related systems are any longer available for use.

Software	Software comprises the programs that execute in stored program digital computers (including Programmable Logic Controllers). Software also includes any data contained within the programs or held on external storage media, which is necessary for the safe operation of the system. Software may: be developed for a particular application; be re-used from previous applications, with or without modification; have been obtained from third party software suppliers (commonly called Commercial Off The Shelf (COTS) software), e.g. database systems and operating systems or be any combination of these three types of software.
Software Error	A software fault that has been triggered which results in the program deviating from the design intent.
Software Failure	The inability of a program to perform a required function correctly.
Software Fault	A defect in the program code and the primary source of a software failure.
Software Safety Requirements	Those requirements that define the safety behaviour of the software. Each Software Safety Requirement is specified in terms of the Behavioural Attributes.
Statement	A claim.
Static analysis	A means of determining certain properties of a program without executing it on a computer. These properties may include aspects of functional behaviour, timing and resource usage. Forms of static analysis include control flow, data flow, information flow, semantic and compliance analysis which are defined elsewhere in these definitions.
System Safety Requirements	Those requirements that define the safety behaviour of the System. Each System Safety Requirement is specified in terms of the Behavioural Attributes.
Timing Properties	The time allowed for the software to respond to given inputs or to periodic events, and/or the performance of the software in terms of transactions or messages handled per unit time.
Total service time	The total service time for a (software) system is measured by adding together the total time that each example of the system has been in service (thus if 50 systems of the same type and model have been in service without revealing any dangerous failures for two years, the total operational experience can be regarded as 100 years or approximately 10^6 hours).
Validity	Sound or defensible. Executed with the proper formalities.

Abbreviations

AEL	Assurance Evidence Level
DRACAS	Defect Reporting, Analysis and Corrective Action System
FMEA	Failure Modes and Effects Analysis
IEC	International Electrotechnical Commission
SI	Safety Integrity

Appendix D to SW 01 Derivation of Safety Objectives

The Regulator is required to set objective safety goals which do not remove the Regulatees' freedom of solution by prescribing the means of compliance. The top-level safety goal for software used in CNS/ATM systems states that the Regulatee is:

G1. To ensure that the risks in deploying any software used in a safety related CNS/ATM system have been reduced to a tolerable level.

NOTE: For the purposes of this section Gn denotes a Safety Goal and Gn.n denotes a Safety Sub-Goal to be met by the Regulatee.

The Air Navigation Order gives the Regulator the responsibility to be assured that the Regulatee is meeting the above goal (G1.). Consequently it is the responsibility of the Regulatee to present a claim that the safety goal has been achieved and convince the regulator that it is true. It is not the responsibility of the Regulator to construct the claim on behalf of the Regulatee. Hence the Regulator requires the Regulatee to demonstrate accomplishment of G1. For accomplishment of G1 to be demonstrated to the Regulator it is necessary:

A1. For arguments and assurance evidence to be available which show that the risks associated with deploying any software used in a safety related ATS system are tolerable.

NOTE: An. denotes a Regulatory (Assurance) Goal and An.n denotes a Regulatory (Assurance) Sub-Goal.

However it is necessary to decompose this Goal into sub-goals that are meaningful regulatory statements that can be comprehended by the Regulatee.

The decomposition can be assisted through an understanding of the goal for software behaviour:

G2. To ensure that any software used in a system only behaves in a manner that is safe and has been predicted.

Another way of saying this is that since the tolerability of the risks associated with deploying systems containing software is established during the system safety process, then the main safety goal for software is to implement those safety requirements allocated to software by the system safety process completely and correctly and to ensure that the implementation of non safety functions does not have an adverse effect on safety.

Therefore the main software safety goal may be divided into three sub-goals; these are:

G2.1 To ensure that the software safety requirements are valid system safety requirements and are necessary and sufficient to achieve the risk tolerability

G2.2 To ensure that safety requirements are implemented completely and correctly

G2.3 To ensure that the implementation contains no functions which have an adverse impact on the safety of the system

In order to be assured that the risk of deploying software is tolerable (goal A1) the arguments and assurance evidence must show that safety goals G2.1, G2.2 and G2.3 have been met. For the assurance evidence to be acceptable it must meet the following criteria:

a) It can be demonstrated that the evidence was collected from the processes and products to which it relates.

b) It has not been altered without the alterations and their justification being made visible.

c) It is available for inspection.

These criteria can be met by the retention and maintenance of all arguments and assurance evidence data and all data used to generate the evidence. They are expressed in the **configuration consistency** goal for software safety assurance:

> **A1.1 To ensure that the arguments and evidence, for the safety of the software in the system context, are from: a known executable version of the software and a known set of software products, data and descriptions that have been used in the production of that version**

Assurance that Goal G2.1 has been met is obtained by assuring that software safety requirements are valid and remain valid during software implementation, as expressed in the **Validity of Safety Requirements** goal for software safety assurance:

> **A2.1 To ensure that arguments and evidence are available which show that the Software Safety requirements correctly state what is necessary and sufficient to achieve tolerable safety, in the system context**

NOTE: This includes requirements to control hazards identified during implementation.

Assurance that Goal G2.2 has been met is obtained by assuring that the requirements have been correctly and completely implemented as expressed in the **Satisfaction of Safety Requirements** goal for software safety assurance:

> **A2.2 To ensure that arguments and evidence are available, which shows that the software satisfies its safety requirements**

However, during the software development process, functions may be introduced which have repercussions on the safety of the ATS system, these will need to be assessed and if necessary, new or changed safety requirements will have to be generated. Otherwise the software safety requirements would no longer be complete and correct.

In order to be assured that the software safety requirements remain complete and correct and, consequently, that objective G2.1 is met for all stages of the development, the software safety requirements must be traceable to the implementation and vice versa. This is expressed in the **Traceability of Safety Requirements** goal for software safety assurance:

> **A2.4 To ensure that arguments and evidence are available which show that all Safety Requirements can be traced to the same level of design at which their satisfaction is demonstrated**

CNS/ATM software will invariably contain software other than that which is derived from software safety requirements. If these (non safety) software requirements are implemented in such a way that they interfere with the safe behaviour of the system then objective G2.3 will not be met.

In order to be assured of compliance with G2.3, behaviour resulting from the implementation of software safety requirements must not be interfered with by behaviour resulting from the implementation of other software requirements. This is expressed in the **Freedom from Interference** goal for software safety assurance:

A2.5 To ensure that arguments and evidence are available which show that functions implemented as a result of Software Safety Requirements are not interfered with by other functions implemented in the software

The arguments given above demonstrate that the five assurance sub-goals A2.1 to A2.5 are necessary and that they are sufficient to achieve the top-level safety goal for safety related software in CNS/ATM systems. The reader is invited to confirm this by negating each sub-goal and considering the consequences on the accomplishment of the top-level safety goal.

SW 01 Annex A - Guidance and Information

The following guidance and information documents are available, on request, from the ATS Safety Requirements Section of ATS Standards Department.

A.1 Guidance on the Application of IEC 61508 for Compliance with SW01

A.2 Guidance on the Application of ED-12B / DO-178B for Compliance with SW01

Part B, Section 4, Generic Requirements and Guidance - General

GEN 01 Windfarms

1 Introduction

Windfarms (Wind powered Turbine Generators) have the potential to degrade radio signals by reflection (multipath interference) and to cause signal modulation effects due to rotating turbine blades. This document provides guidance which an ATS Provider can apply in order to safeguard against the possible impact on ATS operations by a Windfarm development. Sources of guidance to facilitate the process of assessment are also provided.

2 Capture by ATS Provider of development proposal

2.1 An ATS Provider may be notified of a proposal to develop a Windfarm either directly by the developer (in conjunction with notification to the CAA), or from the CAA in the form of a copy of the developer’s application. This notification provides the opportunity to comment, ahead of a formal planning application, on an intention to develop a Windfarm site. Notification may also come directly via the Local Planning Authority.

2.2 In order to ensure comprehensive notification of actual intended development, ATS Providers are advised to arrange for Local Authorities to inform and consult with them, when they receive Windfarm development proposals within a minimum radius of 20 km from their Aerodrome or Radio Site.

NOTE: ATS Providers should adopt a range that provides adequate safeguarding pertinent to their location, subject to a minimum of 20 km. This figure was originally provided by the CAA to pertinent Planning Authorities for safeguarding of En-route Radar equipment. ATS Providers should ensure that any area of particularly intense aircraft activity, e.g. an approach to a runway, is also considered by the LPA as requiring safeguarding. This will normally be outside the 'standard' 20 km range and may extend to 34 km for ILS approaches. It should also be noted that such ranges could require consultation with more than one LPA.

3 Responsibilities and limitations

3.1 Windfarms need to be considered as a safeguarding activity.

3.2 The ATS Provider is responsible for ensuring, as far as is reasonably practicable, that such development does not impact on the safety of the ATS environment.

3.3 The ATS Provider is responsible for deciding whether or not it can accept any degradation to the ATS environment.

3.4 If the ATS Provider predicts that the degradation is unacceptable then it should make representations to the appropriate Local Authority.

3.5 The CAA does not have the power to veto Windfarm development (other than on land actually owned by the CAA).

3.6 The ATS Provider is responsible for mitigating against any deterioration to Air Traffic Services caused by Windfarms. The CAA may request to examine any mitigation measures taken and may vary approvals for ATS where the deterioration, caused by Windfarms, affects Safety.

4 Assessment of effect

4.1 It is not possible to provide generic requirements in CAP670 to address the effects of Windfarms on Air Traffic Services.

4.2 It is reasonable to request the developer of the Windfarm to co-operate in providing evidence that the safety of the ATS provision will not be compromised or degraded by the development. This evidence could be in the form of a safety case style assessment.

4.3 To assist with that assessment the developer and ATS Provider are encouraged to consult CAA Paper 99002 'The Provision of Guidelines for the Installation of Wind Turbines near Aeronautical Radio Stations'. This is available, at modest cost, from Westward documedia.

4.4 Software supporting the Paper and which allows the computation of carrier to interference ratio at a receiver, is available free of charge, from the CAP 670 Editor.

5 Additional guidance

Further guidance regarding Windfarm planning considerations and issues can be sought from:

Planning Policy Guidance notes; PPG 8 and PPG 22 (in particular paragraphs 52-58), as subsets of the Town and Country Planning Act 1990.

The Wireless Telegraphy Act 1949.

GEN 02 Technical Safeguarding of Radio Sites; Guidance Material

1 Introduction

1.1 Aerodromes with their ATS Providers are responsible for the technical safeguarding of all of the radio sites for which they hold approvals under the ANO. This document provides guidance to assist with that process.

1.2 Aerodrome Licensees and ATS Providers who register safeguarding maps with the Local Planning Authorities should receive from the Local Planning Authority copies of applications for developments in and within the vicinity of the Aerodrome. This information should be made available to the person responsible for the technical safeguarding of radio sites.

1.3 If safeguarding is not undertaken then it is likely that a gradual degradation of the integrity of the radio signal will take place. This will be perceived in several ways; for example, complaints from pilots or ATC regarding poor coverage, increased background noise or worsening flight calibration results for ILS. This can be avoided by proactively safeguarding the technical sites.

1.4 The ATSSD Engineering Inspector will expect to see evidence of adequate technical safeguarding. If the quality of service of the radio signal reduces below acceptable limits, he can withdraw the ANO approval until corrective measures have been taken.

2 Definition

Technical Safeguarding is the process employed to protect radio signals from being affected by physical or electromagnetic changes in their transmission environment.

3 Background

Technical Safeguarding consists of two processes, **Physical Protection** and **Radio Spectrum Protection**.

4 Physical Protection

4.1 Most physical objects act as reflectors or diffractors of radio signals. A combination of object size, material, proximity and incident radio wavelength, can make them particularly efficient reflectors or diffractors. Technical site safeguarding, a process applied as part of the technical safeguarding of Radio Sites, seeks to prevent any development near to a radio transmitter or receiver site, which may degrade the radio signal by enabling such reflection or diffraction.

4.2 **Physical Protection Process**

4.2.1 Each aeronautical radio aid has a technical area to be safeguarded associated with it. On an aeronautical chart, a frame, representing this area, is drawn around the aerial of the radio aid. If a proposed development falls within that frame or volume, further analysis, or reasoned outright rejection should be considered. In the case of development within an ILS area it is expected that computer modelling of the development is undertaken. The size and shape of the frame or volume is dependent upon the type of equipment and its aerial system.

4.2.2 The dimensions provided below are examples of frame sizes associated with specific types of equipment. These sizes should be applied in the absence of data from other sources. Aerodromes are encouraged to obtain specific criteria from the manufacturer or supplier of their equipment. It is likely that the manufacturer may specify a smaller area to be safeguarded, which could provide operational benefits to the Aerodrome. Aerodromes are expected to maintain and apply criteria pertinent to their own technical sites. The Engineering Inspector may wish to examine the criteria used.

4.3 **Example frame sizes:**

4.3.1 **ILS**

NOTE: The following dimensions should not be confused with the ILS Critical and Sensitive areas.

4.3.1.1 **ILS Localiser Cat I/II**

The frame can be defined as two separate sectors:

a) A sector of 750 metres radius centred on the localiser and ±60° about the runway centreline at ground level, in the direction of the runway threshold.

b) A sector, centred on the localiser, ±15° about the runway centreline and 1500 metres along the runway, at ground level, in the direction of the runway threshold.

4.3.1.2 **ILS Localiser Cat III**

The above Cat I/II sectors plus two additional sectors:

a) A rectangle 300 metres either side of and parallel to the extended runway centreline commencing 100 metres behind the respective localiser and extending to 100 metres beyond the end of concrete at the landing end of the respective runway. This area is defined at ground level.

b) A volume commencing 100 metres from the end of concrete at ground level on a projected 1:50 slope to a range of 1000 metres and ±300 metres about the extended runway centreline.

NOTE 1: These frames are defined with respect to the localiser site and the landing 'end of concrete' to take account of the variable length of runways and inset threshold conditions.

NOTE 2: Aerodromes may consider extending the above Cat III criteria of ± 300 metres to ± 500 metres if large scale development on the edge of the ± 300 metre boundary is likely.

4.3.2 **ILS Glide Path**

This sector is defined with respect to the glide path aerial mast.

A sector of 750 metres radius ±60° about a line originating at the base of the glide path aerial parallel to the approach runway centreline.

4.3.3 **DME associated with ILS or MLS**

An inverted cone of 500 metres radius with a 2% (1:50) slope, originating at the base of the DME aerial.

4.3.4 **MLS**

Azimuth System

A rectangle ±100 metres either side of the extended runway centreline originating 100 metres behind the aerial and extending to 100 metres beyond the landing end of the respective runway. This area is defined at ground level as 4.3.1.7 a.

Elevation Systems

A sector of 500 metres radius, centred at the base of the elevation aerial, ±30° about a line parallel to the approach runway centreline.

4.3.5 **VOR**

At ground level a circle of 230 metres radius from the site centre with a further slope at 2% (1:50) out to 900 metres radially from the site centre.

4.3.6 **DME**

The foregoing VOR constraints where co-located with a VOR otherwise a 2% (1:50) slope surface originating at the site ground level extending 300 metres radially.

4.3.7 **Radar – 10 cm, 23 cm, 50 cm and SSR**

4.3.7.1 The radar system shall be safeguarded with criteria which are derived from the following as a minimum:

a) Operational Range.

b) Base of Coverage.

c) Operational Usage.

d) Equipment Manufacturer's recommended clearances to prevent deterioration of the system's performance.

4.3.7.2 The criteria for safeguarding should include the following for all radar systems:

a) A Sterile Zone around the antenna to permit clean, uninterrupted beam formation;

   i) which should be precisely defined with respect to a clear reference point on the antenna system,

   ii) which should be derived from the vertical and horizontal beam patterns of the antenna type,

   iii) which should state both the vertical and horizontal extents of the Sterile Zone.

b) A safeguarded slope should be defined around the system which shall assure the system's performance such that it continues to support the operational requirement;

   i) which should be precisely defined with respect to a clear reference point on the antenna system,

ii) which should define the gradient of the slope.

c) The criteria should also include consideration of the construction, shape, location, orientation and materials used in any application.

NOTE 1: Example of Sterile Zone criteria: 'The Sterile Zone is an area of z metres in radius centred on the rotation axis of the radar antenna. The zone extends y metres below the electrical centre of the antenna.'

NOTE 2: Example of slope criteria: 'The protected slope shall be 1 in a*, centred on a point on the rotation axis of the radar antenna that is b* metres below the lower edge of the antenna. The slope shall extend to a ground distance of c* metres from the rotation axis of the antenna.'

*a, b and c are numbers defined by the system characteristics.

4.3.7.3 For clarity, the safeguarded areas should be described diagrammatically as well as textually.

4.3.8 Surface Movement Radar

The airport boundary from ground level.

4.3.9 VHF Direction Finder

Ground level safeguarding of circle radius 120 metres centred on aid, and 2% (1:50) slope from ground level at aid out to 450 metres radially.

4.3.10 VHF / UHF Receivers / Transmitters

Ground level safeguarding of circle radius 91 metres centred on the base of the main aerial tower (or equivalent structure). Additionally, from an elevation of 9 metres on this circle a 2% (1:50) slope out to a radius of 610 metres.

4.3.11 Radar and Radio Link Routes

Certain areas of high ground may need to be safeguarded against development in order to protect radar/radio beams. Such areas should be individually specified.

4.3.12 75 MHz Marker Beacons

Ground level safeguarding out to 100 metres radially.

4.3.13 NDB

From the centre of the aerial, at a height of 5 metres out to 30 metres radius, with a further slope to a height of 14 metres above ground, out to 90 metres radius.

5 Radio Spectrum Protection Process

5.1 Radio signals may also be degraded by interference from other radio sites, such as a broadcast station whose harmonics conflict with an aerodrome frequency. Protection against the development of a site that could produce such interference is managed as part of the Radio Site Clearance process.

5.2 The Radio Site Clearance process of safeguarding against such third party radio site development, is part of a UK wide Ofcom notification activity.

5.3 This activity is effected by the Ofcom sending to UK representative bodies, such as the CAA, copies of Proposals to Establish a Radio Transmitting/Receiving Station. When a location is identified within 5 km of a UK Aeronautical Radio site, a Radio Site Clearance Report is produced. A similar process is used for Windfarm developments within 30 km of an Aeronautical Radio site.

5.4 Radio Spectrum Protection Process

5.4.1 The CAA will assess the Radio Site Clearance Reports and identify anywhere it is considered that there is a risk of interference to safeguarded sites. These reports, along with the associated Ofcom 'Proposal for the Establishment of a Radio Transmitting/Receiving Station' form, will be forwarded to the operator at the affected site.

5.4.2 The documents describe the frequency band, location, output power, modulation and aerial directivity required by the party requesting agreement to establish or modify a radio site.

5.4.3 These should be examined by the site operator, applying engineering principles to decide whether or not to object to a proposal. Reasons for objection would be a realistic fear of co- or adjacent channel interference, caused by the intended carrier, its harmonics or sidebands to any Aerodrome air traffic radio service. The radiated power and aerial directivity of the intended transmitter should also be considered.

5.4.4 Objections should be notified, to the persons as directed and within the timescale identified, on the form.

GEN 03 Safety Requirements for Operational Trials in Air Traffic Services

Part 1 Preliminary Material

1 Introduction

Changes to Air Traffic Management technologies, procedures and practices are subjected to thorough off-line testing and assessment[1] prior to introduction into an operational environment. It is sometimes necessary, in addition to formal off-line testing, to operate such systems operationally for a trials period prior to complete integration into the Air Traffic Management system.

An Operational Trial implements an unproven[2] (or partially proven) change to ATS technology or procedures or practices for the purpose of providing operational Air Traffic Services.

2 Scope

Where trials or testing uses and contributes to the operational Air Traffic Management function during the course of the trial or testing activity, then this trial shall be performed in accordance with the requirements detailed within this document.

This document does not apply to off-line testing, or to any proving activity which has no impact on the operational Air Traffic Management function.

1. Changes to 'ATC Procedures', which can include routine, minor and major changes, may or may not include off-line testing depending on the scope and complexity. Very often the former are subjected to assessment by a panel of selected individuals.
2. Note the term 'unproven' relates to airspace under UK jurisdiction. Technologies, practices and procedures in use elsewhere in the world are considered unproven in terms of utility within the UK's Air Traffic Management environment.

Part 2 Safety Requirements

3 Safety Objective

To ensure that the level of safety of the Air Traffic Management function is retained or improved during instigation, operation and removal of operational trials equipment, procedures or practices (1720).

4 Requirements

4.1 Start and end dates for the Operational Trial shall be submitted and agreed between SRG and the ATS provider prior to implementation of the trial (833).

4.2 Periods of operation (i.e. part time or continuous) shall be defined for the duration of the trials period described above (834).

4.3 Outline proposals for transition from operational trial to full operation shall be submitted to SRG for review prior to commencement of the trial (835).

NOTE: Any approval granted shall relate exclusively to the trial (836), and shall not guarantee or suggest that approval for permanent operation will be granted (837).

4.4 The applicant shall demonstrate that, in the event of short notice failure of the trial, the ability to provide a tolerably safe Air Traffic Management service is not compromised (838).

4.5 If the ATS provider uses a Safety Management System (SMS), then Safety Assurance for the operational trial shall be provided by full and complete adherence to the SMS (839).

4.6 If the ATS provider does not use a SMS, then a full Safety Assessment providing evidence and arguments supporting the trial's safety shall be assembled by the ATS provider for review and approval by SRG (840).

NOTE: The Safety Assessment shall include evidence and arguments demonstrating that the trial does not have a negative impact on the safety of participating or non-participating aircraft and Air Traffic Control Units (ATCUs) (841).

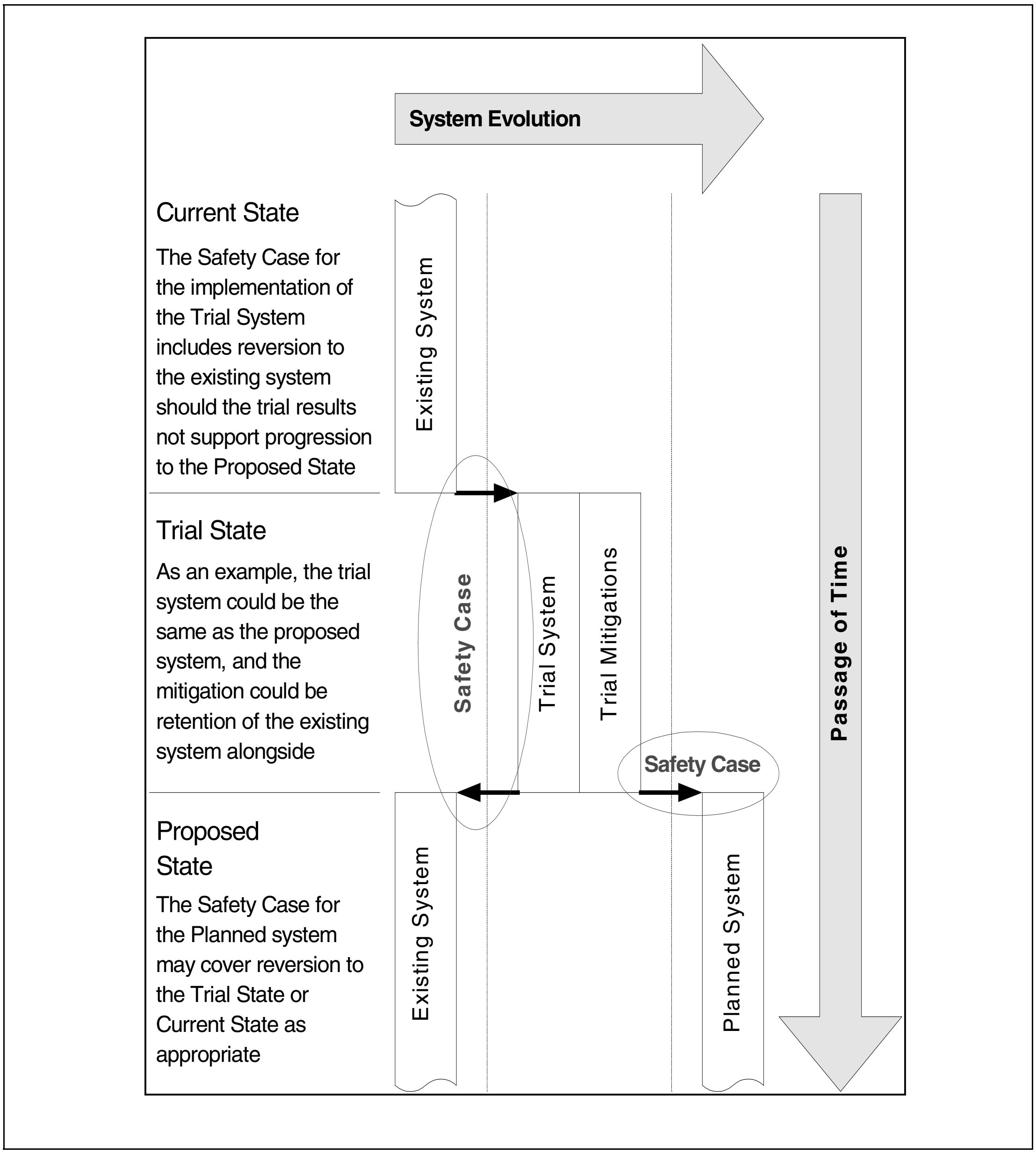
4.7 The terms of approval for an operational trial shall include an undertaking by the proposer to supply to SRG a report containing analysis of the trial's performance, and conclusions relating to the original objectives (842). Timescales (or progress milestones if appropriate) for the issue of this information shall be agreed prior to implementation of the trial (843).

4.8 An operational trial shall be compatible with established mechanisms, processes and where appropriate, equipment, which provides operational services (844).

Appendix Acceptable Means of Compliance

1 A clear distinction is required as to what constitutes an operational trial as opposed to routine testing. Testing, particularly of ground based systems, may use an operational environment in which to perform the test procedures. If the activities taking place affect the method or procedures used to provide the air traffic service, then these should be treated as an Operational Trial.

2 The following diagram illustrates the process by which the Safety of Operational Trials should be managed. Where the term 'Safety Case' is used, this should be taken to mean full and complete adherence to the ATS provider SMS (if this exists) or the production of a detailed Safety Assessment (if an SMS is not in use).



3 Procedures for failure of the trials equipment, procedures and / or practices should provide assurance that in the event of short notice failure of the trial, the ability to provide a tolerably safe Air Traffic Management service is not compromised.

GEN 04 Electro Magnetic Compatibility

1 New equipment brought into service and second hand equipment brought into service for the first time in Europe shall have a CE mark (Directive 93/68/EEC) and an EU declaration of conformity from the manufacturer or European agent attesting its compliance with the EMC Directive 89/336/EMC and any other relevant EU directives.

2 Compliance with the EMC directive has been a legal requirement since 1/1/1996.

3 To confirm compliance, any CE marked product will have a 'Declaration of Conformity' for each of the EU directives relevant to the product. For example, in respect of electrical/electronic apparatus, CE marking indicates compliance with the EMC Directive, although other directives may also be applicable to that apparatus.

4 The CAA is a Notified Body (0190) under the UK EMC Regulations and as such has specific responsibilities for approval and enforcement of the EMC Regulations.

5 In the case of ATS radio transmitting equipment, in addition to the 'Declaration of Conformity' a Type Examination Certificate is required from a Notified Body.

6 The EMC declaration of Conformity shall reference the 'Type Examination Certificate' issued by a Notified Body.

Contents to Part C

Part C, Section 1, Communication

COM 01	**Voice / Data Recording Equipment**
COM 02	**VHF Aeronautical Radio Stations**
COM 03	**Voice Communications Control Systems**
COM 04	**ATC Datalinks**
	COM 04 Appendix - Acceptable Means of Compliance
COM 05	**Information and Alerting Systems**
COM 06	**Automatic Terminal Information Service (ATIS)**
	COM 06 Appendix - ICAO Annex 11 ATIS Message Elements
COM 07	**UHF Radio Equipment and Systems**

Part C, Section 2, - Navigation

ILS 01	**Requirements for ILS Equipment Monitor Alarms**
	ILS 01 Appendix - Calculation of Displacement Sensitivity
ILS 02	**Flight Inspection – Limits to be Applied**
ILS 03	**ILS flight inspection intervals**
ILS 04	**Localiser Width Measurement at Threshold**
ILS 05	**Sideband Reference Glidepath Phase Alarms**
	ILS 05 Annex - Guidance for Compliance
ILS 06	**Requirements for ILS and ILS/DME Identity Keying**
ILS 07	**ILS and ILS/DME Flight Inspection Types and Requirements**
ILS 08	**ILS Radio Noise Monitoring**

ILS 10	**General Requirements for ILS**	
	ILS 10 Annex 1 Guidance Material Relating to the Automatic Calculation of ILS Category	
	ILS 10 Annex 2 Method of Putting an Established Design of ILS into Category I Service	
FLI 02	**The Approval of Flight Calibration Organisations**	
	Annexes Specific to Individual Navigation Aids	11
	Annex 1 - Instrument Landing System	12
	Annex 2 - Microwave Landing System	16
	Annex 3 - GNSS Non-Precision Approach	20
NAV 01	**Engineering Requirements for Instrumented Runway Visual Range (IRVR) Systems**	
NAV 02	**Engineering Requirements for MF Non-Directional Beacons**	
NAV 04	**Engineering Requirements for Conventional and Doppler VHF Omni-Directional Range (CVOR/DVOR) Beacons**	
VDF 01	**Requirements for Flight & Ground Inspection of VHF Direction Finding (VDF) Systems**	

Part C, Section 3 - Surveillance

RAD 01	**Guidelines for Radar System Approval**
RAD 02	**Radar Sensor Engineering Requirements**
RAD 03	**SSR External Monitor Engineering Requirements**
RAD 04	**Primary Approach Radar Markers Engineering Requirements**
RAD 05	**Radar Display Engineering Requirements**
RAD 06	**Aerodrome Traffic Monitor Safety Requirements**
RAD 07	**Ergonomic Aspects for Radar Display Systems**
RAD 08	**Video Map Generation Equipment Requirements**
RAD 09	**Radar Recording Equipment Requirements**

RAD 10	**Surface Movement Radar Systems Requirements**
RAD 11	**Airport Remote Radar Feeds Engineering Requirements**
FLI 03	**Aerodrome Radar Flight Trial Requirements**
MET 01	**General Engineering Design Requirements for Meteorological Equipment**
MET 02	**Engineering Requirements for Ground Based Meteorological Displays**
MET 03	**Engineering Requirements Meteorological Site Communications**
MET 04	**Engineering Requirements for Surface Wind Speed and Direction Measurement**
MET 05	**Engineering Requirements for Ground Based Pressure Measurement Equipment**
MET 06	**Engineering Requirements for Ground Based Temperature and Dew-Point Measurement**
MET 08	**Engineering Requirements Runway/Taxiway Surface Condition Measurement Equipment**
MET 09	**Requirements for the Observation and Dissemination of Meteorological Observations**

Part C, Section 1, Communication

1 Introduction

Section 1 of Part C contains engineering requirements for communications equipment and systems. These documents should be used in conjunction with the Generic Requirements and Guidance contained in Part B as appropriate.

2 Scope

COM 01 'Voice / Data Recording' covers the requirements for the recording of voice and data communications at Air Traffic Control Units. The recording of voice communications between Flight Information Service Officers (FISOs) and pilots is not covered by COM 01 but may be found in CAP 427 Flight Information Service and the FISO Licence Chapter 5 'Recording of Voice Communications'.

COM 02 'VHF Aeronautical Radio Stations' covers the engineering and operational requirements for radio equipment and systems used for Air Traffic and Radio Communication Services. A minimum performance specification for analogue voice and ACARS data link equipment has been included as an appendix to this document and supersedes the CAA Document 438 'Minimum Specification for VHF Amplitude Modulated Transmitter- Receivers'.

The other documents are COM 03 'Voice Communications Control Systems', COM 04 'ATC Datalinks' and COM 05 'Information and Alerting Systems'.

COM 01 Voice / Data Recording Equipment

Part 1 Preliminary Material

1 Introduction

1.1 Under the terms of Article 105 (Air traffic service equipment records) of the Air Navigation Order paragraph (2)(a), recording apparatus is to be provided by the ATS provider of an Aeronautical Radio Station, used for the provision of an Air Traffic Control service by an Air Traffic Control Unit and at the direction of the CAA under the terms of paragraph (2)(b), by the ATS provider of Air Traffic Control Units where an Aeronautical Radio Station is not an integral part of the unit.

1.2 Under the terms of Article 105 paragraph (3)(a), the recording apparatus is required to be capable of recording and replaying the terms or content of any messages or signals transmitted, received, or conveyed through the equipment at the Air Traffic Control Unit or Aeronautical Radio Station.

1.3 Under the terms of Article 105 paragraph (3)(b), the recording apparatus is required to be in operation at all times when an Air Traffic Control service is being provided.

1.4 Under the terms of Article 105 paragraph (4) the recording apparatus requires written approval by the CAA.

NOTE: ANO Article 105 and associated Schedule 15 should be consulted for further details as the full terms are not reproduced in this document. References to specific paragraphs of this article may be included in Part 2 Requirements of this document as appropriate.

2 Scope

2.1 This document sets out the engineering requirements for voice / data recording equipment at Air Traffic Control Units providing an Air Traffic Control Service.

NOTE: The term 'voice / data recording equipment', referred to as 'apparatus' by the ANO, may be abbreviated where appropriate to 'recording equipment' in the remainder of this document. Similarly the term 'communications' applies to both voice and data link communications unless voice or data link are specified.

2.2 The requirements apply, but are not limited to, analogue tape recording / replay equipment using reel to reel, cassette or cartridge magnetic tape archival media and to digital computer based equipment using tape cartridge or other magneto / optical archival media.

2.3 The Minimum Performance Specification for recording equipment is included in Appendix 1 for use in the design, manufacture and procurement of recording equipment.

2.4 EUROCAE WG-50 'CNS/ATM Recording Requirements' have produced a draft document ED-111 ‘Functional Specifications For CNS/ATM Ground Recording’ which may lead to future amendments to this document when published.

Part 2 Requirements

3 Safety Objective

The recording equipment shall provide a complete, identified, intelligible and accurate record of the communications to be recorded which may be used, in the event of an incident, in any investigation by the CAA SRG Transcription Unit (960).

4 General Requirements

4.1 **Minimum Performance Specification**

4.1.1 The recording equipment shall comply with the Minimum Performance Specification in Appendix 1 (961).

NOTE: The manufacturer or supplier of the recording equipment may be required to provide evidence of compliance with this requirement as part of the ATS provider approval process.

4.2 **Transcription Unit Equipment Compatibility**

4.2.1 The Air Traffic Control Unit shall liaise with the CAA SRG Transcription Unit to ensure that the recording equipment is compatible with the replay facilities and working practices in use and shall present evidence to support this in any application for approval (962).

Guidance: At the initial stages when new or replacement recording equipment is being considered, it will be essential to liaise with the CAA SRG Transcription Unit, via the appropriate CAA SRG Regional Offices or other interface, to ensure that compatibility can be achieved.

4.3 **ATS Unit Clocks and Time-Recording Devices**

4.3.1 ATS Unit Clocks and Time-Recording Devices shall use Co-ordinated Universal Time (UTC) and shall express the time in hours and minutes and seconds of the 24-hour day beginning at midnight (963).

4.3.2 ATS Unit Clocks and Time-Recording devices shall be checked as necessary to ensure correct time to within plus and minus 15 seconds of UTC (964).

NOTE: In this case the time accuracy is ± 15 seconds and the resolution is 1 second.

4.3.3 The clock or time-recording device in the recording equipment shall be checked as necessary to ensure that it is maintained within plus and minus 2 seconds of either the ATS Unit master clock source where this exists, another common reference source, or a radio time code receiver utilising terrestrial or Global Positioning System signals (965).

NOTE: This is to ensure all recorded media and reports from engineering and ATC are synchronised.

4.3.4 Wherever Data Link Communications are in operation, clocks and time-recording devices shall be accurate to within plus and minus 1 second of UTC (966).

NOTE: In this case the time accuracy is ± 1 second and the resolution is 1 second.

5 Communications to be Recorded

NOTE: The CAA may require other / additional specific services to be recorded.

5.1 **Air-Ground Communications (Aeronautical Mobile Service)**

NOTE: Reference should be made to COM 02 VHF Aeronautical Radio Communications Equipment Paragraph 7.2.

5.1.1 Direct pilot-controller communications between aircraft stations and aeronautical stations, shall be recorded (967).

5.1.2 The voice communications to be recorded shall be derived from a receiver in the aeronautical station providing 'off-air' signals of the pilot and controller transmissions (968).

5.1.3 Where the voice communications to be recorded are routed via a Voice Communications Control System (VCCS) or other air traffic service equipment to the recording equipment, the continuity of recording shall be ensured in the event of a failure of either the VCCS or air traffic service equipment (969).

5.1.4 **Recommendation:** In area coverage systems the output of the voting or selection unit should be recorded (970).

5.1.5 **Recommendation:** Voice communications derived from appropriate points at the controller's operating position should be recorded (971).

NOTE: This does not preclude unit management taking recordings at other points in the system to facilitate incident/accident investigation.

5.2 **Ground-Ground Communications (Aeronautical Fixed Service)**

5.2.1 **Communications within a Flight Information Region**

5.2.1.1 Direct communications between ATS Units, and between ATS Units and appropriate Military units shall be recorded (972).

NOTE: Whilst the U.K. have notified a difference to ICAO Annex 11 § 6.2.2.3.7 with the wording 'Automatic Recording is not available in each and every case in the United Kingdom', it is expected that full compliance with this ICAO SARP will be achieved. In the meantime any non-compliances may be considered by the CAA on an individual case by case basis.

5.2.1.2 **Recommendation:** Direct communications, which are not already covered, should be recorded (973).

Guidance: ICAO Annex 11 Air Traffic Services § 6.2.2.2.1 and § 6.2.2.2.2 provide information on the communications between ATS Units and other Units which may need to be considered. Communications with appropriate emergency services and adjacent ATC Units with which co-ordination is necessary should also be considered.

5.2.2 **Communications between Flight Information Regions**

5.2.2.1 Direct communications, between Area Control Centres serving contiguous control areas, shall be recorded (974).

5.2.2.2 Direct communications, between adjacent Flight Information Centres or Area Control Centres, shall be recorded (975).

5.2.2.3 **Recommendation:** Direct communications, between adjacent ATS Units, should be recorded (976).

5.2.2.4 **Recommendation:** Direct communications, between an Approach Control Office/ Aerodrome Control Tower and an Area Control Centre, should be recorded (977).

NOTE: Whilst the U.K. have notified a difference to ICAO Annex 11 § 6.2.3.1.2, § 6.2.3.1.3, and § 6.2.3.4 with no explanation or further information given, it is expected that full compliance with this ICAO SARP will be achieved. In the meantime any non-compliances may be considered by the CAA on an individual case by case basis.

5.2.3 Surface Movement Control Service

5.2.3.1 Surface Movement Control Service Communications, used for the control of vehicles and personnel on the manoeuvring area, shall be recorded (978).

5.2.4 Communications within an Air Traffic Control Unit

5.2.4.1 Communications between operational positions at an Air Traffic Control Unit shall be recorded (979).

6 Installation

6.1 General

6.1.1 The recording equipment shall be installed in accordance with the manufacturer's, supplier's or agent's instructions so as to ensure correct and reliable operation (980).

6.1.2 The archival media storage facilities shall be constructed, maintained and operated in accordance with the manufacturer's, supplier's or agent's instructions so as to ensure the reliable retention of data and achievement of expected media lifetimes (981).

6.2 Equipment and Power Supply Configuration

6.2.1 The equipment and power supply configuration shall be such as to ensure the availability of recording, without interruption, when an Air Traffic Service is being provided (982).

6.2.1.1 **Acceptable Means of Compliance:** The provision of separate main and standby recording equipment to ensure the uninterrupted availability of the recording equipment by increasing the reliability of the recording equipment configuration.

6.2.1.2 The provision of a backup power supply from either a central battery system or individual UPS units to ensure the availability of power to the recording equipment and other essential equipment in the event of a mains interruption.

6.2.1.3 **Guidance:** The equipment configuration should take into account such factors as the hours of operation of the ATS Unit, provision for maintenance/repair, ability to replay recorded archival media whilst continuing to record, exchange of media.

6.2.1.4 It is likely that the provision of main and standby equipment will be necessary to achieve the required availability.

6.2.1.5 The incorporation of suitable mains conditioning devices as part of the mains / backup power supply arrangements may be useful in preventing equipment malfunction due to surges, spikes and noise on the power supply.

6.2.2 Where the equipment and power supply configuration is such that the availability of recording, without interruption, cannot be ensured whilst an Air Traffic Service is being provided, then either the provision of the Air Traffic Service shall cease within a time period defined in the Local Instructions for the Air Traffic Control Unit or a written record shall be kept in accordance with Article 105 paragraph (5) of the Air Navigation Order (983).

6.2.3 A practical demonstration of the capability to undertake the requirements of Article 105 paragraph (5) shall be given to the satisfaction of the CAA before this option will be permitted as an alternative to the provision of additional equipment and power supplies to ensure continuity of recording (984).

NOTE: In the event of a complete failure of the recording equipment, it is generally not practical for a written record to be kept of the particulars and summary of each communication in compliance with Article 105 paragraph (5) of the Air Navigation Order and hence additional equipment and power supplies are normally provided to cater for this event.

6.3 **Alarm / Status Indications**

6.3.1 The local and remote alarm / status indications of the recording equipment shall be used as appropriate to alert Air Traffic Control and Engineering personnel to take the necessary actions to ensure the continued operation of the equipment (985).

6.3.2 The remote alarm / status indications shall be 'latching' such that they require positive intervention to check that the recording equipment is operating correctly before any alarm can be cancelled (986).

6.3.2.1 **Guidance:** Whilst it may be appropriate to be able to cancel an audible alarm, another indication, such as a visual alarm should still remain until the alarm condition has been resolved.

6.4 **Working Facilities**

6.4.1 Working facilities shall be provided to enable authorised persons to operate the equipment and undertake other duties such as replay and copying, maintenance, repair and inspection (987).

6.4.1.1 **Guidance:** Facilities may include provision of lighting and mains electrical power in the vicinity of the recording equipment or control console, together with suitable seating and writing surface. Easily accessible connections to the recording equipment may be provided where copies of recordings are required to be made.

6.5 **Disposal of Recording Equipment**

6.5.1 Before the disposal of any Recording Equipment, the CAA SRG Transcription Unit shall be consulted to determine whether there is a need to retain the equipment as a replay facility for any impounded recordings (988).

6.5.1.1 **Guidance:** Any original recordings that have been impounded for accident/legal reasons may be required to be re-played for some considerable time after the accident/incident and CAA legal advice should be sought before disposal.

7 Operation and maintenance

7.1 Procedures

7.1.1 Procedures for the operation and maintenance of the recording equipment shall be produced and incorporated into the Manual of Air Traffic Services (MATS) Part 2 associated with each ATC Unit in accordance with the terms of Article 89 of the Air Navigation Order (989).

7.1.2 **Guidance:** The procedures may refer to Operating or Technical Manuals or other documentation relating to the recording equipment as long as they are readily accessible to the reader. Any preventative maintenance recommended by the manufacturer or supplier of the recording equipment and handling / storage precautions for the archival media may be incorporated into or referred to by the procedures.

7.1.3 The objective of any maintenance activity is to ensure the continued operational availability of the equipment. Maintenance includes both routine maintenance, which may be undertaken by suitably qualified persons at the ATC Unit, and repairs/fault finding which may be carried out by the manufacturer, supplier or a maintenance organisation.

7.2 Recording Equipment Logbook

7.2.1 Details of the operation and maintenance of the recording equipment, the management of the archival media, and visits by authorised persons from the CAA SRG Transcription Unit or ATSSD Regional Office Inspectors shall be recorded in a logbook and preserved for a period of one year, or longer as directed by the CAA (990).

7.2.2 **Acceptable Means of Compliance:** The ATC or Engineering Watch logbook may be used as an alternative to a separate recording equipment logbook if appropriate.

7.2.3 **Guidance:** Where a separate recording equipment logbook is used, it may be advisable to include a brief entry in the ATC or Engineering Watch logbook to note the status or actions concerning the recording equipment with full details being kept in the recording equipment logbook.

7.3 Serviceability and Recording Function Check

7.3.1 A daily check shall be made of the serviceability and recording function of the recording equipment without interrupting the recording of any active communications and including intermediate and archival media storage devices. The results of these checks shall be recorded in the logbook (991).

7.3.1.1 **Acceptable Means of Compliance:** The recording function may be checked manually by making test transmissions on each of the communications channels and confirming that the communications have been recorded and can be replayed. Use may be made of devices or facilities incorporated into the recording equipment which perform automatic checks of the recording function.

7.3.2 A regular check shall be made of the time and date function of the recording equipment, at intervals appropriate to the accuracy of the ATS Unit Clock or Time-Recording Device used as the source. The results of these checks shall be recorded in the logbook (992).

7.3.2.1 **Guidance**: Where the recording equipment time and date function is found to be outside limits, it is acceptable for the discrepancy to be entered into the logbook and a correction made as soon as possible at an appropriate time which does not affect the recording of any active communications or the archiving process.

7.4 Management of Archival Media

7.4.1 Identification

7.4.1.1 Archival media shall each have a unique identity, which shall be used in entries made in the logbook, and shall be shown by the use of an indelible written or printed label firmly attached to the media (993).

7.4.1.2 The records contained on the media shall comply with Article 105 paragraph 3, sub-paragraph c and Schedule 15 Part B of the Air Navigation Order (994).

Guidance: The identity and some of the details required by ANO Schedule 15 Part B may be associated with the media by storing them as a recording on the media in addition to any written or printed information attached to the media.

7.4.2 Storage Capacity

7.4.2.1 The use of the maximum storage capacity available on the archival media, where this equals or exceeds 30 days, shall only be used where the reliability of the recording equipment and the archival media has been demonstrated and the risk of losing data due to the failure of the recording equipment, archival drive or media itself has been minimised (995).

7.4.2.2 **Recommendation:** The archival media should be changed on a daily basis, at appropriate times related to the provision of the ATC Service, or corresponding to ATC and engineering staff duty changes (996).

7.4.2.3 **Guidance:** Whilst advances in technology have produced computer based recording equipment with a variety of archival media drives which are able to record substantial amounts of data, there is an associated risk of losing data due to a failure of the recording equipment or archival drive, which may corrupt the archival media or result in the inability to retrieve recorded data from it.

7.4.2.4 Whilst no universal recommendation can be made as to the number of days data that ought to be held on a single archival media, the retention period of 30 days has been chosen as an upper limit, until such time as more information is available on the failure modes of computer based recording equipment.

7.4.3 Lifetime of Archival Media

7.4.3.1 The archival media shall be replaced before any deterioration results in the loss of recorded data (997).

7.4.3.2 **Acceptable Means of Compliance:** The manufacturer's stated lifetime for the archival media together with media usage data from the logbook may be used as an indicator for replacement. Other means may include tape usage data stored on the media itself or data held within the recording equipment.

7.4.3.3 **Guidance:** Any precautions stated by the manufacturer or supplier of the recording equipment concerning the handling / storage of the archival media are very important in ensuring the integrity of recorded data and achieving the stated lifetimes for the media.

7.5 Retention of Recordings

7.5.1 Recordings on archival media shall be retained for a minimum period of 30 days from the date of the last recorded message (998).

7.5.2 **Acceptable Means of Compliance:** This may be achieved by means of procedures contained in local instruction or by means of the technical capabilities of the voice recording equipment or archival media or a combination of both.

7.6 Impounding of Recordings

7.6.1 On receiving a detailed request concerning recorded transmissions from either the CAA SRG Transcription Unit or the AAIB, normally within the 30 day retention period, archival media containing the specific recorded transmissions shall be removed from normal storage or taken out of use and placed in a separate and secure storage area pending further instructions (999).

7.6.2 **Guidance:** Original recordings may be impounded for a minimum period of three years in the case of accident investigations.

7.7 CAA SRG Access to Recording Equipment

7.7.1 Access to the Recording Equipment shall be permitted to authorised persons from the CAA SRG Transcription Unit, for the purposes of replaying and making copies of original recordings (1000).

7.7.2 **Acceptable Means of Compliance:** If the recording equipment is unable to replay recorded archival media whilst continuing to record communications, then another recorder or dedicated replay-only equipment may be required.

7.8 Prevention of Inadvertent Loss of Recorded Communications

7.8.1 The inadvertent loss of recorded communications, whilst operating the recording equipment, shall be prevented by means of procedures in conjuction with equipment security functions where available (1001).

COM 01 Appendix - Minimum Performance Specification for Recording Equipment

1 Scope

This document comprises the minimum performance specification for analogue and digital recording equipment used at Air Traffic Control Units for the recording of voice and data link communications.

2 General

2.1 Electro Magnetic Compatibility

2.1.1 The recording equipment shall comply with the EMC Directive (1044).

NOTE: Further information is contained in GEN 04.

2.2 Equipment Configuration

2.2.1 The equipment shall be designed with appropriate options to ensure the uninterrupted availability of communications recording (1045).

NOTE: Options might include the duplication of critical internal units such as electronics modules, power supply units, intermediate and archival storage media drives and the ability to interconnect main and standby recording equipment.

2.2.2 Where an option to interconnect main and standby equipment is available, an automatic changeover function shall be provided, which operates the main and standby equipment in parallel to ensure continuity of recordings, for an adjustable time period with a recommended minimum of 10 minutes (1046).

2.3 Alarm / Status Indications

2.3.1 The equipment shall provide appropriate local and remote alarm / status indications including an output to indicate the overall operational status of the equipment (1047).

2.3.2 The remote alarm / status indications shall not be affected by any loss and/or subsequent restoration of electrical power to the equipment (1048).

NOTE: Urgent and non-urgent alarms may be used to distinguish between problems which require immediate attention, such as failure of the recording equipment, and those which do not, such as an impending recording archival media change.

2.4 Time and Date Information

2.4.1 The equipment shall automatically record time (hours/minutes/seconds) and date (day/month/year) information (1049).

2.4.2 Co-ordinated Universal Time (UTC) in hours, minutes and seconds of the 24-hour day beginning at midnight shall be used (1050).

2.4.3 The time shall have an accuracy such that it can be maintained within plus and minus 15 seconds (UTC) (1051), except when data link communications are utilised, when the accuracy shall be plus and minus 1 second (UTC) (1052), within a reasonable period of time and at least for the duration of recording time on a single archival storage media.

2.4.4 The time shall have a resolution of 1 second (1053).

2.4.5 Where an external source is used to derive time and date information the equipment shall incorporate an internal source to be used in the event of failure of the external source or temporary loss of signal from radio time code receivers (1054).

NOTE: The time and date information may be derived from an internal source or via an external interface with the ATC Unit Master Clock where this exists, another common reference source, or a radio time code receivers utilising terrestrial (e.g. MSF &, DCF77) or Global Positioning System signals.

2.5 **Line Interface**

2.5.1 Line interfaces shall be provided which are compatible with telephone connections made via the Public Switched Telephone Network or private lines (1055).

2.5.2 Line interfaces shall be provided which are compatible with radio connections made via the Public Switched Telephone Network or private lines to transmitter, receiver and associated control equipment at 2 Wire or 4 Wire level (1056).

NOTE: Optional modules to provide telephone connection Off-Hook and Ring Detect signals for the contact activation circuits may be incorporated into the line interfaces.

2.6 **Recording Initiation**

2.6.1 **Voice Activation**

2.6.1.1 Voice Activation or Voice Operated Switch (VOX) may be used to initiate recording of telephone signals or other ground-ground communications.

2.6.1.2 The sensitivity of the voice activation circuit shall be adjustable (1057).

2.6.1.3 An adjustable time delay shall be provided after the voice activation circuit releases before recording stops (1058).

2.6.1.4 An adjustable minimum time period shall be provided for the voice activation to prevent spurious responses to noise pulses (1059).

NOTE: Due to the inherent delay with the voice activation circuit responding to initial syllables of speech and delays due to the mechanical inertia in the magnetic tape transport system of analogue equipment, it is possible that initial syllables of speech may not be recorded. The use of a circuit to buffer the signals to be recorded may be used to reduce this effect.

The setting of the voice activation sensitivity is more critical for varying input levels, such as radio signals, which may result in communications not being recorded.

Voice activation is not generally acceptable for radio signals due to these possible effects.

2.6.2 **Contact Activation**

2.6.2.1 Contact activation derived from on / off hook, ring detect or other signaling conditions, may be used to initiate recording of telephone signals or other ground-ground communications.

2.6.2.2 Contact activation derived from transmitter push-to-talk (PTT) and receiver squelch or mute lift conditions shall be used to initiate recording of radio signals (1060).

2.7 Analogue Signal Conditioning

2.7.1 Options for adjusting or disabling Automatic Gain Control (AGC) for individual inputs should be provided where it is used to compensate for variations in line interface levels (1061).

2.7.2 Companding (Compression - Expansion) techniques may be used to match the dynamic range of the line interface levels to that of the recording equipment.

2.8 Human Machine Interface

2.8.1 Audio Output

2.8.1.1 A front panel loudspeaker, volume control and on/off switch shall be provided on the equipment or on a separate remote control panel if this option is provided (1062).

2.8.1.2 A front panel standard headphone socket and volume control shall be provided on the equipment or on a separate remote control panel if this option is provided (1063).

2.8.2 Copy Output

2.8.2.1 A front panel or easily accessible output connector for making copy recordings shall be provided, which may have a preset output adjustment (1064).

2.8.2.2 The output shall comprise one audio channel, which shall be the selected recorded channel, and another audio channel which shall have either a voice synthesised (spoken) time output or tone coded time markers from, or derived from, the time and date information of the original recording (1065).

2.8.3 Security of Recordings

2.8.3.1 Techniques shall be used to reduce the possibility of inadvertent erasure of recorded information (1066).

NOTE: The use of software controlled password, electronic or mechanical keyswitch access or other measures may be appropriate. Where the use of such devices is not feasible, for example with analogue reel to reel magnetic tape recording equipment, then the disabling of the recording/erase mechanism may be necessary, which would then require the provision of a separate bulk erase machine. The use of a single action to record without verification or protection should be avoided.

2.9 Archival Media

2.9.1 The equipment shall utilise removable archival media for the recording of communications (1067).

2.9.2 Guidance on the handling and storage of media shall be provided, as appropriate, with the equipment documentation (1068).

2.10 Replay Functions

2.10.1 The equipment shall be capable of replaying the original recorded communications on archival media in a continuous 'real time' mode and presenting the time and date information separately from but synchronized with the recorded communications (1069).

NOTE: The capability to replay in a continuous ‘real time’ mode, means that the messages can be replayed continuously without interruption or any manual intervention, with any periods of silence or absence of recorded messages re-inserted.

3 Analogue Equipment

Analogue recording equipment is classified as that which records analogue signals in real time directly onto the archival media. Typically magnetic tape reel to reel or cassette transport systems utilising electronic, electrical and mechanical devices are used.

3.1 Recording Check

3.1.1 Devices and/or techniques shall be incorporated to provide a check for successful recording onto archival media (1070).

NOTE: Magnetic tape transport systems can employ off tape monitoring to establish that successful recording has taken place.

3.2 Recording Quality

3.2.1 When compared with a reference of –10dBm at 1,200 Hz, the amplitude variation from 300 Hz to 3,400 Hz shall not exceed ± 3dB (1071)

3.2.2 Signal to noise ratio shall be better than 40 dBA (38dB) when the reference signal is replayed (1072)

3.2.3 Harmonic distortion of the reference signal, replayed at 0dBm, shall not exceed 2.5% (1073)

3.2.4 Crosstalk from adjacent channels shall not exceed 40 dB (1074)

3.2.5 Wow and Flutter shall not exceed 1% (1075)

4 Digital Equipment

Digital recording equipment is classified as that which records digital signals onto intermediate storage media and then regularly transfers the data onto the archival storage media. Magnetic / Optical media archival storage drives utlising electronic, electrical and mechanical devices are used.

4.1 Analogue to Digital Conversion

4.1.1 Voice Coding Scheme

4.1.1.1 The voice coding scheme shall use coding techniques which provide a Mean Opinion Score (MOS) of 4 (Good) or 5 (Excellent), also known as "high quality network speech" or "toll quality speech" (1076).

4.1.1.2 The voice coding scheme shall be able to cope with different types of voice, multiple voices, background noise without any significant deterioration in quality (1077).

4.1.1.3 The voice coding scheme should comply with published European or International standards where available (1078).

NOTE: Voice coding schemes using waveform coding techniques include CCITT G.711 - A/µ-law PCM, CCITT G.721 - ADPCM and CCITT G.728 - LD-CELP.

4.1.2 Data Compression

4.1.2.1 The amount of data compression applied at the analogue to digital conversion either as part of the voice coding scheme or as a separate process, should not significantly degrade the recorded communications (1079).

NOTE: Based on trials involving subjective assessment of data compression of speech for Air Traffic Control applications, 64 kbits/s is the preferred rate (no compression) for Air-Ground communications or radio connections, with 32 kbits/s being an accepted rate (50% compression) for Ground-Ground communications or telephone connections.

4.2 **Intermediate Storage**

4.2.1 Where an intermediate storage device is used, the process by which the communications are transferred onto the archival media shall be automatic (not requiring human intervention) (1080) and shall be secure from attempts to select, alter or interfere in any way with the data (1081).

NOTE: Digital recording equipment may utilise an intermediate storage device such as a hard disk drive (HDD), on which the communications are recorded in real time, before being transferred onto the archival media at regular intervals.

4.2.2 The information on the intermediate storage media shall be transferred onto archival storage media via an appropriate drive mechanism at regular intervals (1082).

4.2.3 The equipment shall use a safe shutdown mode, in the event of power failure or equipment malfunction, to ensure that intermediate storage data is not lost and that the communications can be replayed normally from the archival storage media (1083).

4.3 **Archival Media**

4.3.1 The equipment shall use a safe shutdown mode, in the event of power failure or equipment malfunction, to ensure that any necessary file management information can be written to the archival media, so that the communications can be replayed normally from the archival storage media (1084).

4.3.2 **Recording Check**

4.3.2.1 Devices and/or techniques shall be incorporated to provide a check for successful recording onto archival media (1085).

NOTE: Read after write verification for the intermediate and archive storage media can be used.

4.4 **Recording Quality**

4.4.1 The recording quality shall meet the requirements as for analogue equipment as appropriate (1086).

NOTE: It is anticipated that a suitable measure of recording quality will be defined for digital recording equipment but in the absence of this the quality shall be comparable with that of analogue equipment.

COM 02 VHF Aeronautical Radio Stations

Part 1 Preliminary Material

1 Introduction

1.1 Under the terms of Article 104 (1) of the Air Navigation Order, any Air Traffic Service equipment is required to have CAA approval before being established or used in the United Kingdom. Under the terms of Article 104 (8) an Aeronautical Radio Station is specifically included in the meaning of Air Traffic Service Equipment.

NOTE: The term 'Aeronautical Radio Station' in the definitions contained in the preamble, is taken to include the terms Aeronautical Station and Aeronautical Mobile Station for the purposes of this document.

2 Scope

2.1 This document sets out the engineering requirements for VHF radio equipment and systems at Aeronautical Radio Stations of the Aeronautical Mobile Service established or used within the United Kingdom to provide Air Traffic Services and Radio Communication Services.

NOTE: Air Traffic Services comprise Air Traffic Control (ATC) Service, Flight Information Service (FIS) and Air-Ground Communication Service (AGCS). One or more of these services may be employed in the En-Route Communications Network, at Area Control Centres, and Aerodromes.

2.2 In the absence of any other specific requirements, sections of this document may be applied to Radio Communication Services as appropriate.

NOTE: Radio Communication Services include Operational Control (OPC) Communication Service and what is commonly referred to as 'Sporting and Recreational Users'.

The OPC Communication Service may be provided from Aerodromes or other locations including Off-shore Aeronautical Radio Stations based on fixed and mobile installations and Standby Vessels.

The 'Sporting and Recreational Users' include Gliders, Hang Gliders, Microlights, Parachutists, Balloons. These can be further divided into the categories:- Glider Ground Stations, Common Glider Field Frequency, Balloon Retrieve Vehicle, Parachuting Ground Stations, Hang Glider and Para Glider Ground Stations, Microlight Ground Stations.

2.3 This document applies to fixed, stationary, vehicle, portable and hand held equipment categories comprising transmitter, receiver and transceiver equipment types operating in the VHF Aeronautical Mobile (R) Service allocation 118 MHz to 136.975 MHz, using Double Sideband (DSB) Amplitude Modulation (AM) full carrier with 8.33 kHz or 25kHz channel spacing, intended for analogue voice and data link communications.

3 Definitions and abbreviations

3.1 Definitions

A

Aeronautical Mobile Station	A Station in the Aeronautical Mobile Service, other than an Aircraft Station, intended to be used while in motion or during halts at unspecified points. [Based on ITU RR S1.32, S1.67 & S1.73 and ICAO Annex 10 Volume II Chapter 1]

C

Carrier power (of a radio transmitter)	The average power supplied to the antenna transmission line by a transmitter during one radio frequency cycle taken under the condition of no modulation. [ITU RR S1.159] See Mean Power and Power.
Contingency Equipment	Equipment which is used for business continuity purposes.

D

Designated Operational Coverage	Designated Operational Coverage (DOC) is that volume of airspace needed operationally in order to provide a particular service and within which the facility is afforded frequency protection. [ITU RR S45.1.1] The DOC is quantified by operational range in nautical miles and height in flight level or feet above ground level and defines the limit of the service area associated with the frequency assignment for a particular service. See Radio Service Area.

E

Effective Acceptance Bandwidth	The frequency range over which an applied signal is not rejected by the receiver.
Emergency Equipment	Equipment which is operationally independent of the Main and Standby Equipment, rapidly available for use when required, and used exclusively for the controlled shutdown of an Air Traffic Service in a safe manner.
Equipment Categories	Fixed, Stationary, Vehicle, Portable and Hand Held.
Equipment Redundancy	The use of a combination of Main, Standby and Emergency equipment to improve the overall system reliability and to ensure the continuity of service.
Equipment Types	Transmitter, Receiver and Transceiver.

F

Fixed Equipment	Fixed equipment is that which is permanently installed at a specific location with external connections for power supplies, antennas, audio (microphone and loudspeaker) connections. e.g. Cabinet or rack mounted equipment.
Frequency error	The frequency error is the difference between the measured carrier frequency and its nominal value.

H

Hand Held Equipment	Equipment with integral battery, antenna, PTT key, microphone and loudspeaker, designed to be operated whilst being carried in the hand or worn on the body. Provisions may be made for external connections for antenna, PTT key, microphone, headphone and external power supply or battery pack and desktop cradle or mounting unit, which may enable it to be classified in the Stationary Equipment Category.

L

Limiting Threshold	The limiting threshold is the minimum audio input level, at the modulation input of a transmitter, required to produce a modulation depth, of 85% with a 1 kHz sinewave test signal.

M

Main Equipment	The terms 'Main' and 'Standby' are generally used to describe identical or similar equipment, configured within a system to provide equipment redundancy, in order to improve the overall reliability and to ensure the continuity of service. The terms may also be applied to sub-equipment and modules as well as facilities, functions and services.
Mean power (of a radio transmitter)	The average power supplied to the antenna transmission line by a transmitter during an interval of time sufficiently long compared with the lowest frequency encountered in the modulation taken under normal operating conditions. [ITU RR S1.158] See also Carrier Power and Power.

P

Portable Equipment	Equipment with integral battery, antenna, PTT key, microphone and loudspeaker, designed to be operated as a self contained unit either whilst being carried or at a temporary location. Provisions may be made for external connections for antenna, PTT key, microphone, headphone and external power supply or battery pack, which may enable it to be classified in the Stationary Equipment Category.

Power (of a radio transmitter)	The power of a radio transmitter can be expressed in terms of peak envelope power (PX or pX), mean power (PY or pY) and carrier power (PZ or pZ) according to the class of emission. The symbol 'p' denotes power expressed in watts and symbol 'P' denotes power expressed in decibels relative to a reference level. [Based on ITU RR S1.156]
Psophometric Filter	A psophometric telephone filtering network as described in ITU-T Recommendation P.53 'Psophometer for use on telephone-type circuits'. **NOTE:** The filter characteristic models the audio frequency response of the human ear and is used in noise and signal measurements on telephone circuits and voice communications systems.

R

Radio Service Area	The Radio Service Area is that volume of airspace, bounded by the DOC and a lower height limit within which communications of a specified quality of service are provided. An alternative to defining a lower height limit, where this cannot easily be defined for the whole of the DOC, is to identify areas where the communications quality of service is below that specified.

S

Spurious emission	Emission on frequency or frequencies which are outside the necessary bandwidth and the level of which may be reduced without affecting the corresponding transmission of information. Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products, but exclude out-of-band emissions. [ITU RR S1.145]
Standby Equipment	The terms 'Main' and 'Standby' are generally used to describe identical or similar equipment, configured within a system to provide equipment redundancy, in order to improve the overall reliability and to ensure the continuity of service. The terms may also be applied to sub-equipment and modules as well as facilities, functions and services.
Stationary Equipment	Stationary equipment is that which is installed at a specific location with external connections for power supplies, antennas, audio (microphone and loudspeaker) connections, which is physically mounted such that it can easily be moved once external connections have been released. e.g. Desktop equipment.

V

Vehicle Equipment	Equipment designed for operation and permanent or temporary installation in a vehicle with provision for external connections to vehicle battery, antenna, PTT key, microphone and loudspeaker. Provisions may be made for use of an external power supply or battery pack and desktop cradle or mounting unit, which may enable it to be classified in the Stationary Equipment Category.

W

WT Act	Wireless Telegraphy Act 1949.

3.2 Abbreviations

A

ACARS	Aircraft Communications Addressing and Reporting System
AGCS	Air-Ground Communications Service

C

CEPT	Conference Européenne des Administration des postes et des télécommunications. (European Conference of Postal and Telecommunications Administrations.)

D

D8PSK	Differential Eight Phase Shift Keying

E

ETSI	European Telecommunications Standards Institute

G

GFSK	Gaussian Frequency Shift Keying

M

MSK	Minimum Shift Keying

P

ppm	Parts per million

R

RA	Radiocommunications Agency
RIS	Radio Investigation Service

S

SINAD	(Signal + Noise + Distortion)/(Noise + Distortion)

V

VDL	VHF Digital Link

4 References

1) ETSI EN 300 676 V1.2.1 (2000-05) European Standard (Telecommunications series) 'Electromagnetic compatibility and Radio spectrum Matters (ERM); Ground-based VHF hand-held, mobile and fixed radio transmitters, receivers and transceivers for the VHF aeronautical mobile service using amplitude modulation; Technical characteristics and methods of measurement'.

2) ETSI EN 301 841-1 V1.1.1 (2002-01) European Standard (Telecommunications series) 'Electromagnetic compatibility and Radio spectrum Matters (ERM); VHF air-ground Digital Link (VDL) Mode 2; Technical characteristics and methods of measurement for ground-based equipment, Part 1: Physical layer'.

3) Draft ETSI EN 301 842-1 V1.1.1 (2001-05) European Standard (Telecommunications series) 'Electromagnetic compatibility and Radio spectrum Matters (ERM); VHF air-ground Digital Link (VDL) Mode 4 radio equipment; Technical characteristics and methods of measurement for ground-based equipment, Part 1: General description and physical layer'.

NOTE 1: ETSI European Standards are available in electronic (PDF) format from the ETSI Web Site at http://www.etsi.org/ or in printed format from BSI at the address given below:

BSI - British Standards Institution
Customer Services (GB)
389 Chiswick High Road
LONDON
W4 4AL
UNITED KINGDOM

Telephone: +44 (0) 208 996 9001
Fax: +44 (0) 208 996 7001
E mail: cservices@bsi-global.com

NOTE 2: Draft ETSI European Standards are available from BSI and more information can be found from the UK ETSI Web Site at http://edd.bsi.org.uk/link.php3/tct/101

4) ICAO Annex 10 Aeronautical Telecommunications Volume III - Communication Systems Part I - Digital Data Communication Systems; Part II - Voice Communication Systems.

5) ICAO Annex 10 Aeronautical Telecommunications Volume V (Aeronautical Radio Frequency Spectrum Utilization).

NOTE: The Catalogue of ICAO Publications can be found at the ICAO Web Site at http://www.icao.int/. The ICAO Annex 10 Aeronautical Telecommunications Volume V is available from the ICAO or the UK Sales Agent at the addresses given below:

ICAO
Document Sales Unit
999 University Street
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Gloucestershire
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Telephone: +44 (0) 1242 283 100
Fax: +44 (0) 1242 584 139
E mail: sales@documedia.co.uk

6) CAA Paper 96006 Co-Channel Interference Study (Report prepared by Roke Manor Research Ltd and published by the CAA).

NOTE: CAA publications are available from Documedia Ltd at the address given below:

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Telephone: +44 (0) 1242 283 100
Fax: +44 (0) 1242 584 139
E mail: sales@documedia.co.uk

7) EUROCAE ED-67 'Minimum Operational Performance Specification for devices that prevent unintentional or continuous transmissions' April 1991.

NOTE: Information on EUROCAE Publications can be found at the EUROCAE Web Site at http://www.eurocae.org/ Documents can either be purchased on line or from EUROCAE at the address given below:

EUROCAE
17, rue Hamelin
75116 Paris
FRANCE

Telephone: +33 1 4505 7188
Fax: +33 1 4505 7230
E mail: eurocae@eurocae.com

Part 2 Requirements

5 Safety objective

The equipment and systems at Aeronautical Radio Stations shall provide complete, identified, accurate and uncorrupted voice and data link communications for Air Traffic Services and Radio Communication Services (1002).

6 General Requirements

The requirements in this section are applicable to equipment and systems at all Aeronautical Radio Stations operating on Aeronautical Mobile (R) Service frequency assignments.

6.1 **International Standards**

NOTE: This document incorporates the relevant SARPs from ICAO Annex 10 and Annex 11 together with material from the ITU Radio Regulations.

6.1.1 The equipment, systems, services and facilities shall comply with the applicable international standards, recommended practices and procedures for air navigation services in Annex 10 and Annex 11 to the Convention on International Civil Aviation (376).

6.1.2 The equipment, systems, services and facilities shall comply with the applicable Radio Regulations of the International Telecommunications Union (377).

6.2 **Radio Spectrum Management**

6.2.1 The equipment and systems shall be designed and constructed to operate within the Aeronautical Mobile (R) Service allocation 117.975 MHz to 137.000 MHz (378). The first and last assignable frequencies being 118.000 MHz and 136.975 MHz. For radiotelephony channel spacing is either 25 kHz or 8.33 kHz using Double Sideband (DSB) Amplitude Modulation (AM) full carrier with ITU emission designator 6K80A3EJN for 25 kHz and 5K00A3EJN for 8.33 kHz channel spacing (379). For data link communications channel spacing is 25 kHz using Double Sideband (DSB) Amplitude Modulation (AM) full carrier with ITU emission designators 13K0A2DAN for ACARS using MSK modulation, 14K0G1D for VDL Mode 2 using D8PSK modulation and 13K0F7D for VDL Mode 4 using GFSK modulation (380).

NOTE 1: The equipment and systems are only required to be capable of operation in the modes specified by the ANO Approval. However, new equipment may be purchased with options for other modes of operation to cater for future operational requirements.

NOTE 2: At a future date equipment and systems at specific Aeronautical Stations may be required to be capable of operation with a channel spacing of 8.33 kHz to provide an Air Traffic Control Service.

6.2.2 The equipment and systems shall be installed, operated and maintained in compliance with the terms of specific location dependent or general frequency assignment(s) and the terms and conditions of an ANO Approval granted in respect of the Air Traffic Services or Radio Communication Services being provided (381).

Guidance: The frequency assignments may include parameters such as the DOC, minimum field strength within the DOC, maximum field strength outside the DOC and/or minimum and maximum effective radiated power (ERP). These parameters are designed to support reliable communications and to reduce the probability of co-channel or adjacent channel interference to other users.

For Radio Communication Services the frequency assignments may be made on a shared non-interference basis. Where the DOC associated with these frequency assignments is comparable in size to the UK FIR it is unlikely that reliable communications will be achieved over the whole radio service area and it is not expected that providers will be able to achieve a minimum field strength within the whole DOC.

6.2.3 The DOCs associated with the frequency assignments shall be published to enable aviation users to restrict the use of Air to Ground Communications to the designated airspace (382).

NOTE: Aircraft radio transmissions outside of the DOC are a known source of co-channel and adjacent channel interference to other users.

6.2.4 **Recommendation:** The effective radiated power should be such to provide a minimum field strength of 45 dBμV/m within the radio service area for Air Traffic Services, or such a minimum field strength or minimum effective radiated power as may be specified by the ANO Approval (383).

[Based on ICAO Annex 10 Aeronautical Telecommunications Volume III § 2.2.1.2 Power and Volume V Attachment A § 2.4.]

Guidance: The ICAO Annex 10 Volume III § 2.2.1.2 recommendation specifies that 'On a high percentage of occasions, the effective radiated power should be such as to provide a field strength of at least 75 μV/m (- 109 dBW/m^2) within the defined operational coverage of the facility, on the basis of free space propagation.' This field strength has been assumed to be the median (50 percentile) value and to achieve the 'high percentage of occasions' has been adjusted to a 95 percentile value, considered appropriate for Air Traffic Services, by the use of an additional margin of 8dB based on CCIR (ITU) Recommendation 529-2 using the expression [20 log 75 dBμV/m + 8 dB]. Further information may be found in reference [6].

6.3 WT Act Aeronautical Radio Licence

6.3.1 All Aeronautical Radio Stations shall be suitably licensed under the WT Act prior to any transmissions being made (384).

6.3.2 For new installations that operate on aeronautical frequency assignments, initial applications to establish an Aeronautical Radio Station shall be made to ATSSD, which will trigger a request for a WT Act aeronautical radio licence (385).

Guidance: The Civil Aviation Authority's Directorate of Airspace Policy (DAP) has been appointed by the Radiocommunications Agency as its agent for WT Act aeronautical radio licences.

For established Aeronautical Radio Stations which have ANO Approval, WT Act aeronautical radio licence renewal will be arranged directly between DAP and the service provider.

Failure to renew a WT Act aeronautical radio licence will invalidate the associated ANO Approval. If a service provider does not renew their WT Act aeronautical radio licence within a reasonable period of that licence becoming invalid, the associated frequency assignment will be withdrawn. Co-incident with the withdrawal of the frequency assignment the ANO Approval will be withdrawn. Renewal after the withdrawal of the ANO Approval will be treated as a new application, which may lead to delay and service provider expense in re-establishing an Aeronautical Radio Station.

NOTE: All new Aeronautical Radio Stations must have been assessed under the Air Navigation Order Article 104 by the CAA SRG Air Traffic Services Standards Department before a WT Act aeronautical radio licence can be issued.

6.4 Minimum Performance Specifications

6.4.1 Equipment and systems intended for analogue voice and ACARS data link communications shall comply with the Minimum Performance Specification in Appendix 1 of this document as a precursor to ANO Article 104 Approval (386).

Acceptable Means of Compliance: Compliance with ETSI EN 300 676 [1] will be recognised as an acceptable means of compliance with the Minimum Performance Specifications in Appendix 1 of this document.

Guidance: Demonstration of compliance with the Minimum Performance Specifications in Appendix 1 of this document or ETSI EN 300 676 [1] may be achieved by submitting a test report from a suitable radio test facility.

NOTE: UK CAA SRG or JAA Aircraft Radio Equipment approval is not an acceptable means for demonstrating compliance with this requirement.

6.4.2 Equipment and systems intended for VDL Mode 2 data link communications shall comply with ETSI EN 301 841-1 [2] (387).

Guidance: Demonstration of compliance with ETSI EN 301 841-1 [2] may be achieved by submitting a test report from a suitable radio test facility.

6.5 Inspection of Aeronautical Radio Stations

6.5.1 The equipment and systems at aeronautical radio stations, associated records and WT Act Aeronautical Radio Licence shall be made available for inspection by an authorised person, being a CAA SRG Inspector or a Radiocommunications Agency Radio Investigation Service Officer (388).

Guidance: Demonstration of compliance with the terms and conditions of the ANO Approval and WT Act Aeronautical Radio Licence may be required. This may include measurements to verify transmitter frequency, modulation depth, transmitter output power and a determination of effective radiated power. The ATS Provider responsible for the operation of the Aeronautical Radio Station would normally be expected to provide calibrated measurement equipment for this purpose.

NOTE: Where the transmitter output power is not adjustable, and is at a level which may result in the effective radiated power permitted by the ANO Approval being exceeded, a means for reducing the power will be required to be fitted prior to operation of the equipment.

6.6 Electro Magnetic Compatibility

6.6.1 VHF Radio Equipment and Systems at Aeronautical Radio Stations shall comply with the EMC Directive (389).

NOTE: Further information is contained in GEN 04.

6.7 Maintenance of Aeronautical Radio Stations

6.7.1 Maintenance arrangements shall be established for equipment and systems at Aeronautical Radio Stations associated with the provision of Air Traffic Control Services (390).

NOTE: Further information is contained in APP 02.

6.7.2 Maintenance procedures shall be established for equipment and systems at Aeronautical Radio Stations associated with the provision of Flight Information Service (FIS), Air-Ground Communication Service (AGCS) and Radio Communications Services and appropriate actions taken to ensure the continued compliance with the WT Act Aeronautical Radio Licence, ANO Approval and other applicable standards or requirements (391).

Recommendation: Regular functional and performance checks, including measurements to verify transmitter frequency, modulation depth, output power and a determination of effective radiated power using calibrated measurement equipment, should be undertaken (392).

6.7.3 A record of any functional test, flight checks and particulars of any maintenance, repair, overhaul, replacement or modification shall be kept in respect of the equipment and systems at Aeronautical Radio Stations, as required under ANO Article 105 (1) in accordance with Part A of Schedule 15, (1006) and the records shall be preserved for a period of one year or longer as directed by the CAA (393).

7 Specific Requirements

7.1 Communications Availability

The design, installation, operation and maintenance of equipment and systems shall be such as to ensure an availability of communications appropriate for the Air Traffic Services and Radio Communication Services being provided (394).

Guidance: The availability of communications is dependent on the radio system design, including equipment configuration and power supply arrangements. The selection of equipment with the appropriate duty cycle can also reduce equipment failure. The provision of alarm / status indications is also important in ensuring that appropriate actions are taken to restore communications when a failure occurs.

7.1.1 Radio System Design

7.1.1.1 Communications of a specified quality of service shall be provided within the radio service area appropriate to the services being provided (395).

7.1.1.2 The maximum field strength outside the DOC, as specified in the frequency assignment, shall not be exceeded (396).

Acceptable Means of Compliance: Evidence to demonstrate that the defined quality of service and any other conditions associated with the frequency assignment have been met within the radio service area.

For Air Traffic Control Communications, a combination of radio service area predictions and functional tests would be acceptable. For other Air Traffic Services limited functional tests would be acceptable.

Guidance: Quality of service comprises the two aspects of signal (voice or data) quality and availability. Signal quality can be defined by signal to noise ratio or SINAD for analogue systems and by bit error ratio for digital systems. The availability can be defined in terms of a percentage of time and location.

Where co-channel and adjacent channel interference are the limiting factors, signal quality is directly related to the desired-to-undesired (D/U) signal ratio criteria used in the frequency assignment planning process, the results of which give a minimum field strength within the DOC which should be achieved and a maximum field strength outside the DOC which must not be exceeded. The signal quality at the receiver can be affected by local noise and interference effects such as man made noise and precipitation static.

NOTE: Radio system design includes the consideration of location dependent factors such as a clear radio line of sight, location of antenna, antenna type, transmitter power etc... to ensure reliable radio propagation paths are achieved.

7.1.1.3 **Recommendation:** The Radio Service Area should be published to provide aviation users with information on the anticipated service volume within which reliable communications may be expected (397).

NOTE: Where the communications quality of service cannot easily be achieved uniformly over the service volume at the lower height limit of the Radio Service Area, an alternative is to publish the DOC and to identify areas within which the quality of service is not achieved. (See 3.1 Definitions of DOC and Radio Service Area.)

7.1.1.4 The antennas shall be installed such as to provide vertically polarised radiation (398).

7.1.2 Equipment Configuration

7.1.2.1 The equipment configuration shall be such as to ensure the availability of communications appropriate to the service being provided (399).

NOTE: The configuration of equipment includes associated antennas, cables, filters, commutation units and other equipment necessary for the operation of the equipment and systems.

Acceptable Means of Compliance:

Air Traffic Control Services – The provision of main, standby and emergency equipment redundancy together with system and location dependent redundancy measures.

Air Traffic Services (non-ATC) – For Flight Information Services, the provision of main, and emergency equipment redundancy. For Air-Ground Communication Services, the provision of main equipment is considered sufficient for this level of service.

NOTE: Equipment provided in addition to the above would be considered to be Contingency Equipment.

7.1.2.2 The equipment type shall be appropriate for the service being provided and be compatible with the equipment configuration (400).

Guidance: Whilst it is feasible to use transceivers and separate receivers to derive Off-Air Sidetone for Air Traffic Control and the output for Voice Recording, the lack of redundancy in the modules within typical transceivers and the likelihood of an intermittent duty cycle restriction on the transmitter and power supply mean that transceivers are not generally suitable for use in Air Traffic Control Services as main or standby equipment, although they may be suitable for emergency equipment in particular situations.

For Flight Information Services, a transceiver or separate transmitter and receiver are considered suitable as main equipment, with a hand held or portable transceiver being used for emergency equipment.

NOTE: Main and Standby equipment may be operated as 'System A' and 'System B' where either may be considered as Main whilst in operational service and the other is considered as Standby, awaiting selection in the event of failure of the Main equipment or when the Main equipment is taken out of service for maintenance.

7.1.3 **Duty Cycle - Radio Transmitters / Power Supply Units**

The duty cycle for Radio Transmitters and associated Power Supply Units shall be appropriate for the service being provided (401).

Guidance: Air Traffic Control Services are likely to generate peaks in use which may exceed the duty cycle of equipment rated for intermittent use and thus continuously rated equipment with a duty cycle of 100% is likely to be required. VHF Radio Transmitters used for ATIS and VOLMET obviously require continuously rated equipment.

7.1.4 **Power Supply**

7.1.4.1 For an Air Traffic Control Service, the power supply for the emergency equipment shall be independent of that for the main equipment (402).

Acceptable Means of Compliance: The independence of the power supplies need only be for a known limited period provided that the MATS Part 2 procedures manage the safety issues this introduces.

7.1.4.2 Users shall be provided with an indication of failure of the power supply to the emergency equipment (403) and instructions shall be provided in MATS Part 2 for user actions in the event of failure (404).

7.1.4.3 **Recommendation:** For an Air Traffic Control Service a primary and alternative power supply should be provided to increase the availability of power to equipment and systems in the event of an interruption to one of the power supplies (405). Change over between supplies should be on a 'no break' basis (406). The primary and alternative supplies should be independent of each other for a known period of time (407). An indication of failure for each power supply should be provided to the user (408) and corrective action taken in the event of failure (409). MATS Part 2 procedures should instruct the user of actions necessary in the event of failure (410).

[ICAO Annex 10 Aeronautical Telecommunications Volume I Paragraph 2.9 Secondary power supply for radio navigation aids and communication systems.]

7.1.4.4 **Guidance:** The incorporation of suitable conditioning devices as part of the power supply arrangements may be useful in preventing equipment malfunction due to surges, spikes and noise on the power supply.

7.1.5 Alarm / Status Indications

For an Air Traffic Control Service, the system shall provide an indication of system failure that may have an effect on the service being provided, in a timely manner (411), so that actions can be taken to ensure the safe continued provision of an ATC Service or if necessary the controlled withdrawal of the service (412).

Recommendation: The Significance to the user of the indication of failure should be obvious from the indication given (413).

The failure indication should remain obvious to the user whilst the condition causing the failure indication remains (414). Consideration should be given to providing a power supply to the alarm indication that is not dependent upon the system it is monitoring (415).

Changes in the System's state should attract the operator's attention, without continuing to distract once they are aware of the change of state (416). Attention should be drawn both when failures are detected and when they clear (417). Attention to subsequent status changes should not be masked (418). The attention seeking indication should have both visual and audible elements and the ability for the user to acknowledge that they are aware of the change of state thereby removing the attention seeking element (419).

7.2 Interface to Voice / Data Recording Equipment

7.2.1 The system at Aeronautical Radio Stations shall provide all the necessary signals and information to the Voice / Data Recording Equipment in compliance with Article 105 of the Air Navigation Order (420).

Acceptable Means of Compliance: For Aeronautical Radio Stations using a separate transmitter and receiver, the receiver audio output may be used as the signal source for the recording equipment. For Aeronautical Radio Stations using a transceiver, a separate receiver on the same frequency will be required.

Guidance: Where a separate transmitter and receiver are used, an 'off-air' sidetone will be present at the audio output of the receiver when the associated transmitter is operated.

Where a transceiver is used, the receiver is normally muted in transmit mode, and sidetone is not present at the audio output. A separate receiver and antenna can be used to derive an 'off-air' sidetone.

If a separate receiver is used to record aircraft station transmissions, the antenna and receiver combination must provide a signal comparable in strength and reception area to that of the main antenna and transceiver.

7.3 Provision of Off-air Sidetone

NOTE: Reference should be made to COM 03 Voice Communications Control Systems, RTF Communications.

7.3.1 Where Off-air sidetone is provided for Air Traffic Services, it shall be a replica of the transmitted voice communications without any degradation of quality such as to cause annoyance or disturbance to the operator (421).

NOTE: The Acceptable Means of Compliance and Guidance in paragraph 7.2.1. can be applied as appropriate to the provision of Off-air Sidetone.

7.4 Provision of Emergency Frequency 121.500 MHz

7.4.1 The emergency frequency 121.500 MHz shall be provided at area control centres and flight information centres; aerodrome control towers and approach control offices serving international aerodromes and international alternative aerodromes (422).

7.5 Unintentional or Continuous Transmissions

NOTE: Reference should be made to COM 03 Voice Communications Control Systems, RTF Communications.

7.5.1 The equipment and systems at Aeronautical Radio Stations shall not fail in a manner such as to cause unintentional or continuous transmissions (423).

7.5.2 **Recommendation:** New equipment and systems at Aeronautical Radio Stations should incorporate features to prevent unintentional or continuous transmissions, unless this is contrary to the intended purpose for which they have been designed (424). For existing equipment and systems, consideration should be given to incorporating such devices by retrofit, modification or add-on circuitry where appropriate (425).

The equipment and systems should conform to the 'Minimum Operational Performance Specification for devices that prevent unintentional or continuous transmissions' EUROCAE document ED-67 April 1991 [7], so far as it is appropriate for ground based systems (426).

COM 02 Appendix - Minimum Performance Specification for ground-based transmitters, receivers and transceivers for the VHF aeronautical mobile service intended for analogue voice and ACARS data link.

1 Scope

1.1 This document comprises the minimum performance specification for ground-based transmitters, receivers and transceivers for the VHF aeronautical mobile service intended for analogue voice and ACARS data link.

1.2 This document has been written to be used in the initial assessment of the performance of the equipment and the production of a test report as a means of demonstrating compliance with the minimum performance specification requirements in order to qualify for acceptance as being suitable for approval by the CAA under ANO Article 104.

1.3 This document is based on ICAO Annex 10 Volume III [4], the ITU Radio Regulations and ETSI EN 300 676 [1].

2 General

The requirements in this section may be determined by inspection or testing of the equipment, or based on a manufacturer's declaration or other supporting evidence.

2.1 Assignable Frequencies / Channel Labelling

2.1.1 8.33 kHz Channel Spacing - Assignable Frequencies

Equipment designed for 8.33 kHz channel spacing shall be able to operate on all frequencies in Group F of the List of Assignable Frequencies, Appendix to Chapter 4, ICAO Annex 10 Volume V [5] (1007).

2.1.2 8.33 kHz Channel Spacing - Channel Labelling

The channel labelling used for 8.33 kHz channel spacing shall be based on a channel / frequency pairing in accordance with table 4-1 (bis) of paragraph 4.1.2.4, Chapter 4, ICAO Annex 10 Volume V [5] (1008).

2.1.3 25 kHz Channel Spacing - Assignable Frequencies

Equipment designed for 25 kHz channel spacing shall be able to operate on all frequencies between 118.000 MHz and 136.975 MHz in accordance with paragraph 4.1.2.3, Chapter 4 and Groups A, B, C, D & E of the List of Assignable Frequencies, Appendix to Chapter 4, ICAO Annex 10 Volume V [5] (1009).

2.2 Transmitter Operation

2.2.1 Transmitter Frequency Synthesiser

The transmitter shall be inhibited while any frequency synthesiser used within the transmitter is out of lock (1010).

2.2.2 Transmitter Switching Operations

The transmitter shall be inhibited during channel / frequency switching operations (1011).

2.3 **Controls and Indicators**

The equipment shall have the following controls and indicators as a minimum:

- a visual indication that the device is switched on (1012)
- a facility to disable the squelch for test purposes (1013)
- a visual indication that the carrier is being produced (1014)

The equipment shall comply with the following condition:

- user access to any control, which if wrongly set might impair the technical characteristics of the equipment, shall be prevented under normal conditions of operation (1015).

2.4 **Class of Emission and Modulation Characteristics**

The equipment shall use Double Side Band (DSB) Amplitude Modulation (AM) full carrier, with ITU emission designator 6K80A3EJN for 25 kHz and 5K00A3EJN for 8.33 kHz channel spacing analogue voice and 13K0A2DAN using MSK modulation for 25 kHz channel spacing ACARS data link communications (1016).

3 Technical Characteristics

3.1 **Normal Test Conditions**

3.1.1 **Temperature and Humidity**

The temperature and humidity conditions for tests shall be a combination of temperature, within the range +15°C to +35°C, and humidity, within the range 20% to 75%, representative of that under normal operating conditions (1017).

3.2 **Receiver Test Signal Arrangement**

3.2.1 **Test Signal Sources**

Test signal sources shall be connected to the receiver input in such a way that the impedance presented to the receiver input is 50 Ω, irrespective of whether one or more test signals are applied to the receiver simultaneously (1018).

3.2.2 **Nominal Frequency**

The nominal frequency of the receiver is the carrier frequency of the selected channel.

3.2.3 **Normal Test Signal**

The normal test signal shall be a Double Side Band signal with carrier, amplitude modulated with 1 kHz sinewave to a depth of 30 % (1019).

3.2.4 **Squelch**

Unless otherwise stated the receiver squelch facility shall be made inoperative for the duration of the tests (1020).

3.2.5 **Normal Audio Output Power**

The rated audio frequency output power is the value stated by the manufacturer to be the maximum power available at the output, for which all the requirements of this document are met.

The normal audio frequency output power shall be maintained at 50 % of the rated output in the presence of a desired signal unless otherwise defined (1021).

3.3 Transmitter Test Arrangements

3.3.1 Coaxial Termination

The transmitter output shall be connected to a non-reactive, non radiating 50 Ω coaxial termination (1022).

3.3.2 Normal test signal

The normal test signal shall be a 1kHz sinewave at a level that produces a 30 % amplitude modulation depth, of the transmitter RF output, unless otherwise defined (1023).

3.4 Test Channels

Unless otherwise stated the equipment shall be tested on the following three frequencies under non-radiating conditions (1024):

118.000 MHz

127.500 MHz

136.975 MHz

3.5 Methods of Measurement

The methods of measurement used shall be defined in the test report (1025). Suitable methods of measurement can be found in ETSI EN 300 676 [1]

3.6 Transmitter Parameters

3.6.1 Frequency Error

The frequency error is the difference between the measured carrier frequency and its nominal value. The carrier frequency shall be measured under normal test conditions on each of the test channels, in the absence of modulation with the transmitter connected to a coaxial termination (1026) and shall be within the values specified below for the appropriate station configuration and channel spacing (1027):

Station Configuration	Channel Spacing	Frequency Error
Single Carrier	8.33 kHz	± 1 ppm
Single Carrier	25 kHz	± 20 ppm
2 Carrier Offset	25 kHz	± 15.3 ppm
3 Carrier Offset	25 kHz	± 5 ppm
4 Carrier Offset	25 kHz	± 3.8 ppm
5 Carrier Offset	25 kHz	± 0.3 ppm

3.6.2 Carrier Power

The carrier power is the mean power delivered to the coaxial termination during transmission in the absence of modulation. The carrier power shall be measured under normal test conditions on each of the test channels, in the absence of modulation (1028) and shall not vary by more than ± 1.5 dB from the manufacturer's rated output power (1029). Where the transmitter carrier power is adjustable, the measurements shall be made at the lowest and highest power output level at which the transmitter is intended to operate (1030).

3.6.3 **Amplitude Modulation**

The amplitude modulation depth for speech shall be at least 85% with a 1 kHz sinewave test signal set to a level 3 dB above the limiting threshold applied to the speech modulation input (1031).

NOTE 1: The limiting threshold is defined as the minimum audio input level required to produce a modulation depth of 85 % with a 1 kHz sinewave test signal.

NOTE 2: The average modulation depth for speech should be maintained at the highest practicable level without overmodulation. [ICAO Annex 10 Volume III Part II Recommendation 2.2.1.4]. This may be achieved by a number of techniques including audio frequency and radio frequency signal processing.

The amplitude modulation depth for data shall be at least 85% with a 1 kHz sinewave test signal set to a level of 0 dBm applied to the data modulation input (1032).

3.6.4 **Conducted spurious emission**

The conducted spurious emissions shall be measured with the transmitter connected to the coaxial termination and operating on the test channel of 127.500 MHz in the absence of modulation (1033).

The measurements shall be made over a frequency range from 30 MHz to 1 GHz, with a reference bandwidth of 100 kHz, excluding the channel on which the transmitter is operating and an exclusion band of ±1 MHz from the centre frequency of the emission (1034).

For transmitters installed on or before 1st January 2003 (valid until 1st January 2012)

The power level of any measured spurious emissions shall be less than the value given by the transmitter rated power minus the attenuation (dBc) given in the table below, without exceeding the absolute power level (1035).

Transmitter Rated Power	Attenuation	Power Level
> 25 W	60 dBc	1 mW
≤ 25 W	40 dBc	25 μW

For transmitters installed after 1st January 2003 and for all transmitters after 1st January 2012

The power level of any measured spurious emissions shall be less than the value given by the transmitter rated power in Watts (P) minus the attenuation (dBc) given by the less stringent limit of 70 dBc or ($43 + 10 \text{ Log}_{10}$ (P)) dBc (1036).

3.7 **Receiver Parameters**

3.7.1 **Frequency Error**

The frequency error, measured under Normal Test Conditions, shall be within ± 1 ppm for 8.33 kHz and ± 20 ppm for 25 kHz channel spacing (1037).

3.7.2 **Sensitivity**

The sensitivity of the receiver is the minimum level of signal, at the nominal frequency with normal test modulation, which when applied to the input produces normal audio output power at a SINAD ratio of 12 dB measured at the receiver output using a psophometric filter.

The measured sensitivity shall be at least –101 dBm on each of the test channels (1038).

3.7.3 **Effective Acceptance Bandwidth**

The effective acceptance bandwidth is the frequency range over which the receiver output exceeds a specified SINAD ratio for a defined input signal. The designed effective acceptance bandwidth takes into account receiver frequency error, intermediate frequency filter responses and doppler shift allowance for aircraft transmissions.

The effective acceptance bandwidth shall be at least ± 8.5 kHz for 25 kHz receivers and ± 2.8 kHz for 8.33 kHz receivers from the nominal frequency with a normal test signal applied to the receiver input at a level of 6dB above that which produces a SINAD ratio of 12dB measured at the receiver output using a psophometric filter (1039).

For receivers intended for use with 3, 4, and 5 offset channels the effective acceptance bandwidth shall be at least ± 11 kHz (1040).

3.7.4 **Adjacent Channel Rejection**

The adjacent channel rejection is a measure of the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of an unwanted modulated signal, differing in frequency from the wanted signal by the channel spacing. The adjacent channel rejection shall be measured at the upper and lower adjacent channels (1041).

The upper and lower adjacent channel rejection shall be greater than 60 dB (1042)

3.7.5 **Conducted spurious emission**

The conducted spurious emission, measured over a frequency range from 30 MHz to 1 GHz, with a reference bandwidth of 100 kHz, shall be less than –30 dBm (1 μW) (1043).

COM 03 Voice Communications Control Systems

Part 1 Preliminary Material

1 Introduction

1.1 Under the terms of Article 104 (1) of the Air Navigation Order, any Air Traffic Service Equipment is required to have CAA approval before being established or used in the United Kingdom.

1.2 This document covers Voice Communications Control Systems (VCCS) providing communications facilities for the following categories of service described in ICAO Annex 11 Chapter 6 'Air Traffic Services Requirements for Communications':

'The Aeronautical Mobile Service (Air-Ground Communications) which uses radiotelephony and/or digital data interchange for radio communications in the VHF Aeronautical Mobile Band'.

'The Aeronautical Fixed Service (Ground-Ground Communications) which uses direct-speech communications and/or digital data interchange over radio communications links and other telecommunications media such as optical fibre and land lines'.

'The Surface Movement Control Service which uses two-way radiotelephony communications to provide an aerodrome control service for the control of vehicles on manoeuvring areas, except where communication by a system of visual signals is deemed to be adequate'.

1.3 The structure of this document has been arranged to consider these services under the broad heading of 'COMMUNICATIONS FACILITIES'. The Aeronautical Mobile Service and the Surface Movement Control Service are normally provided using radio communications and will be referred to by the description 'radiotelephony communications' abbreviated to 'RTF communications'. The Aeronautical Fixed Service incorporating telephone and interposition communications (Intercom) will be referred to by the description 'Ground-Ground Communications'. The term 'lines of communication' covers both 'RTF communications' and 'Ground-Ground Communications'.

2 Scope

This document sets out the engineering requirements for VCCS communications facilities established or used at locations within the United Kingdom providing Air Traffic Services.

3 References

1) ICAO Annex 11 — Air Traffic Services.
2) ICAO Annex 10 Aeronautical Telecommunications Volume III - Communication Systems Part I - Digital Data Communication Systems; Part II - Voice Communication Systems.

Part 2 Requirements

4 Safety Objective

The VCCS shall enable direct, rapid, continuous and intelligible two-way voice communications for Air Traffic Services (1087).

5 General Requirements

5.1 International Standards

5.1.1 The equipment, systems, services and facilities shall comply with the applicable international standards, recommended practices and procedures for air navigation services in Annex 10 [2] and Annex 11 [1] to the Convention on International Civil Aviation (1088).

5.2 Electro Magnetic Compatibility

5.2.1 The VCCS shall comply with the EMC Directive (1089).

NOTE: Further information is contained in GEN 04.

6 Communications Facilities

6.1 General

6.1.1 The operator shall have clear visual and audible indication of the status of all available lines of communication (1090).

6.1.2 The operator shall have the ability to select or deselect independently lines of communication or facilities in any combination, without affecting the operation of other lines of communication or facilities available at that or any other position (1091).

6.1.3 Where the system configuration can be changed, a means of quickly restoring the last set option configuration before any failure shall be provided (1092).

6.1.4 **Recommendation:** Operator workload should be reduced to a minimum by implementing functions with single keypress operation where practicable (1093).

6.1.5 Headsets shall be provided except at units with very low density operations where loudspeaker and free-standing microphone (ie no headset capability) may be authorised (1094).

6.1.6 **Recommendation:** Loudspeaker and headset earphone volume should be audible at the operating position when set to their minimum level (1095).

NOTE: The air-ground communications may be switchable between headset and loudspeaker as traffic conditions dictate.

6.1.7 **Recommendation:** Headsets are the preferred audio interface equipment and should be configured to operate in split mode (1096).

NOTE 1: Split headset mode implies the following:

RTF Communications only – Transmissions heard in both earpieces. RTF Communications and Ground-Ground Communications – RTF transmissions heard in one earpiece and Ground-Ground Communications heard in the other earpiece. When the operator makes an RTF Communications transmission sidetone is heard in both earpieces.

NOTE 2: Handsets, desk or hand microphone may be used in combination with the desk loudspeaker where the ambient noise or traffic levels permit such operations.

6.1.8 Operating positions shall have a loudspeaker which will allow selected lines of communication to be monitored (1097).

6.1.9 **Recommendation:** Operating positions should have provision for the connection of a number of headsets enabling instructor/student, dual operator and supervisor monitoring facilities (1098).

6.1.10 The instructor/student facility, where provided, shall enable direct communications via headsets (1099).

6.1.11 The instructor/student facility, where provided, shall enable the instructor to interrupt any student communications at any time (1100).

NOTE: The instructor/student interrupt may be achieved by use of a dedicated instructor PTT Press-To-Talk control incorporating separate switches for RTF Communications and Ground-Ground Communications.

6.1.12 Operating positions shall have provision for at least two momentary action PTT controls, one of which shall permit 'hands-free' operation (1101). The controls shall be used to control RTF Communications transmissions (1102).

NOTE: Typical PTT controls may be panel mounted switches, headset in-line switches, foot switches, switches incorporated into desk or handheld microphones and handsets.

6.1.13 The audio level of each audio outlet shall be independently adjustable (1103) and any communications shall still remain audible and intelligible to the operator when the minimum level is selected (1104).

6.1.14 Separate controls for the audio level of RTF Communications and Ground-Ground Communications shall be provided with the setting in use being apparent to the operator (1105).

6.1.15 **Recommendation:** All lines of communication should incorporate an automatic gain control function in order to maintain adequate speech signal levels (1106).

6.1.16 Where an automatic gain control function is used, only one device or function shall operate on any signal path (1107).

NOTE: Where such devices or functions are incorporated, a signal gain path memory or similar feature can be used to prevent distortion of the initial syllables of speech at the beginning of a transmission or after pauses in speech. The principle of operation being that the last dynamic gain/attenuation setting is stored and used for subsequent transmissions.

6.1.17 The design and implementation of the voice switch shall be such that any input can be connected to any output without the possibility of blocking occurring (1108).

6.2 RTF Communications

NOTE: Reference should be made to COM 02 'VHF Aeronautical Radio Stations' and COM 07 'UHF Radio Equipment and Systems' (1109).

6.2.1 Air-ground Communications on appropriate frequencies shall be provided (1110).

6.2.2 Two-way radiotelephony communication facilities shall be provided for aerodrome (surface movement) control service for the purpose of controlling vehicles on the manoeuvring area, except where communication by a system of visual signals is deemed to be adequate (1111).

NOTE: This communication facility is normally provided by UHF radio equipment and systems but the use of VHF Aeronautical Mobile Service frequencies may be permitted for ground to ground communications in specific circumstances.

Recommendation: Where conditions warrant, separate communication channels should be provided for the control of vehicles on the manoeuvring area (1112).

Recommendation: VHF air-ground communications should be cross-coupled to UHF two-way radiotelephony communications for vehicles operating on the active runway (1113).

NOTE: Cross-coupling between the VHF air-ground communications used for the control of aircraft and the UHF two-way radiotelephony communications used for the control of vehicles provides situational awareness for the aircrew, controller and operator of the vehicle. The vehicle operator is aware of any aircraft transmissions by monitoring the cross-coupled VHF Air-Ground Communications and has direct two-way radiotelephony communications with the controller. In some cases the transmissions from vehicles are re-transmitted to aircraft. As separate transmit and receive frequencies are used at UHF between the base station and vehicles, talkthrough facilities may be used to enable vehicles to hear one another.

6.2.3 RTF communications which have been selected shall always be available irrespective of the state of other lines of communication (1114).

6.2.4 The operator shall be provided with a degree of assurance that Air-Ground Communications transmissions have been successful (1115).

NOTE: The normally accepted method of implementing this is to provide off-air sidetone to the operator's headset derived from either the radio receiver associated with the transmitter for that radio channel, or from a separate receiver. It is recognised that the future widespread implementation of digital telecommunications systems may mean that off-air sidetone cannot be implemented in all situations. In which case alternative ways of indicating the successful transmissions may be used.

6.2.5 **Recommendation:** The operator should be provided with a degree of assurance that two-way radiotelephony communications for the control of vehicles on the manoeuvring area transmissions have been successful (1116).

NOTE: The normally accepted method of implementing this is to provide off-air sidetone to the operator's headset. Where UHF Radio Equipment and Systems are used, it may be necessary to provide a separate receiver in addition to the base station receiver, in order to derive the off-air sidetone signal for both directions of transmission.

6.2.6 The operator shall be provided with the facility to select more than one air-ground communications frequency simultaneously (1117). When the PTT control is operated communications shall be transmitted on all selected frequencies to aircraft (1118). When the PTT is released the operator shall be provided with the combined audio signals from all selected frequencies (1119).

NOTE: The operator will normally be provided with off-air sidetone derived from a combination of all the received audio signals from all selected frequencies. It is recognised that the operator is unlikely to be able to determine whether transmissions on each and every selected frequency have been successful, alternative ways of indicating the successful transmissions may be required. It is also acknowledged that the combination of the received audio signals may result in distortion of the overall off-air sidetone. Particular attention may be required in the design and implementation.

6.2.7 **Recommendation:** When two or more ATS frequencies are being used by a controller, consideration should be given to providing facilities to allow ATS and aircraft transmissions on any of the frequencies to be simultaneously retransmitted on the other frequencies in use thus permitting aircraft stations within range to hear all transmissions to and from the controller (1120).

NOTE: The operator will normally be provided with off-air sidetone derived from only one of the received audio signals. This may be arranged such that the signal paths utilise all the cross-coupled transmit and receive communications channels selected.

6.2.8 The operator shall be provided with the facility to select the state of any available radio channel and an appropriate visual/aural indication shall be given to indicate the selection made (1121).

NOTE: Typical states normally found:

a) Channel off.

b) Channel receive only.

c) Channel transmit and receive.

d) Selection of duplicated transmitters and/or receivers.

e) Selection of Cross-coupling.

6.2.9 The operator shall be provided with a visual/aural indication of the status of available radio channels (1122).

NOTE: Typical status reports normally found:

a) Aircraft or vehicle call/receiver mute lift.

b) PTT operation.

6.2.10 The delay between operating the PTT control and the appropriate electrical or electronic signal being present at the interface with the VCCS shall be as low as practical (1123).

NOTE: A delay of 20ms or less should be achievable.

6.2.11 The delay between receiving the appropriate electrical or electronic signal at the interface with the VCCS and the activation of any electrical or electronic device, visual or aural indication shall be as low as practical (1124).

NOTE: A delay of 20ms or less should be achievable.

6.2.12 When Air-Ground Communications transmissions to aircraft are in progress, Ground-Ground Communications also in progress at the same time shall not be transmitted to the aircraft (1125). An indication shall be given to the other party that Air-Ground Communications are in progress and this may be achieved by relaying the operators' speech (1126).

6.2.13 The VCCS shall not fail in a manner such as to cause unintentional or continuous transmissions (1127).

NOTE: The equipment and systems should conform to the 'Minimum Operational Performance Specification for devices that prevent unintentional or continuous transmissions' EUROCAE document ED-67 April 1991, so far as it is appropriate for ground based systems.

6.2.14 Anti-Blocking Systems (ABS) – Providers must ensure that the installation and operation of such a system will not be detrimental to the integrity or reliability of the communications system (1128). An isolating switch must be provided at the ATC operating position which will effectively remove the ABS from the RTF system (1129). ABS must not be fitted to an emergency RTF system (1130). The received audio volume to the controller must not be affected by the addition of the ABS (1131).

NOTE: An ABS prevents transmissions when the associated receiver is in use. The CAA does not currently propose to make installation of ABS a requirement or a recommendation for Air Traffic Control units.

6.2.15 Comprehensive training shall be provided to both Air Traffic Engineers and Air Traffic Controllers on the possible effects of failures within a communications system which has an ABS fitted (1132). MATS Part 2 and Engineering Instructions are to include this information (1133).

6.2.16 There shall be a visual or other indication to the controller that an ABS system is selected for use (1134).

6.2.17 **Recommendation:** There should be a visual indication to the controller that the ABS is inhibiting controller transmission (1135).

6.2.18 **Recommendation:** The duration of a transmission inhibited by an ABS should be detectable on the associated voice recording (1136).

6.3 Ground-Ground Communications

6.3.1 The Provider shall satisfy the CAA that the Aeronautical Fixed Services equipment is adequate for the task for which it is to be used (1137). Among other things, consideration shall be given to reliability, integrity, levels of redundancy, hours of service, classification of airspace and complexity of traffic (1138).

6.3.2 Ground-Ground Communications shall be provided for the telecommunications services required by the air traffic control unit (1139).

6.3.3 There shall be provision for direct and immediate broadcast and break-in interposition communications (intercom) between supervisors/operators at different positions which shall be possible irrespective of the state of other lines of communication (1140).

NOTE 1: A broadcast call is used between one position and all others, whereas a break-in call is only between two positions.

NOTE 2: In some cases it may be necessary to provide an indication of the receipt of an intercom call and to identify the operating position from which the call originated.

6.3.4 Intercom communications shall not be transmitted on any RTF frequency or Ground-Ground Communications (1141).

6.3.5 An adequate number of connection(s) to the public telephone system must be provided (1142).

6.3.6 Other Aeronautical Fixed Services are to be provided as appropriate (1143).

NOTE 1: They may include a means of communicating:

a) Between operational positions within the unit.

b) Directly with adjacent Air Traffic Service units including the parent Area Control Centre.

NOTE 2: In certain circumstances an automated dialling system may satisfy the requirements. Maximum connection times may be specified by the CAA.

NOTE 3: The provision of Aeronautical Fixed Services directly into the headsets may be required by the CAA.

6.3.7 Operating positions shall have provision for connection to the Public Switched Telephone Network (1144).

6.3.8 **Recommendation:** In order to achieve a high availability of communications, the Telecommunications Network access should be duplicated and routing/operator diversity used as appropriate (1145).

NOTE: Access to Telecommunications Network Operators is essential to the implementation of a Ground-Ground Communications network required for the operation of an Air Traffic Control Unit. Access may be via the Public Switched Telephone Network or via private lines and networks.

6.3.9 **Recommendation:** Where mobile, cellular or personal communications networks are used to fulfil the requirement to access the Public Telecommunications Network, the availability under conditions of congestion should be considered and a priority access facility arranged with the network operator (1146).

NOTE: The method of access to a Telecommunications Network Operator is not limited to landline connections and may be by means of optical fibre, microwave radio or by mobile cellular or personal communications networks.

6.4 Interface to Voice / Data Recording Equipment

The VCCS shall provide all the necessary signals and information to the Voice / Data Recording Equipment in compliance with Article 105 of the Air Navigation Order (1147).

7 System Performance

7.1 The clarity and volume of communications is to be 'readable' or 'perfectly readable' (see MATS Part 1) (1148).

7.2 **Voice Transmission Quality – Radio Transmissions**

7.2.1 The voice transmission quality of those communications facilities that utilise radio transmissions, the Aeronautical Mobile Service and the Surface Movement Control Service, shall meet or exceed a quality defined by the following:

a) The frequency response shall be such that the gain at any frequency between 300Hz and 3.4 kHz shall be within ± 3dB of the gain at 1kHz (1149).

b) The Total Harmonic Distortion (THD) shall not exceed 2% at any frequency between 300Hz and 3.4kHz with any gain controls adjusted to give the maximum permitted audio level at the headset or handset (1150).

c) Residual noise and hum on any correctly terminated idle voice circuit shall not exceed -60dBm (1151).

NOTE 1: The minimum voice channel audio frequency bandwidth for Air-Ground Communications using VHF Aeronautical Mobile radio frequencies has been determined as 400 Hz to 2.7 kHz for 25 kHz channel spacing.

NOTE 2: The voice transmission quality requirements apply to the voice channel only and do not include microphone and headset characteristics.

7.3 **Voice Transmission Quality – Non-Radio Transmissions**

7.3.1 The voice transmission quality of non-radio transmissions, shall meet or exceed those requirements as may be defined in standards for systems which are connected to the Public Switched Telephone Network (1152).

7.3.2 In the absence of any such standards referred to in 7.3.1, the following shall be met:

a) The frequency response shall be such that the gain at any frequency between 300Hz and 3.4 kHz shall be within ± 3dB of the gain at 1kHz (1153).

b) The Total Harmonic Distortion (THD) shall not exceed 2% at any frequency between 300Hz and 3.4kHz with any gain controls adjusted to give the maximum permitted audio level at the headset or handset (1154).

c) The Crosstalk level on any voice circuit shall not exceed -60dBm when a 1kHz tone is injected into any other circuit at a level of 10dB above nominal test tone level, with all voice circuits correctly terminated (1155).

d) Residual noise and hum on any correctly terminated idle voice circuit shall not exceed -60dBm (1156).

NOTE: The voice transmission quality requirements apply to the voice channel only and do not include microphone and headset characteristics.

COM 04 ATC Datalinks

Part 1 Preliminary Material

1 Introduction

Datalink applications have been available globally for Aircraft Operations Control (AOC) and Aircraft Administrative Control (AAC) functions for many years. The networks, systems and applications providing this functionality are well established, and aircraft equipage is widespread. Since the mid 1990s the systems and networks designed for this function have been expanded to provide limited Air Traffic Control (ATC) applications.

Datalink technology is intended to provide enhancements to the processes used within the provision of Air Traffic Services. In its most simplistic form, the radio communications between Air Traffic Control (ATC) and aircraft could be accomplished by digital data transmission using datalink. However the provision of datalink facilities may give rise to significant benefits in the following areas[1].

Capacity

Range

Reliability

Speed

Security

2 Scope

This document applies to the use of datalink technologies and applications for 'low risk' ATM functions. (i.e. those which are not critical in terms of safety and / or time.) It is applicable to both Aeronautical Fixed Services and Aeronautical Radio Stations.

This document covers the use of private networks, such as those provided by ARINC and SITA.

The use of datalink technology for applications other than those detailed within this document will either be the subject of an amendment to this document or a new CAP670 requirement.

1. The benefits listed here are only some of those which have been identified by EUROCONTROL ODIAC Task Force in the EATCHIP Transition Guidelines for Initial Air/Ground Data Communications Services, EUROCAE WG-45 Data Link Applications ED-78, ED-85, ED-89, ED-106, EUROCAE WG-53 / RTCA SC-189 Air Traffic Services ED-100 and ICAO Manual of Air Traffic Services Data Links Applications (Doc 9694).

Part 2 Safety Requirements

3 Safety Objective

To ensure that the level of safety of the ATM function is maintained or improved during installation, transition and operation of datalink equipment, applications and procedures (1003).

4 Requirements

4.1 A comprehensive safety assessment of the datalink application / system and its interfaces with existing ATC equipment, people and procedures shall be performed and submitted as part of the approvals process (371).

4.2 Safety Assurance for a datalink application / system shall be provided by full and complete adherence to the ATS provider's Safety Management System, if this exists (372). If the ATS provider does not use a SMS, then evidence and arguments supporting the safety of each datalink application / system shall be assembled by the ATS provider for review and approval by SRG (373).

4.3 Provided the Safety Assessment concludes that the datalink system / application is at least tolerably safe, then the use of private datalink networks, which may pre-date the ICAO SARPs, shall be permitted for the following categories[1] of communications messages:

- Meteorological Communications
- Flight Regularity Communications
- Aeronautical Information Service Messages
- Network/Systems Administration (374)

4.4 Communications in categories assigned a higher priority than those listed above may be permitted if the ATS provider supplies SRG with evidence, in addition to the Safety Assessment, proving that:

- The application is not time critical

  and

- Procedures exist for ensuring that the failure of datalink systems has no long term, short term, or immediate effect on the ability of the aircraft or ATSU to complete the communication at an appropriate time (375).

1. These message categories are referenced in the ICAO Manual of Air Traffic Services Data Links Applications (Doc 9694) and the ICAO Manual of Technical Provisions for the Aeronautical Telecommunications Network (ATN) (Doc 9705)

COM 04 Appendix - Acceptable Means of Compliance

1 Operational Requirements

The datalink application / system should be demonstrably compliant with its Operational Requirement (OR), produced by the ATS Provider (1157). This OR should form the basis for the collection of evidence that the stable implementation of the application / system is suitable for operational service (1158).

The OR should include performance and safety requirements pertinent to the application / system concerned (1159).

The OR should specifically reference any security needs pertinent to the application / system concerned (1160).

2 Compatibility

Any datalink system supporting existing functionality should be backwards compatible with any existing ATC methods, procedures and equipment which currently provides all or part of the service for which it is designed (1161).

Any incompatibilities should be identified, and an impact assessment performed on the ability of the revised systems and procedures to meet the OR of all ATSUs using the datalink system / application (1162).

The datalink system should be compatible with all levels of aircraft equipment normally expected to be present in the ATSU's operational area of interest (1163).

3 Guidance

Guidance on the implementation of datalink applications is available from various national and international bodies. On an application specific basis these documents may be used as part of an acceptable means of compliance. Examples of such documentation are as follows:

EUROCAE	Data-Link Application System Document (DLASD) for the "Departure Clearance" Data-Link Service ED-85 June 1998
EUROCAE	Data-Link Application System Document (DLASD) for the "ATIS" Data-Link Service ED-89 September 2000
EUROCAE	Data-Link Application System Document (DLASD) for the "Oceanic Clearance" Data-Link Service ED-106 May 2001
EUROCAE	Guidance Material for the Establishment of Data Link Supported ATS Services ED-78 June 1997
EUROCAE/ RTCA	Interoperability Requirements for ATS Applications using ARINC 622 Data Communications ED-100 September 2000
EUROCONTROL	ODIAC Task Force Operational Requirements Document (ORD)
EUROCONTROL	ODIAC Task Force EATCHIP Transition Guidelines for Initial Air/ Ground Data Communications Services Edition 2.0 OPR.ET1.ST05.1000-GUI-01-00
ICAO	Manual of Air Traffic Services Data Link Applications Doc 9694

COM 05 Information and Alerting Systems

Part 1 Preliminary Material

1 Introduction

1.1 Information and alerting systems used in the provision of an Air Traffic Service are required to be approved for use under the terms of Article 104 of the Air Navigation Order.

1.2 This document may be used in isolation or in conjunction with other requirements documents published by the CAA.

2 Scope

This document sets out the safety requirements for information and alerting systems used at locations within the United Kingdom providing Air Traffic Services.

Part 2 Requirements

3 Flight data display

Flight data displays (such as flight progress strip boards or pinboards) are to be provided (204). Approval may be given for shared displays (for example where two radar controllers work side by side with the data display between them).

4 Status Indicators

Any equipment or facility which has a direct effect on aircraft safety shall have a display showing its status, if not readily apparent, visible to the controller (205). Examples of such equipment/facilities are runway arrester gear or barriers, taxiway closures, etc.

5 Clocks

5.1 A clock which is easily visible from each control position is to be provided (206). UTC shall be shown in hours, minutes and seconds (207) and is to be accurate to within ±15 seconds per day (208).

5.2 Each control position should have a clock (209).

6 Data Display Systems (DDS)

6.1 Providers must satisfy the CAA that the system is adequate for its purpose by design or by procedural mitigation (210).

NOTE: If the system is not capable of demonstrating the required level of safety, for example because integrity or reliability is not as predicted, then it will be acceptable to include procedures in MATS Part 2 which mitigate deficiencies to ensure that a failure (total or partial) is not hazardous. Included in these procedures will be details of alternative sources of safety-related information.

6.2 All systems on which information is displayed to ATC for operational use should be designed, installed, configured and maintained in a manner which ensures the integrity of the information (211). As the hazard to aircraft of passing incorrect, misleading, corrupt or anomalous information can vary according to its phase of flight, the integrity requirements will vary accordingly.

6.3 DDS for operational use by controllers should be easily visible from relevant control positions (212). The display should be clear and free from reflections (213). Systems should not divert the attention of controllers at operational positions unless specifically designed to do so (214).

7 Aeronautical Ground Lighting (AGL) Control and Monitoring Equipment

7.1 An indication, easily visible from the aerodrome control position(s), showing the actual serviceability status of AGL services (as opposed to the switch position), shall be provided (215). The equipment shall indicate when failure or abnormal operation of the AGL service selected for use falls below levels required by the aerodrome licence (216). These levels are outlined in CAP 168.

7.2 Modern AGL equipment is capable of providing highly detailed system performance information. The serviceability status information required to be passed to pilots shall be readily established from the indications visible from the aerodrome control position(s) (217).

NOTE 1: The CAA is currently considering the introduction of a revised method of AGL serviceability reporting. Further guidance on these proposals and additional information on their impact on planned changes to AGL control and monitoring equipment is available from the appropriate Regional Manager ATS Safety Regulation or the Policy Section of the Aerodrome Standards Department.

NOTE 2: CAP 168 Licensing of Aerodromes describes the technical requirements for AGL control and monitoring equipment.

7.3 All projects concerning AGL should be conducted in accordance with CAP 655 Aeronautical Ground Lighting and processed through the Policy, Standardisation and Development Section of the Aerodrome Standards Department (218).

8 Landing Clearance Indicator (LCI)

8.1 When Surveillance Radar Approaches terminating at a distance of less than 2 NM from touchdown are conducted, a landing clearance indicator of approved design must be provided (219).

8.2 The LCI enables reliable, instantaneous, non-voice communication between the aerodrome controller and the radar controller carrying out the SRA. It usually takes the form of a panel of coloured, lighted buttons at each control position.

8.3 The system should incorporate a means by which the aerodrome controller can indicate to the radar controller that an aircraft is to be instructed to make an immediate go-around (220). An audio alert should be associated with this indication (221).

8.4 At units where an LCI system is installed instructions on its use must be included in the MATS Part 2 (222). Details on the interpretation of the various indications are important, particularly at aerodromes where flying training involving planned go-arounds takes place.

9 Surface Movement Radar (SMR)

Surface Movement Radar equipment must be approved by the CAA under Article 104 of the ANO (223). The orientation of the picture in relation to the view from the VCR will depend on the tasks carried out by the Controller. At a unit where the controller has clearly defined and fairly narrow tasks to perform the orientation is to be such that the runway on the SMR is aligned with the view of the runway from the control position (224). At units where the task is broader in nature, the large number of factors having an effect on the alignment of the SMR requires each case to be considered on its merits. Advice on orientation should be sought from the CAA (225).

10 Visual Signalling

A signal lamp with interchangeable coloured lenses (white, red and green) and spare bulb shall be provided (226) and must be accessible to the controller (227). The lamp must enable control of aerodrome traffic as laid down in the Rules of the Air Regulations 1991 (228). The light must be visible from all points of the manoeuvring area (229).

NOTE: Shining the lamp through tinted glass or blinds can affect the perceived colour of the signal.

11 Automatic Terminal Information Service (ATIS)

An ATIS, among other functions, relieves the controller of the requirement to provide to aircraft certain information of a repetitive nature. As such it is considered to be part of the Air Traffic Control unit benefiting from it and the Provider of that unit is to ensure that the ATIS complies with the CAA's requirements (230).

12 Emergency Services Alerting

12.1 An audible method of alerting airfield emergency services shall be provided as a primary means of callout (231). A standby means of alerting airfield emergency services, independent of the primary method, shall be identified (232).

NOTE: Advice and information on suitable devices or methods can be sought from the CAA.

12.2 A means of communicating with other emergency services shall be provided (233).

12.3 Check-lists of actions to be carried out in the event of an emergency (one check-list for each category of emergency) shall be provided (234). These are to be easily accessible to the controllers likely to use them (235).

12.4 Approval of the aerodrome's Emergency Orders is the responsibility of the CAA.

COM 06 Automatic Terminal Information Service (ATIS)

Part 1 Preliminary Material

1 Introduction

1.1 Under the terms of Article 104 (1) of the Air Navigation Order, any Air Traffic Service Equipment is required to have CAA approval before being established or used in the United Kingdom.

1.2 The Automatic Terminal Information Service (ATIS) may be implemented by Voice-ATIS and data link (D-ATIS). An aerodrome Voice-ATIS may be provided by an Air Traffic Service provider, using either a dedicated VHF transmitter or a CVOR/DVOR transmitter. A D-ATIS may be provided by an Air Traffic Service provider, in conjunction with a data link communication service provider, using a VHF ground station network or by satellite.

1.3 In the U.K. ATIS is provided as an optional Flight Information Service in association with an Air Traffic Control Service.

2 Scope

2.1 This document sets out the engineering requirements for Voice-ATIS and D-ATIS Flight Information Service established or used within the United Kingdom in support of an Air Traffic Control Service.

2.2 The U.K. Meteorological Authority is responsible for the regulation of meteorological services. The responsibility for the regulation of the equipment and systems described in the 'MET' requirements documents in CAP 670 Part C Section 3 has yet to be determined. It is likely that these documents will be amended to reflect any transfer of responsibilities from SRG ATSSD to the U.K. Meteorological Authority.

2.3 For the purpose of this document, ATIS is only considered to include the collation of meteorological and aerodrome data, the preparation of messages and the transmission of the messages.

3 Definitions and Abbreviations

3.1 Definitions

A

Automatic terminal information service	The automatic provision of current, routine information to arriving and departing aircraft throughout 24 hours or a specified portion thereof. (ICAO Annex 11, Chapter 1)

D

Data link-automatic terminal information service	The provision of ATIS via data link. (ICAO Annex 11, Chapter 1)

V

Voice-automatic terminal information service	The provision of ATIS by means of continuous and repetitive voice broadcasts. (ICAO Annex 11, Chapter 1)

3.2 Abbreviations

A

ATIS	Automatic terminal information service

D

D-ATIS	Data link-automatic terminal information service

V

Voice-ATIS	Voice-automatic terminal information service

4 References

1) ICAO Annex 11 — Air Traffic Services.
2) ICAO Annex 10 Aeronautical Telecommunications Volume III - Communication Systems Part I - Digital Data Communication Systems; Part II - Voice Communication Systems
3) ICAO Annex 3 — Meteorological Service for International Air Navigation.
4) ICAO Procedures for Air Navigation Services — Air Traffic Management (Doc 4444-ATM/501).
5) ICAO Regional Supplementary Procedures (Doc 7030/4).
6) ICAO Manual of Air Traffic Services Data Link Applications (Doc 9694).
7) UK Aeronautical Information Publication – AIP Part 1 General (GEN)

Part 2 Requirements

5 Safety Objective

The Automatic Terminal Information Service (ATIS) equipment and systems shall provide complete, identified, accurate and uncorrupted voice / data communications (1004).

6 General Requirements

6.1 International Standards

6.1.1 The equipment, systems, services and facilities shall comply with the applicable international standards, recommended practices and procedures for air navigation services in Annex 11 [1], Annex 10 [2] and Annex 3 [3] to the Convention on International Civil Aviation (236).

6.2 Electro Magnetic Compatibility

The equipment and systems shall comply with the EMC Directive (237).

NOTE: Further information is contained in GEN 04.

6.3 Interface to Voice / Data Recording Equipment

The equipment and systems used in the provision of a Voice-ATIS or D-ATIS shall provide all the necessary signals and information to the Voice / Data Recording Equipment in compliance with Article 105 of the Air Navigation Order (238).

NOTE: EUROCAE WG-50 'CNS/ATM Recording Requirements' have commenced work on drafting a Minimum Operational Performance Specification specifically for the ground recording of data-link communications which may lead to future amendments to CAP 670 Part C Section 1 COM 01 'Voice / Data Recording Equipment'.

6.4 Manual of Air Traffic Services Part 2

6.4.1 Appropriate material relating to the operation of the ATIS shall be written for inclusion in the Manual of Air Traffic Services Part 2 (239).

NOTE: See CAP 670 Part B Section 2 ATC 02 'ATC Documentation' for the requirements and details on the format of the Manual of Air Traffic Services Part 2.

7 Specific Requirements

7.1 Voice-ATIS and D-ATIS

7.1.1 The ATIS message shall relate to a single aerodrome (240).

7.1.2 The ATIS message shall be updated immediately a significant change occurs (241).

7.1.3 The preparation and dissemination of the ATIS message shall be the responsibility of the Air Traffic Service provider (242).

7.1.4 Individual ATIS messages shall be identified by a letter designator from the ICAO spelling alphabet assigned consecutively in alphabetical order (243).

7.2 **Voice-ATIS**

Guidance: In the event of failure of the Voice-ATIS, the Air Traffic Controller is able to provide the ATIS information using the control VHF frequency or, where the workload prevents this, by the opening of another alternative VHF frequency by an additional Air Traffic Controller or assistant.

7.2.1 Voice-ATIS shall be provided at aerodromes where there is an operational requirement to reduce ATC VHF air-ground communications workload (244).

NOTE: Although this is an ICAO standard, in the U.K., the provision of a Voice-ATIS may be limited by the availability of discrete VHF frequencies which are in short supply.

Guidance: In the U.K. ATIS is associated with the provision of an ATC Service. The objective of ATIS is to reduce ATC workload by the use of a means other than the controller's VHF air-ground communications frequency to convey current and routine meteorological and aerodrome information to aircraft.

7.2.2 Voice-ATIS broadcasts shall comprise (245):

a) One broadcast for arriving aircraft or

b) One broadcast for departing aircraft or

c) One broadcast for arriving and departing aircraft or

d) Two separate broadcasts for arriving and departing aircraft where the combined broadcast would be excessively long.

7.2.3 Voice-ATIS shall be provided on a discrete VHF frequency whenever practicable (246).

Guidance: As the VHF spectrum is congested and there is a shortage of available radio frequency assignments, any application for the use of a VHF frequency assignment will require a justification of the operational requirements.

7.2.4 When a discrete VHF frequency is not available, Voice-ATIS may be provided on the most appropriate terminal navigation aid (247).

Guidance: CVOR or DVOR facilities are considered to be appropriate navigation aids subject to evidence from the Air Traffic Service provider of the Voice-ATIS, justifying the choice of navigation aid, taking into account the Designated Operational Coverage, quality of the voice transmissions and any other appropriate factors. The Air Traffic Service provider of a CVOR or DVOR navigation aid used for Voice-ATIS would be responsible for demonstrating compliance with NAV 04.

7.2.5 Voice-ATIS may not be provided on an ILS facility (248).

7.2.6 Voice-ATIS broadcasts, when provided, shall be continuous and repetitive (249).

7.3 **D-ATIS**

Guidance: In the event of failure of the D-ATIS, the ATIS information can be obtained from the Voice-ATIS. Where both D-ATIS and Voice-ATIS fail, the situation is the same as that for a failure of the Voice-ATIS.

It is likely that interface arrangements will need to be established between the Air Traffic Service Providers, operating the aerodrome Voice-ATIS, and the D-ATIS, to ensure compliance with the following ICAO SARPS.

NOTE: Guidance material relating to D-ATIS is contained in reference [6]. The technical requirements for the D-ATIS application are contained in Part I Chapter 3 of reference [2].

7.3.1 Where D-ATIS supplements the existing availability of Voice-ATIS, the content and format of the information shall be identical (250).

7.3.2 Where D-ATIS supplements the existing availability of Voice-ATIS, when the ATIS requires updating, the Voice-ATIS and D-ATIS shall be updated simultaneously (251).

7.3.3 Where D-ATIS broadcast includes real time meteorological information, which is within the parameters of the significant change criteria [3], then the content shall be considered identical for the purpose of maintaining the same designator (252).

7.4 Collation of Meteorological and Aerodrome Data

7.4.1 The meteorological data used in the preparation of ATIS messages shall be compliant with ICAO Annex 3 (253).

7.4.2 The meteorological data shall be extracted from the local meteorological routine or special report (254).

7.4.3 Where rapidly changing meteorological conditions preclude the inclusion of a weather report, the ATIS message shall contain information that the relevant weather information will be given on initial contact with the Air Traffic Control Unit (255).

7.4.4 The Air Traffic Service Provider shall ensure that the accuracy and integrity of the data used in the preparation of the ATIS message is maintained at a level appropriate to the operational requirements (256).

Guidance: It is likely that the interface arrangements between the Air Traffic Service Provider and the Data Link Communications Service Provider will enable the Air Traffic Service Provider to obtain evidence of compliance with this requirement for the Data Link operations.

7.5 Preparation of Messages

7.5.1 Where the Voice-ATIS broadcast messages are not prepared by the aerodrome ATC Unit, the organisation responsible for this task shall immediately make known the information contained in the current broadcast to the ATC Unit (257).

7.5.2 Voice-ATIS broadcasts shall be prepared in the English language (258).

NOTE: In the U.K. the ICAO Recommendation is a Requirement as the English Language is used for all voice communications.

7.5.3 **Recommendation:** The Voice-ATIS broadcast should be prepared to achieve optimum readability consistent with message length, speed of transmission and human factors performance (259).

Guidance: The message length should not exceed 30 seconds.

7.5.4 **Recommendation:** The message contents should be kept as brief as possible and information additional to that specified in ICAO Annex 11, 4.3.7. to 4.3.9 should only be included in exceptional circumstances (260).

7.5.5 The message contents shall contain the elements of information as defined in ICAO Annex 11, 4.3.7. to 4.3.9 in the order given (261).

NOTE: Appendix 1 contains a summary of the ATIS message elements in ICAO Annex 11.

7.5.6 **Guidance:** The ATIS messages need not contain any instructions to request that the aircrew acknowledge the receipt of the information on initial contact with the appropriate ATC Unit as this requirement is promulgated elsewhere. [Reference [5] paragraph 11.1.3 and reference [7] GEN 3-3-3 paragraph 2.6]

7.5.7 **Guidance:** Where the preparation of messages involves recording speech using a microphone, care should be taken to ensure that any background noise does not degrade the quality of the recording.

7.5.8 **Guidance:** Where the preparation of messages is done automatically, using either synthesised or pre-recorded spoken words or phrases, care should be taken to ensure that the quality and readability of the recording is equivalent to that achieved by manual recording.

7.6 Transmission of Messages

7.6.1 Voice-ATIS VHF Transmitter

Guidance: CAP 670 Part C Section 1 COM 02 'VHF Aeronautical Radio Stations' contains requirements for all radio equipment including Voice-ATIS VHF Transmitters and VHF Transmitters used for ACARS and VDL Mode 2 data link communications.

7.6.2 Voice-ATIS CVOR/DVOR Transmitter

Guidance: CAP 670 Part C Section 2 NAV 04 'Engineering Requirements for Conventional and Doppler VHF Omni-Directional Range (CVOR/DVOR) Beacons' includes the option of providing Voice-ATIS by using the speech modulation input to the transmitter.

The Designated Operational Coverage and frequency assignment terms and conditions must be consistent with both the CVOR/DVOR and Voice-ATIS operational requirements. Radio coverage problems may be found if the CVOR/DVOR is not located on or near the aerodrome providing the Voice-ATIS.

Where the CVOR/DVOR beacon is not the direct responsibility of the aerodrome ATS Provider providing the Voice-ATIS, then a service level agreement or some other arrangement might be necessary to ensure compliance with operational requirements and to cover aspects such as maintenance.

7.6.3 D-ATIS VHF Ground Station Network / Satellite

Guidance: CAP 670 Part C Section 1 COM 04 'ATC Datalinks' covers the provision of D-ATIS by Air Traffic Service Providers. The ATIS may be delivered to aircraft by means of a VHF ground station network and/or earth stations of the mobile satellite service operated by Data Link Communications Service Providers.

If any of the VHF ground stations are located within the U.K. then they will require ANO approval and CAP 670 Part C Section 1 COM 02 'VHF Aeronautical Radio Stations' applies.

7.6.4 Voice-ATIS Telephone Information Service

Guidance: Access to the Voice-ATIS may be provided via a telephone information service as an additional service to aviation users.

COM 06 Appendix - ICAO Annex 11 ATIS Message Elements

Message Elements		Footnote	Arrival & Departure	Arrival	Departure
(a)	name of aerodrome		✓	✓	✓
(b)	arrival and/or departure indicator		✓	✓	✓
(c)	contract type, if communication is via D-ATIS		✓	✓	✓
(d)	designator		✓	✓	✓
(e)	time of observation, if appropriate		✓	✓	✓
(f)	type of approach(es) to be expected		✓	✓	
(g)	the runway(s) in use; status of arresting system constituting a potential hazard, if any		✓	✓	✓
(h)	significant runway surface conditions and, if appropriate, braking action		✓	✓	✓
(i)	holding / departure delay, if appropriate		✓	✓	✓
(j)	transition level, if applicable		✓	✓	✓
(k)	other essential operational information		✓	✓	✓
(l)	surface wind direction and speed, including significant variations and, if surface wind sensors related specifically to the sections of the runway(s) in use are available and the information is required by operators, the indication of the runway and the section of the runway to which the information refers		✓	✓	✓
(m)	visibility and, when applicable, RVR	*	✓	✓	✓
(n)	present weather	*	✓	✓	✓
(o)	cloud below 1 500 m (5 000 ft) or below the highest minimum sector altitude, whichever is greater; cumulonimbus; if the sky is obscured, vertical visibility when available	*	✓	✓	✓
(p)	air temperature		✓	✓	✓
(q)	dew point temperature	†	✓	✓	✓
(r)	altimeter setting(s);		✓	✓	✓
(s)	any available information on significant meteorological phenomena in the approach and climb-out areas including wind shear, and information on recent weather of operational significance		✓	✓	✓
(t)	trend-type landing forecast, when available; and		✓	✓	✓
(u)	specific ATIS instructions		✓	✓	✓

Footnote	
*	Those elements are replaced by the term “CAVOK”, whenever the conditions as specified in reference [4] Chapter 11 prevail.
†	As determined on the basis of regional air navigation agreements. See reference [5].

COM 07 UHF Radio Equipment and Systems

Part 1 Preliminary Material

1 Introduction

1.1 Under the terms of Article 104 (1) of the Air Navigation Order, any Air Traffic Service Equipment is required to have CAA approval before being established or used in the United Kingdom. Under the terms of Article 104 (8) an Aeronautical Radio Station is specifically included in the meaning of Air Traffic Service Equipment.

1.2 The definition of 'Aeronautical Radio Station' in Article 129 (1) is considered to include UHF radio equipment and systems at Base Stations and Land Mobile Stations of the Land Mobile Service, where they are used for the purpose of assisting aircraft.

1.3 The CAA regulatory responsibility for UHF radio equipment and systems is limited to those aspects associated with the ANO Approval. The Radiocommunications Agency, the U.K. Radio Regulatory Authority, are responsible for PMR equipment conformance and WT Act licensing.

2 Scope

2.1 This document sets out the engineering requirements for UHF radio equipment and systems at Base Stations and Land Mobile Stations established or used within the United Kingdom in support of Air Traffic Services Ground to Ground Communications at aerodromes.

2.2 This document applies to the equipment categories of fixed (Base Station), vehicle, portable and hand held (Land Mobile Station) comprising equipment types of transmitter, receiver (Base Station) and transceiver (Land Mobile Station).

2.3 This document applies to UHF radio equipment and systems operating on CAA frequency assignments in the UHF Land Mobile Service allocation 450 MHz to 470 MHz, using Frequency Modulation (FM) with 12.5 kHz channel spacing, for analogue voice communications.

NOTE: The Radiocommunications Authority has made available to the CAA a number of channels within the UHF PMR band for aerodrome use, which are afforded better protection from interference than other PMR UHF channels. These channels are for specific aerodrome communications such as those used for ground movement (surface movement) control service, fire service and air traffic engineering.

3 Definitions and abbreviations

3.1 Definitions

B

Base Station	A land station in the land mobile service. (ITU RR S1.71)

D

Duplex Operation	Operating method in which transmission is possible simultaneously in both directions of a telecommunication channel. (ITU RR S1.126).

E

Emergency Equipment	Equipment which is operationally independent of the Main and Standby Equipment, rapidly available for use when required, and used exclusively for the controlled shutdown of an Air Traffic Service in a safe manner.
Equipment Categories	Fixed, Stationary, Vehicle, Portable and Hand Held.
Equipment Redundancy	The use of a combination of Main, Standby and Emergency equipment to improve the overall system reliability and to ensure the continuity of service.
Equipment Types	Transmitter, Receiver and Transceiver.

F

Fixed Equipment	Fixed equipment is that which is permanently installed at a specific location with external connections for power supplies, antennas, audio (microphone and loudspeaker) connections. e.g. Cabinet or rack mounted equipment.

H

Hand Held Equipment	Equipment with integral battery, antenna, PTT key, microphone and loudspeaker, designed to be operated whilst being carried in the hand or worn on the body. Provisions may be made for external connections for antenna, PTT key, microphone, headphone and external power supply or battery pack and desktop cradle or mounting unit, which may enable it to be classified in the Stationary Equipment Category.

L

Land Mobile Service	A mobile service between base stations and land mobile stations, or between land mobile stations. (ITU RR S1.26)
Land Mobile Station	A mobile station in the land mobile service capable of surface movement within the geographical limits of a country or continent. (ITU RR S1.73)
Land Station	A station in the mobile service not intended to be used while in motion. (ITU RR S1.69)

M

Main Equipment	The terms 'Main' and 'Standby' are generally used to describe identical or similar equipment, configured within a system to provide equipment redundancy, in order to improve the overall reliability and to ensure the continuity of service. The terms may also be applied to sub-equipment and modules as well as facilities, functions and services.

P

Portable Equipment	Equipment with integral battery, antenna, PTT key, microphone and loudspeaker, designed to be operated as a self contained unit either whilst being carried or at a temporary location. Provisions may be made for external connections for antenna, PTT key, microphone, headphone and external power supply or battery pack, which may enable it to be classified in the Stationary Equipment Category.
Private Business Radio	Term used by the Radiocommunications Agency for Private land Mobile Radio and related services.
Private land Mobile Radio	Radio equipment and systems in the Land Mobile Service used for the exclusive benefit and solely in the interests of the licensee's business as opposed to Public Mobile Radio equipment and systems which are provided commercially for use by others.

R

Radio Service Area	The Radio Service Area is that volume of airspace, bounded by the DOC and a lower height limit within which communications of a specified quality of service are provided. An alternative to defining a lower height limit, where this cannot easily be defined for the whole of the DOC, is to identify areas where the communications quality of service is below that specified.

S

Semi-Duplex Operation	A method which is simplex operation at one end of the circuit and duplex operation at the other. (ITU RR S1.127)
Simplex Operation	Operating method in which transmission is made possible alternately in each direction of a telecommunication channel, for example by means of manual control. (ITU RR S1.125)
Standby Equipment	The terms 'Main' and 'Standby' are generally used to describe identical or similar equipment, configured within a system to provide equipment redundancy, in order to improve the overall reliability and to ensure the continuity of service. The terms may also be applied to sub-equipment and modules as well as facilities, functions and services.

Stationary Equipment	Stationary equipment is that which is installed at a specific location with external connections for power supplies, antennas, audio (microphone and loudspeaker) connections, which is physically mounted such that it can easily be moved once external connections have been released. e.g. Desktop equipment.
V	
Vehicle Equipment	Equipment designed for operation and permanent or temporary installation in a vehicle with provision for external connections to vehicle battery, antenna, PTT key, microphone and loudspeaker. Provisions may be made for use of an external power supply or battery pack and desktop cradle or mounting unit, which may enable it to be classified in the Stationary Equipment Category.
W	
WT Act	Wireless Telegraphy Act 1949.

3.2 **Abbreviations**

E	
ETSI	European Telecommunications Standards Institute
P	
PBR	Private Business Radio
PMR	Private land Mobile Radio
R	
RA	Radiocommunications Agency
RIS	Radio Investigation Service
S	
SINAD	(Signal + Noise + Distortion)/(Noise + Distortion)

4 References

1) ICAO Annex 10 Aeronautical Telecommunications Volume III - Communication Systems Part I - Digital Data Communication Systems; Part II - Voice Communication Systems
2) ICAO Annex 11 Air Traffic Services
3) ICAO Annex 14 Aerodromes Volume I — Aerodrome Design and Operations

NOTE: The Catalogue of ICAO Publications can be found at the ICAO Web Site at http://www.icao.int/ ICAO Publications are available from the ICAO or the UK Sales Agent at the addresses given below:

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4) Private Business Radio Licence and Installation Information
   - RA 1 Application Form for a Private Business Radio Speech and Data Systems Licence
   - RA 126 Private Business Radio Speech and Data Systems Licence Guidance Notes
   - RA 123 Private Business Radio Licence Fees
   - RA 223 Information Sheet on Private Business Radio (PBR) Installation Requirements
5) UK Interface Requirement 2001 Private Business Mobile Radio
6) MPT 1303 Angle modulated VHF and UHF radio equipment, incorporating integral antennae, for use in the Private Mobile Radio Service.
7) MPT 1326 Angle-modulated VHF and UHF radio equipment for use at fixed and mobile stations in the Private Mobile Radio Service.

NOTE: Radiocommunications Agency information sheets, general publications, licence application forms and guidance notes, MPT specifications and other documents concerning the use of the radio spectrum and equipment approval can be found at http://www.radio.gov.uk/ and are also available from the Information and Library Service of the Radiocommunications Agency at the address given below:

The Information and Library Service
Radiocommunications Agency
Wyndham House
189 Marsh Wall
London
E14 9SX

Telephone: 020 7211 0502 or 0505
Fax: 020 7211 0507
Email: library@ra.gsi.gov.uk

8) Directive 1999/5/EC of the European Parliament and of the Council of 9 March 1999 on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity. Official Journal L 091, 07/04/1999 p. 0010 - 0028

9) ETSI EN 300 086-1 European Standard (Telecommunications series) 'Electromagnetic compatibility and Radio spectrum Matters (ERM); Land Mobile Service; Radio equipment with an internal or external RF connector intended primarily for analogue speech; Part 1: Technical characteristics and methods of measurement'.

10) ETSI EN 300 086-2 European Standard (Telecommunications series) 'Electromagnetic compatibility and Radio spectrum Matters (ERM); Land Mobile Service; Radio equipment with an internal or external RF connector intended primarily for analogue speech; Part 2: Harmonized EN covering essential requirements under article 3.2 of the R&TTE Directive'.

11) ETSI EN 300 113-1 European Standard (Telecommunications series) 'Electromagnetic compatibility and Radio spectrum Matters (ERM); Land mobile service; Radio equipment intended for the transmission of data (and/or speech) using constant or non-constant envelope modulation and having an antenna connector; Part 1: Technical characteristics and methods of measurement'.

12) ETSI EN 300 113-2 European Standard (Telecommunications series) 'Electromagnetic compatibility and Radio spectrum Matters (ERM);Land mobile service; Radio equipment intended for the transmission of data (and/or speech) using constant or non-constant envelope modulation and having an antenna connector; Part 2: Harmonized EN covering essential requirements under article 3.2 of the R&TTE Directive'.

13) ETSI EN 301 489-1 European Standard (Telecommunications series) 'Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 1: Common technical requirements'

14) ETSI EN 301 489-5 European Standard (Telecommunications series) 'Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 5: Specific conditions for Private land Mobile Radio (PMR) and ancillary equipment (speech and non-speech)'.

NOTE 1: ETSI European Standards are available in electronic (PDF) format from the ETSI Web Site at http://www.etsi.org/ or in printed format from BSI at the address given below:

BSI - British Standards Institution
Customer Services (GB)
389 Chiswick High Road
LONDON
W4 4AL
UNITED KINGDOM

Telephone:	+44 (0) 208 996 9001
Fax:	+44 (0) 208 996 7001
E mail:	cservices@bsi-global.com

NOTE 2: The ETSI website should be consulted to determine the version of the standard which should be used where more than one version exists.

15) EUROCAE ED-67 'Minimum Operational Performance Specification for devices that prevent unintentional or continuous transmissions' April 1991.

NOTE: Information on EUROCAE Publications can be found at the EUROCAE Web Site at http://www.eurocae.org/ Documents can either be purchased on line or from EUROCAE at the address given below:

EUROCAE
17, rue Hamelin
75116 Paris
FRANCE

Telephone:	+33 1 4505 7188
Fax:	+33 1 4505 7230
E-mail:	eurocae@eurocae.com

Part 2 Requirements

5 Safety Objective

The UHF radio equipment and systems shall provide complete, identified, accurate and uncorrupted voice communications for Air Traffic Services Ground to Ground Communications (1005).

6 International Standards

6.1 The equipment, systems, services and facilities shall comply with the applicable international standards, recommended practices and procedures for air navigation services in Annex 10 [1], Annex 11 [2] and Annex 14 [3] to the Convention on International Civil Aviation (262).

6.2 The equipment, systems, services and facilities shall comply with the applicable Radio Regulations of the International Telecommunications Union (263).

6.3 Two-way radiotelephony communication facilities shall be provided for aerodrome (surface movement) control service for the purpose of controlling vehicles on the manoeuvring area, except where communication by a system of visual signals is deemed to be adequate (264).

NOTE: This communication facility is normally provided by UHF radio equipment and systems but the use of VHF Aeronautical Mobile Service frequencies may be permitted for ground to ground communications in specific circumstances.

6.4 **Recommendation:** Where conditions warrant, separate communication channels should be provided for the control of vehicles on the manoeuvring area (265).

6.5 The driver of a radio-equipped vehicle shall establish two-way radio communication with the aerodrome control tower before entering the manoeuvring area and with the appropriate designated authority before entering the apron (266).

6.6 The driver of a radio-equipped vehicle shall maintain a continuous listening watch on the assigned frequency when on the movement area (267).

NOTE: Guidance on aerodrome vehicle operations is contained in ICAO Annex 14 Attachment A Section 17 and includes operators qualifications, competency, radiotelephony operating procedures and phraseology.

7 Radio Spectrum Management

7.1 The equipment and systems shall be designed and constructed to operate within the Land Mobile Service allocation 450 MHz to 470 MHz with a channel spacing of 12.5 kHz using Frequency Modulation (FM) with ITU emission designator 11K0F3EJN using semi-duplex operation (268).

NOTE: The Base Station equipment uses duplex operation and the Land Mobile Station equipment uses simplex operation.

7.2 The equipment and systems shall be installed, operated and maintained in compliance with the terms of specific location dependent or general frequency assignment(s) and the terms and conditions of an ANO Approval granted by the CAA in respect of the Air Traffic Services Ground to Ground Communications being provided (269).

8 WT Act PBR Licence

Guidance: A WT Act Private Business Radio (PBR) On-site licence issued by the Radiocommunications Agency will be required prior to the establishment of the Base Station and the installation or operation of equipment and systems. Further information [4] may be obtained from the Radiocommunications Agency.

NOTE: All new Aeronautical Radio Stations must have been assessed as fit for purpose under the Air Navigation Order Article 104 by the CAA SRG Air Traffic Services Standards Department before a radio licence can be issued.

9 Equipment Specifications

9.1 **Guidance:** The minimum equipment requirements comprise the parameters for the licensing of the equipment, contained in the United Kingdom Radio Interface Requirement [5] published by the Radiocommunications Agency, in accordance with Directive 1999/5/EC [8] Articles 4.1 and 7.2 and the essential requirements in Article 3.2.

9.2 Type approval specifications have been produced, including MPT 1303 [6], MPT1326 [7], ETSI EN 300 086-1 [9], ETSI EN 300 086-2 [10], ETSI EN 300 113-1 [11], ETSI EN 300 113-2 [12]. Further details and information on the applicability of these standards may be obtained from the Radiocommunications Agency.

10 Inspection of UHF Equipment and Systems

10.1 The equipment, systems and associated records shall be made available for inspection by an authorised person, being a CAA SRG Regional Inspector, for the purpose of demonstrating compliance with the terms and conditions of the ANO Approval and CAP 670 requirements (270).

10.2 **Guidance:** The Radiocommunications Agency Radio Investigation Services may inspect the equipment and systems to ensure compliance with the terms and conditions of the WT Act licence. Further details on the licensing and regulation of PBR may be obtained from the Radiocommunications Agency.

11 Electro Magnetic Compatibility

UHF Radio Equipment and Systems shall comply with the EMC Directive (271).

NOTE: Further information is contained in Part B Section 4, GEN 04.

12 Maintenance of UHF Equipment and Systems

Maintenance arrangements shall be established for UHF Radio Equipment and Systems at aerodromes associated with the provision of Air Traffic Services (272).

NOTE: Further information is contained in Part B Section 1, APP 02.

13 Communications Availability

13.1 The design, installation, operation and maintenance of equipment and systems shall be such as to ensure an availability of communications appropriate for the Air Traffic Services being provided (273).

13.2 **Guidance:** The availability of communications is dependent on the radio system design, including equipment configuration and power supply arrangements. The selection of equipment with the appropriate duty cycle can also reduce equipment failure. The provision of alarm / status indications is also important in ensuring that appropriate actions are taken to restore communications when a failure occurs.

14 Radio System Design

14.1 Communications of a specified quality of service shall be provided within the radio service area appropriate to the services being provided (274).

14.2 **Acceptable Means of Compliance:** Evidence to demonstrate that the defined quality of service has been achieved within the radio service area.

14.3 For Air Traffic Control communications, a combination of radio service area predictions and ground functional tests would be acceptable. For other Air Traffic Services radio service area predictions or limited ground functional tests.

14.4 **Guidance:** Quality of service comprises the two aspects of signal (voice or data) quality and availability. Signal quality can be defined by signal to noise ratio or SINAD for analogue systems and by bit error ratio for digital systems. The availability can be defined in terms of a percentage of time and location.

NOTE 1: Radio system design includes the consideration of location dependent factors such as a clear radio line of sight, location of antenna, antenna type, transmitter power etc... to ensure reliable radio propagation paths are achieved.

NOTE 2: The quality of service within the radio service area includes the consideration of additional propagation loss due to buildings or other structures obscuring the line of sight between the base station and the mobile station.

14.5 The antennas shall be installed such as to provide vertically polarised emissions (275).

15 Equipment Configuration

15.1 The equipment configuration shall be such as to ensure the availability of communications appropriate to the service being provided (276).

NOTE: The configuration of equipment includes associated antennas, cables, filters, commutation units and other equipment necessary for the operation of the equipment and systems.

15.2 **Acceptable Means of Compliance:**

15.2.1 **Aerodrome Air Traffic Control Services** - The provision of main, standby and emergency equipment redundancy.

15.2.2 **Aerodrome Air Traffic Services (non-ATC)** - For Flight Information Services, the provision of main and emergency equipment redundancy. For Air-Ground Communication Services, the provision of main equipment is considered sufficient for this level of service.

NOTE: Main and Standby equipment may be operated as 'System A' and 'System B' where either may be considered as Main whilst in operational service and the other is considered as Standby, awaiting selection in the event of failure of the Main equipment or when the Main equipment is taken out of service for maintenance.

16 Power Supply

16.1 For an Air Traffic Control Service, the power supply for the emergency equipment shall be independent of that for the main equipment (277).

16.2 **Acceptable Means of Compliance:** The independence of the power supplies need only be for a known limited period provided that the MATS Part 2 procedures manage the safety issues this introduces.

16.3 Users shall be provided with an indication of failure of the power supply to the emergency equipment and instructions shall be provided in MATS Part 2 for user actions in the event of failure (278).

16.4 **Recommendation:** For an Air Traffic Control Service a primary and alternative power supply should be provided to increase the availability of power to equipment and systems in the event of an interruption to one of the power supplies (279). Change over between supplies should be on a 'no break' basis (280). The primary and alternative supplies should be independent of each other for a known period of time (281). An indication of failure for each power supply should be provided to the user and corrective action taken in the event of failure (282). MATS Part 2 procedures should instruct the user of actions necessary in the event of failure (283).

16.5 [ICAO Annex 10 Aeronautical Telecommunications Volume I Paragraph 2.9 Secondary power supply for radio navigation aids and communication systems.]

16.6 **Guidance:** The incorporation of suitable conditioning devices as part of the mains / backup power supply arrangements may be useful in preventing equipment malfunction due to surges, spikes and noise on the power supply.

17 Alarm / Status Indications

17.1 For an Air Traffic Control Service, the system shall provide an indication of system failure that may have an effect on the service being provided, in a timely manner, so that actions can be taken to ensure the safe continued provision of an ATC Service or if necessary the controlled withdrawal of the service (284).

17.2 **Recommendation:** The Significance to the user of the indication of failure should be obvious from the indication given (285).

17.3 The failure indication should remain obvious to the user whilst the condition causing the failure indication remains (286). Consideration should be given to providing a power supply to the alarm indication that is not dependent upon the system it is monitoring (287).

17.4 Changes in the System's state should attract the operator's attention, without continuing to distract once they are aware of the change of state (288). Attention should be drawn both when failures are detected and when they clear (289). Attention to subsequent status changes should not be masked (290). The attention seeking indication should have both visual and audible elements and the ability for the user to acknowledge that they are aware of the change of state thereby removing the attention seeking element (291).

18 Interface to Voice / Data Recording Equipment

18.1 The equipment and systems at the Base Station shall provide all the necessary signals and information to the Voice / Data Recording Equipment in compliance with Article 105 of the Air Navigation Order (292).

18.2 **Acceptable Means of Compliance:** As the Base Station operates in duplex mode and comprises a separate transmitter and receiver, the receiver audio output may be used as the signal source for the recording equipment for Land Mobile Station transmissions. A separate receiver will be required as a signal source for the Base Station transmissions.

18.3 **Recommendation:** Automatic recording facilities should be provided on communications channels used for the control of vehicles on the manoeuvring area (293). [ICAO Annex 11 6.3.1.2]

19 Provision of Off-air Sidetone

NOTE: Reference should be made to Part C Section 1, COM 03 Voice Communications Control Systems, RTF Communications.

Where Off-air sidetone is provided for Air Traffic Services, it shall be a replica of the transmitted voice communications without any degradation of quality such as to cause annoyance or disturbance to the operator (294).

NOTE: The Acceptable Means of Compliance and Guidance in paragraph 7.2.1. can be applied as appropriate to the provision of Off-air Sidetone.

20 Unintentional or Continuous Transmissions

NOTE: Reference should be made to Part C Section 1, COM 03 Voice Communications Control Systems, RTF Communications.

20.1 The equipment and systems at Aeronautical Radio Stations shall not fail in a manner such as to cause unintentional or continuous transmissions (295).

20.2 **Recommendation:** New equipment and systems at Aeronautical Radio Stations should incorporate features to prevent unintentional or continuous transmissions, unless this is contrary to the intended purpose for which they have been designed (296). For existing equipment and systems, consideration should be given to incorporating such devices by retrofit, modification or add-on circuitry where appropriate (297).

20.3 The equipment and systems should conform to the 'Minimum Operational Performance Specification for devices that prevent unintentional or continuous transmissions' EUROCAE document ED-67 April 1991 [15], so far as it is appropriate for ground based systems (298).

Part C, Section 2, - Navigation

1 Introduction

Section 2 of Part C contains engineering requirements for navigation equipment and systems. The approval of flight calibration organisations is included in this section in recognition of their role in the approval and continuing operation of navigational aids. These documents should be used in conjunction with the Generic Requirements and Guidance contained in Part B as appropriate.

2 Scope

The 'ILS' documents cover all aspects of Instrument Landing Systems and some ILS / DME flight inspection and identity keying requirements.

FLI 02 covers the procedures and requirements for the approval of flight calibration organisations. It is divided into sections covering the approval procedure, flight calibration system for navigational aids in general and specific annexes for ILS and MLS.

The 'NAV' documents cover Instrumented Runway Visual Range systems, MF Non-Directional Beacons, Conventional and Doppler VHF Omni-Directional Range Beacons.

The 'VDF' document covers the flight and ground inspection of VHF Direction Finding Systems.

ILS 01 Requirements for ILS Equipment Monitor Alarms

Part 1 Preliminary Material

1 Introduction

Under the terms of Article 104 of the Air Navigation Order all ILS installations intended for use at civil airports within the United Kingdom require approval by the CAA.

2 Scope

This document defines the monitor limits applicable to all categories of ILS.

Part 2 Requirements

3 Safety Objective

The equipment shall not radiate guidance signals which are outside standard operational tolerances (1164).

4 Alarm and Warning Settings

4.1 Monitor alarm settings shall not exceed the limits given in Table 1 (1165)

NOTE: Certain equipment has the facility for pre-alarm or warning. The setting of these parameters will be decided by the manufacturer or operator of the equipment. Where these parameters are fully adjustable, it is often helpful to set them to the ICAO 'adjust and maintain' limits. These limits are separately defined for certain parameters in ICAO Annex 10 as limits within which the equipment should normally be operated, i.e. if the equipment is found to be outside these tolerances during a flight or ground inspection, adjustments should be made. The monitor limits for certain parameters are wider than the 'adjust and maintain' limits to prevent unnecessary shutdowns of the equipment at critical times. There is no mandatory requirement for use of monitor pre-alarms or warnings.

4.2 If flight or ground tests show that the operational alarm limits exceed those given in Table 2, the monitor system shall be adjusted to tighter limits than those given inTable 1 (1166).

4.3 Monitor limits shall not be so tight that equipment instability can cause false shutdowns (1167).

4.4 Table 1 shows the maximum permissible alarm limits for all categories of ILS equipment. In the case of equipment fitted with both hardware and software monitors, these limits shall apply to the hardware monitors (1168). The software monitors shall be set to slightly narrower limits (1169).

5 Method of Testing

5.1 At commissioning, localiser alarms shall be checked by ground or flight inspection and glidepath alarms by flight inspection (1170).

5.2 Table 2 shows the maximum permitted change, measured in the field, when a system is adjusted to its alarm limits (1171). On a system with several sets of monitors, the system shall be adjusted to a point where sufficient alarms are generated to cause a changeover/shutdown (1172). On systems with combined hardware/software monitors, only the hardware monitor alarms shall be active for these tests (1173).

NOTE: θ is used in the following paragraphs to denote the nominal guide path angle.

5.3 Adjustments Used for Simulation of Alarms

Localiser centreline:	Modulation balance
Localiser displacement:	Sideband power
Glidepath angle:	Modulation balance
Glidepath displacement:	Sideband power

5.4 For sideband reference glidepath systems, additional tests shall be applied:

5.4.1 The upper aerial shall be dephased until an alarm occurs (1174). Clearance, angle and displacement sensitivity shall be measured (1175). The procedure shall then be repeated with the aerial dephased in the opposite direction (1176). Full details of this requirement are contained in ILS 05 and summarised below.

5.4.2 The angle and displacement sensitivity shall not exceed the glidepath tolerances given in Table 2 (1177).

5.4.3 The fly-up signal measured at 0.3θ shall not fall below 150 µA (1178).

NOTE: The alarms present in this test may occur on any of the system monitors, provided sufficient alarms are present to cause a system shutdown.

5.5 The alarm points of all individual monitor units shall be measured at commissioning, using independent test equipment (1179). The figures measured shall be recorded as standard figures (1180).

5.5.1 Measurement of individual monitor units shall be repeated at intervals not exceeding 6 months (1181).

5.5.2 The monitor calibration interval may be extended to 12 months if it can be demonstrated with a confidence of 95%, that the monitors have a reliability of 0.95 or better (1182).

NOTE 1: A failure is defined as a monitor whose ddm centring or alarm points are found to be more than 10% of the alarm value or 1 µA, whichever is the greater, from the standard values.

NOTE 2: This requires a large sample size. (Minimum of 60 with no failures or 95 with one failure.)

5.5.3 Monitors used in the assessment need not all be on the same airport, but all shall be of an identical type (1183).

Table 1 Normal monitor alarms

	Cat I	**Cat II**	**Cat III**
Localiser			
Centreline	± 1.5% ddm (15μA)	± 1.1% ddm (11μA)	± 0.9% ddm (8μA)
Displacement sensitivity	± 17%	± 17% of nominal input	± 17%
Clearance	± 20%	± 20% of nominal input	± 20%
Modulation sum (sdm)	± 4%	± 4%	± 4%
Identity modulation (if fitted)	± 5%	± 5%	± 5%
Frequency difference (dual frequency)	± 3 kHz	± 3 kHz	± 3 kHz
Glidepath			
Angle	± 4% ddm (35μA)	± 4% ddm (35μA)	± 4% ddm (35μA)
Displacement sensitivity	± 25%	± 25% of nominal input	± 25%
Clearance	± 20%	± 20% of nominal input	± 20%
Modulation sum (sdm)	± 5%	± 5%	± 5%
Frequency difference (dual frequency)	± 5 kHz	± 5 kHz	± 5 kHz
Common to both			
RF level (single frequency)	-3dB	-3dB	-3dB
	Provided that coverage is satisfactory when power is reduced to the alarm level.		
RF level (dual frequency)	± 1dB	± 1dB	± 1dB
	Unless tests have shown that a wider limit may be used.		

NOTE: On a glidepath system operating with the correct nominal displacement sensitivity, an angle alarm tolerance of ±5.4% ddm corresponds to a change in angle of .075. The figure of 4% ddm (35 μA) has been chosen to allow for a system which may be operating near its lower limit of displacement sensitivity.

6 Special Cases

NOTE: Even though a system may meet the requirements of Table 2, results of a flight inspection may require that the figures given in Table 2 are modified. These cases are detailed below.

6.1 **Glidepath with no separate clearance transmitter:**

If the 'fly-up' signal at 0.3θ is <200μA, the displacement sensitivity monitor alarms shall be set to ±20% of the nominal displacement sensitivity (1184).

6.2 **Localiser with no separate clearance system:**

If clearance in the region between ±10° and ±35° is at any point <170 μA, the displacement sensitivity monitor alarms shall be set to ±10% of the nominal displacement sensitivity (1185).

6.3 **Localiser with a separate clearance transmitter:**

If clearance in the region between ±10° and ±35° is at any point <170 μA, the clearance monitor alarms shall be set to ±10% of the nominal clearance input (1186).

7 Changeover and Shutdown Times

7.1 The maximum TOTAL time of false radiation shall not exceed the number of seconds shown in Table 3 (1187).

NOTE: In the case of a common fault, eg. the aerial system, in a system configured for immediate changeover, the quoted time is the total time from beginning of the fault until final shutdown of the system.

7.2 For Category I & II systems, where immediate changeover is not provided, the delay from the time of shutdown of the main transmitter to the start of radiation from the standby transmitter shall be 20 ± 2 seconds (1188).

7.3 For systems having this delay, the figures given in Table 3 shall apply separately to each transmitter of the system (1189).

Table 2 System Alarms Measured by Ground/Flight Inspection

	Cat I	Cat II	Cat III
Localiser			
Centreline	± 35 ft	± 25 ft	± 20 ft
	at the landing threshold		
Displacement sensitivity	± 17%	± 17%	± 17%
	of nominal displacement sensitivity		
Glidepath			
Angle	± 7.5%	± 7.5%	± 7.5%
	of nominal glidepath angle		
Displacement sensitivity	± 25%	± 25%	± 25%
	of nominal displacement sensitivity		

Table 3 Changeover and Shutdown Times (in seconds)

	Cat I	Cat II	Cat III
Localiser	10	5	2
Glidepath	6	2	2

ILS 01 Appendix - Calculation of Displacement Sensitivity

In many cases it is more usual to measure the signal width rather than the displacement sensitivity as defined by ICAO. For example on a glidepath system the flight inspection will normally measure the angle between 75 μA fly-up and 75 μA fly-down. To convert changes in displacement sensitivity to changes in angle, the following formulae should be applied.

An x% REDUCTION in displacement sensitivity (decrease in sideband power) will produce a GREATER width angle of (1190):

(nominal angle) ÷ [(100 – x)/100]

An x% INCREASE in displacement sensitivity (increase in sideband power) will produce a NARROWER width angle of (1191):

(nominal angle) ÷ [(100 + x)/100]

Examples

As an example, wide alarm on a standard 3° glidepath,

(25% decrease in displacement sensitivity):

(nominal angle) ÷ [(100 – x)/100] = 0.72 ÷ (75/100) = 0.96°

Similarly, narrow alarm:

(nominal angle) ÷ [(100 + x)/100] = 0.72 ÷ (125/100) = 0.58°

ILS 02 Flight Inspection – Limits to be Applied

Part 1 Preliminary Material

1 Introduction

1.1 Article 104 (2) of The Air Navigation Order requires that a navigation aid is 'flight checked on such occasions as the CAA may require'.

1.2 The purpose of this document is to ensure that a system, when flight inspected, is operating within defined limits.

2 Scope

This document defines the limits to be applied to all parameters measured during ILS flight inspection. It does not define the frequency of inspection or the need for particular tests. This document only defines the limits to be applied when particular tests are made.

Part 2 Requirements

3 Safety Objective

The equipment shall provide a complete, identified, accurate and uncorrupted source of guidance information to aircraft (1192).

4 Commissioning

4.1 Commissioning flight inspections of localisers and glidepaths shall be made with all field monitors in their final positions (1193).

NOTE: An engineering flight inspection may be necessary to establish the position of the glidepath field monitor.

5 Localiser

5.1 Alignment

5.1.1 Periodic

Cat I ± 5.0% (1194).

Cat II ± 2.5% (1195).

Cat III ± 1.4% (1196).

Of the nominal total angular sector width.

5.1.2 Commissioning

Cat I ± 1.5%.

Cat II ± 1.0%.

Cat III ± 0.5%.

Of the nominal total angular sector width (1197).

5.2 Displacement Sensitivity

5.2.1 Periodic

Cat I ± 17%.

Cat II ± 17%.

Cat III ± 10%.

Of the nominal displacement sensitivity (1198).

5.2.2 **Commissioning**

Cat I ± 5%.

Cat II ± 5%.

Cat III ± 3%.

Of the nominal displacement sensitivity (1199).

NOTE 1: For offset localisers, the Cat I limits will be applied.

NOTE 2: In no cases is the total sector width permitted to exceed 6 degrees.

5.3 **Symmetry (either side of the courseline)**

45% to 55% of the measured displacement sensitivity (1200). In cases of disagreement with the ground figures, the ground measurements at threshold shall be used for assessment (1201).

5.4 **Power Ratio (two frequency system)**

On the localiser centreline, the course signal must exceed the clearance signal by a minimum of 12 dB (1202).

5.5 **Course Structure**

Course structure shall have a probability of 95% or better of not exceeding the limits given below, when assessed over a 40 second interval (1203).

NOTE: Guidance on structure assessment may be found in Attachment C to ICAO Annex 10.

5.5.1 **Cat I**

30 μA (0.031 ddm) 8NM from the ILS reference datum to point A, then decreasing at a linear rate to 15 μA (0.015 ddm) at point B. 15 μA (0.015 ddm) from point B to point C (1204).

5.5.2 **Cat II**

30 μA (0.031 ddm) 8NM from the ILS reference datum to point A, then decreasing at a linear rate to 5 μA (0.005 ddm) at point B. 5 μA from point B to the ILS reference datum (1205).

5.5.3 **Cat III**

30 μA (0.031 ddm) 8NM from the ILS reference datum to point A, then decreasing at a linear rate to 5 μA (0.005 ddm) at point B. 5 μA from point B to the ILS reference datum (1206).

5.6 **Off Course Clearance**

Substantially linear increase from the front courseline to an angle where the deflection current is 195 μA (0.20 ddm) (1207). From this angle to 10° on the same side, the deflection current must not fall below 195 μA (0.20 ddm) (1208). From ±10° to ±35° the deflection current must not fall below 165μA (0.17 ddm) (1209).

NOTE: It is desirable that the deflection current in the region between 10° and 35° should not be below 195 μA (0.20 ddm) (1210). Wherever possible, systems should be adjusted to achieve this.

5.7 **Coverage**

5.7.1 **Periodic**

Usable signals at 25 NM on the localiser centreline (1211).

5.7.2 **Commissioning**

5.7.2.1 Usable signals at 25 NM, from the localiser centreline to ±10° from the centreline (1212).

5.7.2.2 Usable signals at 17 NM, from ±10° to ±35° from the localiser centreline (1213).

5.7.2.3 Usable signals shall be receivable to the distances specified, at and above a height of 2000 feet above the elevation of the threshold or 1000 feet above the elevation of highest point within the intermediate and final approach areas, whichever is the higher (1214).

5.7.2.4 A usable signal is defined as a signal producing localiser flag current of not less than 275 µA and a ddm conforming to requirements of section 4.6.

5.8 **Polarisation**

Polarisation error when the aircraft is in a roll attitude of 20° shall be no greater than:

Cat I 0.016 ddm (1215).

Cat II 0.008 ddm (1216).

Cat III 0.005 ddm (1217).

5.9 **Modulation Depth**

Modulation depth shall be measured when approaching the facility, where the ddm is approximately zero (1218).

5.9.1 **Periodic**

The sum of the modulation depths of the navigational tones shall be between 36% and 44% (1219).

5.9.2 **Commissioning**

The sum of the modulation depths of the navigational tones shall be between 39% and 41% (1220).

5.10 **Identification**

Clear identification giving no perceptible interference to the basic localiser functions (1221).

5.11 **Course Structure Stability**

Cat I ± 43 µA (0.045 ddm).

Cat II ± 30 µA (0.031 ddm).

Cat III ± 30 µA (0.031 ddm) (1222).

These tests cannot be used to confirm the conformance of the facility to defined standards. Their purpose is to identify any marked deterioration in the structure which may require further investigation.

6 Glidepath

6.1 Angle

6.1.1 Periodic

Cat I ± 6.0%.

Cat II ± 6.0%.

Cat III ± 4.0%.

Of the promulgated glidepath angle (1223).

6.1.2 Commissioning

Cat I ± 1.5%.

Cat II ± 1.0%.

Cat III ± 1.0%.

Of the promulgated glidepath angle (1224).

6.2 Displacement Sensitivity

6.2.1 Periodic

Cat I ± 25%.

Cat II ± 20%.

Cat III ± 15%.

Of the nominal displacement sensitivity (1225).

6.2.2 Commissioning

Cat I ± 8%.

Cat II ± 6%.

Cat III ± 5%.

Of the nominal displacement sensitivity (1226).

6.3 Symmetry (of upper/lower half sector)

6.3.1 Commissioning

Cat I 33% to 67%.

Cat II 42% to 58%.

Cat III 42% to 58%.

Of the measured displacement sensitivity (1227).

6.4 **Clearance Below Path (normal operation)**

Smooth increase in ddm from the glidepath angle to an angle where 190 µA fly-up (0.22 ddm) is reached. This shall occur at not less than 0.3θ (1228). Where this is achieved at an angle above 0.3θ, the fly-up must not fall below 190 µA (0.22 ddm) between this angle and 0.3θ (1229).

Where coverage between 0.45θ and 0.3θ is less than the specified datum, but sufficient current is present to remove the flag alarm, the fly-up shall not fall below 190µA (0.22 ddm) (1230).

6.5 **Clearance Below Path**

(Two frequency system – course signals only.)

6.5.1 **Cat I**

Fly-up (150 Hz) deflection shall exist at all angles between 0.3θ and the glidepath angle (1231).

6.5.2 **Cat II**

Smooth increase in ddm from the glidepath angle to an angle where 150 µA fly-up (0.175 ddm) is reached. Between this angle and 0.3θ the ddm must remain 150 Hz predominant (1232).

6.5.3 **Cat III**

Smooth increase in fly-up from the glidepath angle to an angle where 150 µA fly-up (0.175 ddm) is reached. Between this angle and 0.3θ the ddm must remain 150 Hz predominant (1233).

NOTE: For the tests above, with clearance signals removed, there is no requirement to meet any coverage (signal-strength) specification. Only the value of ddm is being examined.

6.6 **Clearance Below Path (at ±8° azimuth)**

During the prescribed level flight, a minimum deflection current of 190 µA (0.22 ddm) must be achieved at 0.45θ (1234).

6.7 **Clearance Above Path**

Smooth increase in fly-down from the glidepath angle to an angle where the fly-down is 190 µA (0.22 ddm) (1235). Between this angle and 1.8θ, the fly-down must not fall below 150 µA (0.175 ddm) (1236).

6.8 **Coverage**

Adequate coverage must exist to 10 NM and down to 0.45θ or a lower angle down to 0.3θ, as required to safeguard the promulgated glidepath intercept procedure (1237).

Adequate coverage is defined as a receiver input exceeding the equivalent of a 40 µV source of EMF and a total impedance of 50 ohms resistive, together with sufficient current to remove the flag alarm.

6.9 **Course Structure**

Course structure shall have a probability of 95% or better of not exceeding the limits given below, when assessed over a 40 second interval (1238).

NOTE: Guidance on structure assessment may be found in Attachment C to ICAO Annex 10.

6.9.1 **Cat I**

30 μA (0.035 ddm) 8 NM from the ILS reference datum to point C (1239).

6.9.2 **Cat II**

30 μA (0.035 ddm) 8 NM from the ILS reference datum to point A, then decreasing at a linear rate to 20 μA (0.023 ddm) at point B. 20 μA from point B to the ILS reference datum (1240).

6.9.3 **Cat III**

30 μA (0.035 ddm) 8 NM from the ILS reference datum to point A, then decreasing at a linear rate to 20 μA (0.023 ddm) at point B. 20 μA from point B to the ILS reference datum (1241).

6.10 **Modulation Depth**

Modulation depth shall be measured when approaching the facility, where the ddm is approximately zero (1242).

6.10.1 **Periodic**

The sum of the depths of modulation of the navigational tones shall be between 75% and 85% (1243).

6.10.2 **Commissioning**

The sum of the depths of modulation of the navigational tones shall be between 78% and 82% (1244).

6.11 **Course Structure Stability**

Cat I	± 50 μA (0.058 ddm).
Cat II	± 35 μA (0.040 ddm).
Cat III	± 35 μA (0.040 ddm) (1245).

These tests cannot be used to confirm the conformance of the facility to defined standards. Their purpose is to identify any marked deterioration in the structure which may require further investigation.

7 Marker Beacon

7.1 **Fly-through Times**

The time for which the signal is above the datum level (corrected to a ground speed of 96 knots) should be between:

Inner	2 and 4 seconds.
Middle	4 and 8 seconds.
Outer	8 and 16 seconds (1246).

8 DME with ILS

8.1 Identification

Clear and distinct along the front courseline to the coverage limit. If synchronised with the associated ILS, the correctness of the keying sequence must be verified (1618).

8.2 Accuracy

8.2.1 Periodic

±0.10 Nautical Miles or better from ILS point A to the ILS reference datum (1247).

8.2.2 Commissioning

±0.03 Nautical Miles or better from ILS point A to the ILS reference datum (1248).

8.3 Coverage

The DME receiver input shall not fall below -90 dBm throughout the normal ILS service volume (1619).

9 Analysis of Flight Inspection Records

9.1 The system operator is responsible for analysing the flight inspection records and informing the relevant engineering inspector of any deficiencies in the performance of the navigation aids.

9.2 With the agreement of the appropriate SRG Engineering Inspector, an airport may delegate the task of examining the flight inspection records to a specialist organisation. This may be the same organisation that makes the flight inspection.

NOTE: Copies of all ILS flight inspections are supplied to SRG by flight inspection organisations. They form part of an on-going audit of these organisations but are not examined in detail with respect to individual airports.

ILS 03 ILS flight inspection intervals

Part 1 Preliminary Material

This document is produced and published by the CAA. It provides those requirements that must be met to achieve approval under the Air Navigation Order. This document is based upon those relevant and applicable ICAO standards and recommended practices. This document supersedes and replaces all earlier versions.

1 Introduction

It is an ICAO requirement that all radio navigation aids shall be the subject of periodic flight checks (1249).

2 Scope

This document details the prescribed intervals, their tolerances and the additional requirements for an extended flight inspection interval. It is applicable to all systems in the UK.

Part 2 Requirements

3 Safety Objective

To ensure that the ILS provides an accurate and uncorrupted source of guidance information, the critical parameters of the radiated signal shall be verified by flight inspection at defined intervals (1250).

4 Flight Inspection Intervals

For ILS facilities, the prescribed interval between successive inspections is 120 days unless an extended interval has been granted (1251).

Where an extended interval has been granted, the prescribed interval between successive inspections is 180 days (1252).

For facilities without a glidepath the prescribed interval between successive inspections is 180 days (1253).

4.1 Tolerances

A tolerance of +20 days is applicable to the prescribed intervals. Operators shall strive to ensure that flight inspection takes place as closely as possible to the prescribed intervals. If the previous inspection lasted more than one day, the interval shall be calculated from the date when the inspection started (1254).

4.2 Alerting engineering inspectors

Operators shall inform their SRG engineering inspector whenever the due date for inspection has been exceeded by 5 days (1255). No further action is needed at that time, but the inspector shall be forewarned of possible problems (1256).

4.3 Inspections earlier than the due date

Flight inspections may be made up to 7 days earlier than the due date without affecting the due date for the next inspection (1257). If an inspection is made more than 7 days before the due date, the date of subsequent inspections shall be advanced (1258).

4.4 Tolerance extension for certain facilities

Under exceptional circumstances, for facilities not using an extended inspection interval, the tolerance period of 20 days may be extended by a further period not exceeding 25 days (1259). This extension shall be granted only by the CAA and shall be granted only if the CAA is satisfied that:

a) Previous flight inspections do not have marginal results and do not show any tendency toward parameter drift (1260).

b) Monitor readings are stable (1261).

c) Ground checks, where applicable, are stable (1262).

d) No adverse reports have been received from users in the period since the last flight inspection (1263).

4.5 Delays due to adverse weather

4.5.1 Occasionally, prolonged periods of adverse weather may prevent an inspection being completed within the permitted tolerance. If this occurs, the system may continue in operation for a further 25 days provided that a reduced flight inspection has been made within the permitted tolerance interval (1264).

4.5.2 The minimum inspection requirements are:

Localiser: part orbit ± 35° at approximately 6 nautical miles for both transmitters (1265).

Glidepath: Level slice starting at 10 nautical miles, at the height normally used for such a flight on the facility, for both transmitters (1266).

4.5.3 The system may continue in operation for 25 days, provided that both the system operator and the CAA are satisfied that no significant changes have occurred since the previous inspection (1267). The system shall be withdrawn from service if the outstanding parts of the inspection are not completed within the 25 days (1268).

5 Extended Inspection Intervals

The following information contains the requirements for granting and maintaining an extended ILS flight inspection interval. Extended flight inspection intervals shall be granted on a 'system by system' basis, as information becomes available and is examined by SRG (1269). Systems failing to meet the designated criteria shall remain with the 120 day inspection interval regardless of how long the equipment has been installed (1270).

5.1 Environmental Considerations

NOTE 1: The ILS is protected against interference from moveable and small fixed objects by the establishment of critical and sensitive areas. These areas are protected by physical markings defined in local instructions specific to each airport.

NOTE 2: Areas beyond the critical and sensitive areas, where development of buildings etc could affect the ILS performance, are protected by safeguarding requirements.

The ILS shall be safeguarded satisfactorily.

5.2 Maintenance – general

NOTE 1: All organisations concerned with ILS maintenance are checked at regular intervals by the Regional Inspector for the particular area.

NOTE 2: The inspection covers general organisation, staff competency, documentation, test equipment and matters pertinent to safe operation of an ILS system.

The Regional Inspector shall be satisfied with all aspects before 180 day intervals can be considered (1271).

5.3 Documentation

A minimum level of station records shall exist as detailed below (1272). These records shall be retained on station and copies be supplied to the CAA (1273). Station records shall also be available for the time period covering the previous four flight inspections (1274). This is to assist in assessing equipment stability prior to moving to 180 day intervals (1275).

5.3.1 Minimum Station Record Requirements

5.3.1.1 All equipment monitor readings which must be taken at monthly, or more frequent intervals (1276). These shall be recorded for all transmitters capable of operating into the aerial (1277).

5.3.1.2 Far-field monitor recordings which must be marked with the time and date at prescribed intervals or localiser centreline and width measurements made at threshold (1278). These measurements shall be made as near as possible to the time at which equipment monitor readings are taken (1279).

NOTE 1: Width measurements may be made at points other than 105 metres from threshold, providing that a proportional relationship is established between this point and the full sector width.

NOTE 2: For CAT I Localisers using 14 or less radiating elements, field measurements may be made approximately 300 metres in front of the local transmitting aerial.

5.3.1.3 **Recommendation:** Glidepath field measurements are not mandatory but would be of great help in proving equipment stability. It is recommended that monthly field checks are made on null reference and sideband reference glidepaths (1280).

5.3.1.4 Post flight check field measurements:

i.e. localiser field measurements made as soon as possible after a flight inspection (1281).

5.3.1.5 Post flight check monitor readings:

i.e. equipment monitor readings taken as soon as possible after a flight check (1282).

5.3.1.6 Calibration figures for all the system monitor alarms which must be measured at 6 monthly or more frequent intervals (1283).

a) On Glidepath systems these monitor checks shall be made using independent test equipment and not by adjusting the main transmitter (1284).

b) On CAT III systems, ALL system monitor alarm checks shall be made using independent test equipment (1285).

5.3.1.7 Meteorological conditions at the time of the flight inspection (1286).

5.3.2 ILS Parameter Reporting Form

A completed reporting form shall be submitted to the Regional inspector at the time of any occurrence listed on the form (1287).

5.4 Flight Inspection and Far Field Measurements

Before being permitted to operate with 180 day flight inspection intervals, a system shall have shown satisfactory stability in the previous four flight inspections (1288). The limits which shall be met at the previous four inspections, and at all times that the 180 day interval is used are detailed below (1289).

5.4.1 **Localiser**

5.4.1.1 Alignment: 75% of the tolerances applied in ILS 02 hence:

CAT I	± 26 feet	11 µA.
CAT II	± 13 feet	5.5 µA.
CAT III	± 7.5 feet	3.5 µA. (1290)

5.4.1.2 Displacement Sensitivity: 75 % of the tolerances applied in ILS 02 hence:

CAT I	± 13% of nominal figure.
CAT II	± 13% of nominal figure.
CAT III	± 8% of nominal figure. (1291)

5.4.1.3 All other localiser parameters will retain the existing limits of ILS 02 (1292).

5.4.1.4 In the event of flight inspection results falling outside the tolerances given above, the localiser field measurements shall be taken into consideration, when assessing the feasibility of continuing with 180 day intervals (1293).

5.4.2 **Glidepath**

5.4.2.1 Angle:

Cat I and Cat II will retain the existing ILS 02 limits since these are already tighter than the ICAO Annex 10 limits (1294). For Cat III, 75% of the tolerances applied in ILS 02 which are:

5.4.2.2 Displacement sensitivity:

75% of the tolerances applied in ILS 02.

CAT I	± 19% of nominal figure.
CAT II	± 15% of nominal figure.
CAT III	± 11% of nominal figure (1295).

5.4.2.3 Below Path Clearance:

The clearance below path 10 NM from the reference datum at 0.3 shall be 220 µA or greater (1296). All other glidepath parameters shall retain the existing limits of ILS 02 (1297).

5.5 **Supplementary Flight Inspections**

A supplementary flight inspection must be made 90 days ± 20 days after a routine flight inspection if at that inspection any parameter was found outside the flight inspection tolerances stated above, and subsequently adjusted (1298).

Only the parameters found out of tolerance need to be checked by the supplementary flight inspection.

5.5.1 A supplementary flight inspection may be requested by SRG at any time if the following conditions arise:

An ILS reporting form has been submitted for a listed occurrence.

A Regional Inspector considers that any aspect of maintenance is not being correctly carried out.

An inspection of equipment monitor records, which may be requested at any time by SRG, shows any evidence of instability.

Changes have been made within the safeguarded areas.

A routine inspection has shown any unusual, though not necessarily out of tolerance, aberrations in the course structure.

ILS 04 Localiser Width Measurement at Threshold

Part 1 Preliminary Material

1 Introduction

With the exception of certain short runways, ICAO Annex 10 defines the displacement sensitivity (width) of a localiser radiation pattern at the runway threshold. Airports having the necessary measuring equipment may elect to use ground measurements as their definitive measurement.

NOTE: There are some airports which do not have the necessary equipment to make the ground measurements required by this document. The method will not be mandatory.

2 Scope

This document sets out the localiser width measurement requirements for Cat I, Cat II and Cat III ILS.

Part 2 Requirements

3 Position of Measuring Points

3.1 Field measurement points for each runway shall meet the following requirements:

3.1.1 The measurement points shall be at the runway threshold (1299) and 110 metres offset from the runway centre-line, unless the conditions in 3.1.2 or 3.1.3 apply (1300).

3.1.2 If the offset distance defined in 3.1.1 cannot be used due to obstructions, etc., the distance may be reduced to not less than 60 metres (1301).

3.1.3 If the requirements of 3.1.1 and 3.1.2 cannot be met, the measurements may be made at a point closer to the localiser. The points should not be less than half the runway length from the localiser (1302).

NOTE: Far-field monitor readings may be used in place of portable equipment for that side of the runway where the far field monitor is installed, unless the far field width monitor is less than 60 metres from the runway centreline.

4 Implementation

4.1 At commissioning, the displacement sensitivity shall be measured by flight inspection (1303). If the ground and air measurements differ by more than 5% the disagreement shall be investigated (1304).

NOTE: At subsequent flight inspections the displacement sensitivity need not be measured unless a specific request is made.

4.2 The flight inspection shall still include semi-orbits from which linearity in the course sectors can be examined (1305).

4.3 All airports wishing to use the ground measurements as standard shall submit the following information to the CAA:

a) Position of the ground measurement points (1306).

b) Details of the equipment to be used for this measurement (1307).

5 Measurement

5.1 The localiser displacement sensitivity shall be measured at a time as near as possible to that of the flight inspection (1308).

NOTE: The displacement sensitivity should be measured on the same day as a flight inspection unless ground conditions prevent this being done. If the measurement cannot be made prior to the flight inspection, it must be done as soon as possible afterwards. The result of the measurement is needed by the flight inspection organisation as part of the structure measurement calculations. In the absence of the figure, the localiser's nominal width will be used in the calculations.

5.2 The flight inspection report shall show whether the width figure is an air or ground measurement (1309).

5.3 The measurements may be made either in DDM or μA deflection current at the measurement points. For standardisation these results shall be converted into localiser full sector width, i.e. the theoretical angle between the points at which 0.155 DDM would occur (1310).

5.4 The airport’s ILS maintenance instructions shall show the method of calculating the width angle from the ground measurements (1311).

6 Tolerances

6.1 The normal tolerances used for flight inspection shall apply (1312).

6.2 If ground measurements show a width exceeding 6°, the system shall be adjusted or taken out of service (1313).

NOTE: The ICAO Annex 10 requirement that a localiser width angle must not exceed 6° is interpreted as an 'adjust and maintain' limit. The system alarms will still be set to ±17% of the nominal displacement sensitivity.

7 Commissioning Figures

Certain localisers will have a calculated width of 6° or more. These systems will be promulgated as having a nominal 6° total sector width. At commissioning the width angle shall be set to slightly less than 6°. The stability of modern equipment is such that a figure of 5.8° at commissioning will not exceed 6° with normal routine maintenance.

ILS 05 Sideband Reference Glidepath Phase Alarms

Part 1 Preliminary Material

1 Introduction

1.1 The sideband reference glidepath characteristics are more susceptible to small phase changes in the transmitting aerial system than any other common glidepath.

1.2 For these reasons it is essential that the system monitors can detect any faults which could cause the system to radiate signals not complying with international specifications.

2 Scope

This requirement outlines the test and verification procedures to be applied to ensure correct glidepath phasing and monitor operation. It applies to all sideband reference systems in the UK.

Part 2 Requirements

3 Safety Objective

A sideband reference glidepath shall provide an accurate and uncorrupted source of guidance information to an aircraft (1314).

4 Need For Tests

The test procedure shall be applied:

a) At commissioning (1315)

b) Whenever major changes have been made to the aerial system (1316).

c) Whenever a flight inspection has shown the system to be non-compliant with specifications and no alarm has been shown by the monitors (1317).

NOTE: If the monitor phase tests are not successful and transmitter adjustments are required, parts of the normal flight inspection will have to be repeated. Unless staff are highly confident that all phasing is correct, it is advisable to consult the guidelines given in Annex 1 before starting the main flight inspection.

5 Verification Procedure

5.1 **Safety Objective**

The monitor system shall be capable of detecting any phase change which could cause the radiation of unsafe guidance information (1318).

5.2 The system aerial phaser shall be adjusted until the monitors show sufficient alarms to cause a shutdown (1319).

5.3 The flight inspection shall measure the radiated signal – normally by flying a level slice (1320).

5.4 The system aerial phaser shall be adjusted in the opposite direction to produce alarms (1321).

5.5 The flight inspection shall measure the radiated signal (1322).

5.6 In both alarm conditions, the glidepath angle shall not be less than 0.925θ (1323) and the fly-up signal at 0.3θ must not be less than 150 μA (1324).

NOTE 1: If the aerial phase control does not have sufficient range to reach the alarm condition, it is permissible to add adaptors or extender cables to give the required phase change.

NOTE 2: The monitor alarm may occur on either the position or width monitors – either is acceptable provided the conditions in 5.6 are met.

5.7 The manufacturer and/or system operator shall be responsible for correcting any defects in the system (1325). A further demonstration of monitor operation shall then be required (1326).

ILS 05 Annex - Guidance for Compliance

1 Introduction

1.1 The sideband reference glidepath characteristics are more susceptible to small phase changes in the transmitting aerial system than any other common glidepath.

1.2 A simplified way of seeing the problem is to consider the signal from the lower aerial. This signal alone would give twice full scale fly-down on a pilot's indicator. It is only the presence of the upper aerial signal, when combined with the lower aerial signal, which produces the fly-up signal below the glidepath. Any error in the relative phase of the signals from the two aerials will result in the signal from the lower aerial having more effect. This results in weaker fly-up signals near the ground and a lower glidepath angle.

NOTE: It is not the policy of the CAA to provide precise system adjustment procedures but in view of the high cost of flight inspection some guidelines are offered.

2 Guidelines

2.1 The guidelines in this annex are arranged as below:

2.2 Section 3 describes the faults which may exist if the phase alarm test has been attempted and failed.

2.3 Section 4 describes a procedure for adjusting and verifying that the transmitter aerial phasing is correct. If the phasing is verified as described using a repeatable method of de-phasing. The monitor phase alarms can be verified using only ground measurements. If there are any doubts about the accuracy of transmitter aerial phasing, it is advisable to apply the tests detailed in this section.

2.4 Section 5 describes the verification of monitor phase alarms based on results from tests in section 4.

NOTE: Sections 3, 4 and 5 are only suggested methods of avoiding excessive flying hours. The system operator/manufacturer may use any method of adjustment to ensure that the system will pass the required tests.

3 Non Compliance With Monitor Test

3.1 If the reduced fly-up and glidepath angle in both tests (phase advance and phase retard) are similar, but outside permitted tolerances:

This indicates that in the normal condition both the transmitter aerial phasing and the monitor signal phasing are correct. The only adjustment required would be to increase the sensitivity of the monitors. The CAA would not require further flight inspection. The changes in monitor sensitivity can be verified using ground test equipment.

3.2 If the fly-up and glidepath angle in both tests are not similar:

This indicates that either the transmitter aerial phasing or the monitor phasing (or both) are wrong. If, in either test, the fly-up was higher than in the normal condition, an error in the transmitter aerial phasing exists.

4 Verification of Transmitter Aerial Phasing

4.1 The transmitter aerial phasing should be adjusted to give the correct phase of signals in the far-field. This is the condition which gives maximum fly-up signals at low angles – the usual measurement point is 0.3θ.

4.2 The correct phasing can be verified by altering the transmitter aerial phasing and making a level slice flight inspection. The system is then de-phased by the same amount in the opposite direction and the level slice repeated.

4.3 The two flight inspection results should be similar and both show a fall in the fly-up at 0.3θ and a lower glidepath angle.

4.4 If the de-phasing is done by using a calibrated phaser, or by inserting fixed adaptors or extension cables in the aerial feeds, it is possible to avoid further flying of the phase alarms. The amount of phase change used for the tests is not critical, but a value of approximately 40° gives an easily measurable change.

4.5 When the phasing has been adjusted and verified by this method, the remaining parts of the flight inspection may be completed. Further flight inspection of the phase alarms will not be required.

5 Adjustment and Verification of Monitoring

5.1 The monitor may now be adjusted until its response to de-phasing is symmetrical. The same phaser settings or extension links that were used in section 4 must be used for these tests.

5.2 The monitor response will be adjusted by its phasing controls in the case of an integral monitor, or by its physical position in the case of a field monitor.

5.3 The final setting of the monitor must be such that identical changes are seen for advance or retard of the transmitting aerial signals.

5.4 It will be known that the phase test link or calibrated phaser setting gives a certain fall in fly-up signals and glidepath angle. This test will also give a monitor change as measured in 5.3.

5.5 By applying a suitable scaling factor, it will be possible to calculate whether the system monitors would reach alarm before transmissions were outside specification. The only adjustment then required would be a change in sensitivity which could be verified by ground equipment tests.

ILS 06 Requirements for ILS and ILS/DME Identity Keying

Part 1 Preliminary Material

1 Introduction

ICAO Annex 10 requires that ILS and DME systems shall radiate an identity code when they are operationally available.

2 Scope

This document defines the identity keying requirements for all categories of ILS including those systems with an associated DME.

Part 2 Requirements

3 Safety Objective

An operationally available ILS or DME shall radiate an identity code permitting it and its operational status to be positively identified (1327).

4 Keying Sequence

4.1 **Safety Objective**

An associated ILS and DME shall radiate identity codes which positively identify their association (1328).

4.2 When a DME is associated with an ILS, the identity keying of both systems shall be synchronised (1329). ICAO Annex 10 refers to this as 'associated' code.

4.3 A complete keying sequence shall occupy approximately 40 seconds (1330).

NOTE: In the following descriptions the 40 second interval is represented by /4 and the number of times the Morse code is repeated in that interval is shown by the preceding figure. i.e. 1/4 means that the Morse code identity occurs once in each 40 second interval.

5 Master Equipment

Unless the DME is also associated with an MLS, either the DME or the ILS may be used as the master identity keyer.

6 System Operation

6.1 If at any time the master equipment fails, the slave equipment shall revert to totally independent keying (1331).

6.2 If the master keyer is subsequently returned to service, the slave equipment shall automatically return to normal slave operation, with no requirement for manual resetting at the slave equipment (1332).

6.3 When a localiser is acting as slave to a DME it shall key 3/4. The DME keying shall be synchronised to occur where there is an interval in the localiser keying. If the DME fails, the localiser shall revert to 4/4 keying with no gap where the DME identity would have been (1333).

6.4 When a DME is slave to a localiser, it shall key 1/4. If the localiser fails, the DME shall continue to key 1/4. i.e. the DME shall key itself at the correct rate for an independent DME (1334).

6.5 Regardless of which equipment is master or slave, a failure in one equipment shall neither leave the associated equipment without identity (1335) nor cause it to close down (1336).

7 Slave Monitor Information

NOTE 1: If the slave equipment fails, there is no requirement for the master equipment to alter its keying sequence.

NOTE 2: Certain types of ILS and DME equipment, when used as master, have the facility to accept an input from the slave's status monitor. This signal can be used to alter the keying sequence of the master. If this facility exists, it may be used.

7.1 If this system is used, the master equipment shall automatically return to associated keying when the slave equipment is returned to service (1337).

8 Independent Operation

An ILS with no associated DME shall always key 4/4, i.e. the Morse code shall be repeated at regular intervals, not less than 6 times per minute (1338).

9 Use of Letter I Prefix

If the DME identity code has an 'I' prefix, the DME shall continue to radiate this prefix if the associated localiser fails (1339).

10 Equipment Out of Service

NOTE: It is sometimes necessary to radiate signals from equipment which is not available for operational use. This can occur during commissioning tests or engineering investigations.

10.1 Whenever the equipment is not available for operational use, the identity keying shall be suppressed (1340).

NOTE 1: Radiation of continuous unkeyed tone is permitted.

NOTE 2: During commissioning and engineering flight inspections, the normal identity code may be radiated for short periods at the navaid inspector's request.

10.2 The use of the code TST for extended periods of testing shall no longer be permitted (1341).

ILS 07 ILS and ILS/DME Flight Inspection Types and Requirements

Part 1 Preliminary Material

1 Introduction

It is a requirement that all ILS systems are checked by flight inspection at prescribed intervals (1342).

2 Scope

This document defines the different types of ILS and DME flight inspection and the parameters which must be measured at each inspection for all categories of ILS.

Part 2 Requirements

3 Safety Objective

To ensure that the ILS provides an accurate and uncorrupted source of guidance information, the critical parameters of the radiated signal shall be verified at defined intervals (1343).

4 Parameters To Be Measured

The following table gives details of the parameters which must be measured at each type of flight inspection (1344). The first column gives a cross reference to ILS 02 which contains tolerance limits for each parameter.

	Description	Commissioning	Annual /Cat	Routine	Engineering
ILS 02 reference	**Transmitter to be checked**				
5.0	**Localiser**				
5.1	Alignment	1 & 2	1 & 2	1 & 2	As required
5.2	Displacement Sensitivity	1 & 2	1 & 2	1 & 2	As required
5.4	Power Ratio	1 or 2	None	None	As required
5.5	Course Structure	1 or 2	1 or 2	None	As required
5.6	Off Course Clearance	1 & 2	1 & 2	1 & 2	As required
5.7	Front Course Coverage	1 or 2	1 or 2	None	As required
	Biased Structure	1 or 2	1 or 2[1]	None	As required
5.8	Polarisation	As required	As required	As required	As required
5.9	Modulation Depth	1 & 2	1 & 2	1 & 2	As required
5.10	Identification	1 & 2	1 & 2	1 & 2	None
5.11	Structure Stability	1 or 2	1 or 2	1 or 2	None
	Field Strength	1 & 2	1 & 2	1 & 2	As required

1. Only required for Categorisation, not for Annual

	Description	**Commissioning**	**Annual /Cat**	**Routine**	**Engineering**
ILS 02 reference	**Transmitter to be checked**				
6.0	**Glidepath**				
6.1	Angle	1 & 2	1 & 2	1 & 2	As required
6.2	Displacement Sensitivity	1 & 2	1 & 2	1 & 2	As required
6.4	Clearance below path	1 & 2	1 & 2	1 & 2	As required
6.5	Course only – Two Freq M	1 or 2	None	None	As required
6.6	Clearance below path ±8°	1 & 2	1 & 2	1 & 2	As required
6.7	Clearance above path	1 & 2	1 & 2	1 & 2	As required
6.8	Coverage	1 & 2	1 & 2	1 & 2	As required
6.9	Course Structure	1 or 2	1 or 2	None	As required
	Biased Structure	1 or 2	1 or 2[1]	None	As required
6.10	Modulation Depth	1 & 2	1 & 2	1 & 2	As required
6.11	Structure Stability	1 or 2	1 or 2	1 or 2	None
	Field Strength	1 & 2	1 & 2	1 & 2	As required
	Monitor Alarms	1 or 2	None	None	As required
7.0	**Marker Beacon**				
7.1	Fly through time	1 & 2	1 & 2	1 & 2	As required
	Modulation	1 & 2	1 & 2	1 & 2	As required
	Field Strength	1 & 2	1 & 2	1 & 2	As required
8.0	**Associated DME**				
8.1	Identification	1 & 2	1 & 2	1 & 2	None
8.2	Accuracy	1 & 2	1 & 2	1 & 2	As required
8.3	Coverage	1 or 2	1 or 2	None	As required
	Orbit Check	1 or 2	None	None	As required
	Promulgated Procedure[2]	1 or 2	1 or 2	1 or 2	None

1. Only required for Categorisation, not for Annual
2. When any other navigational aids are used to support the procedure, they shall be observed during the inspection and any deficiencies noted.

5 Responsibilities

5.1 The operating authority shall be responsible for ensuring compliance with these requirements (1345).

5.2 All flight inspections shall be made by an organisation having Authority approval under the ANO for the specific category of ILS being inspected (1346).

NOTE: Certain types of engineering work will require that the system be flight checked before being returned to service. If an operator is uncertain of the type of inspection required, he should contact a Regional Inspector for clarification.

ILS 07 Annex - Guidance Material Concerning Flight Inspection

1 Introduction

This annex gives further guidance concerning the inspection of certain specific parameters.

2 Glidepath Alarm Tests

2.1 The following tests shall be made at all commissioning inspections and following any engineering work involving the aerial distribution unit, feeder cables, aerials or monitor combining unit.

a) Angle low and width wide simultaneously.

b) Phase advance alarm.

c) Phase retard alarm.

2.2 The change in monitor reading and the flight inspection figures shall be recorded for each flight.

2.3 For each simulated alarm, the flight inspection shall measure the glidepath angle, displacement sensitivity and the DDM & field strength at 0.3θ.

NOTE 1: On certain systems it is difficult to adjust the aerial phasing so that the system is just at the alarm point. For this reason it is permissible to make the tests with the monitor near to or just beyond the alarm point. Provided that both the monitors and the flight inspection figures show reasonable symmetry, the behaviour at the alarm points can be calculated.

NOTE 2: It is not possible to state specific limits for this type of inspection.

2.4 **Method of simulating phase alarms**

2.4.1 **Null reference**

Adjustment of SBO phase, which is the same as the relative phase between upper and lower aerials.

2.4.2 **Sideband reference**

Adjustment of the relative phase between upper and lower aerials.

NOTE: Further guidance concerning Sideband Reference Phase alarms may be found in ILS 05.

2.4.3 **Type M**

Adjustment of the relative phase between the middle, upper and lower aerials.

3 DME Coverage

These checks shall normally be made at the same time as ILS checks and serve to confirm that the DME is usable throughout the ILS coverage region.

4 DME Orbit

4.1 This orbit shall be made at a range suitable for use of accurate distance reference equipment. It shall be at a radius of 5 nautical miles or greater.

4.2 The height shall correspond to a vertical angle of 2° above the DME site.

4.3 Accurate distance correlation shall be made at intervals not exceeding 5°.

4.4 Field strength shall be measured at intervals not exceeding 5°.

5 Polarisation

5.1 This check is only required at the commissioning of an aerial system which is new to the UK. Otherwise, polarisation checks are only required when specific engineering problems arise.

5.2 Measurements shall be made with a roll attitude of 20°.

ILS 08 ILS Radio Noise Monitoring

Part 1 Preliminary Material

Foreword

This document is produced and published by the Air Traffic Services Standards Department (Safety Regulation Group) of the UK Civil Aviation Authority. It identifies those specific engineering requirements that must be met to achieve approval for equipment, systems and organisations under the Air Navigation Order. This is a consultative document based upon those relevant and applicable ICAO standards and recommended practices. This document supersedes and replaces all earlier versions.

1 Introduction

Radio signals from extraneous sources may interfere with the guidance information of an ILS signal. The problem becomes more important for Cat II and Cat III systems, where a higher level of integrity is required than for Cat I.

Interference monitoring and data recording has been carried out on Cat II and Cat III airfields for many years, allowing trends in the background interference level to be analysed. For this trend analysis to remain valid, it is essential that new monitoring equipment is compatible with the previous system of measurement. For this reason, this document is highly prescriptive in certain areas.

At present, techniques for monitoring interference on an operational channel are only in the development phase. The existing system assumes that the interference is equally distributed throughout the localiser band. Hence all channels except the active ILS frequency are monitored.

Advanced equipment may be used which for example, can recognise interference on the operational channel or examine the complete frequency band with no gaps. However, the equipment shall also comply with all requirements in this document.

2 Scope

This requirement applies to all ILS localisers operated at Cat II or Cat III.

3 References

ICAO Annex 10

4 Definitions Symbols and Abbreviations

A 'general use' glossary of definitions and abbreviations can be found in the Preamble of CAP 670. There are no additional terms invoked by this requirement document.

Part 2 Requirements

5 Safety Objective

The instrument landing system shall provide an accurate and uncorrupted source of guidance to aircraft (1347).

6 Equipment

NOTE: Throughout this requirement, all references to signal voltages are the voltages measured at the aerial when terminated with 50 Ω. When calibrating the equipment, due allowance must be made for cable losses.

6.1 **Automatic Scanning :**

Ability to bypass up to 5 channels (1348)

6.2 **Frequency range:**

108.00 - 112.00 MHz (1349)

6.3 **Frequency tolerance:**

± 0.005% (1350)

6.4 **Channel spacing:**

50 kHz (1351)

6.5 **IF bandwidth:**

The 3dB bandwidth shall be between ±10 and ±15 kHz (1352). The exact figure shall be stated as it is required for analysis calculations (1353).

6.6 **Receiver sensitivity:**

2µV for 10dB (signal + noise)/noise ratio at 50% Mod AM or FM deviation 30% of IF bandwidth (1354).

6.7 **Modulation detector:**

The standard detector shall be for amplitude modulation (1355). For normal monitoring this detector shall provide the output to the audio storage device (1620).

6.8 **Recommendation.** The receiver should also be able to detect frequency modulation (1621).

NOTE: A receiver which automatically selects the correct detector for the modulation mode may be used. If this is used, the stored records should show the type of detector in use at the time of recording.

6.9 **Audio bandwidth:**

The minimum 3dB bandwidth of the receiver and recording equipment shall be 300 to 3,400 Hz (1356).

6.10 **Spurious responses**

The receiver shall provide adequate immunity to interference from two-signal third order intermodulation products caused by signals outside the band being examined (1357). This may be achieved by using a receiver which meets the requirements of ICAO Annex 10 Paragraph 3.1.4

6.11 **Dynamic range**

6.11.1 The receiver shall measure signal strengths in the range 2µV to 100µV (1358).

6.11.2 The receiver shall be capable of detecting modulation when the signal strength is in the range 2µV to 1000µV (1359)

6.12 **Interval between successive scans**

Between 1 and 2 minutes when no modulation is being recorded (1360). This figure shall be quoted since it will be required for the analysis of data (1361).

In other cases the total scan time will be determined by the recording time.

6.13 **Scanning dwell time on each channel**

For signals greater than Threshold 1 but less than Threshold 2: The receiver shall dwell on the channel long enough to allow the time, channel number and signal strength to be logged (1362).

6.13.1 For signals greater than Threshold 2: The receiver shall dwell on the channel long enough to allow the time, channel number and signal strength to be logged, and for demodulated audio signals to be recorded (1363).

6.14 **Audio Recording duration**

When a signal exceeds threshold 2, the demodulated audio signal shall be recorded for a continuous period of approximately 20 seconds (1364).

NOTE: To save recording space, if 10 successive scans have found the same channel with a signal exceeding Threshold 2, modulation recording of that channel may be terminated and only the signal strength need be logged.

6.15 **Channels to be examined at each scan:**

Initially, all except the operational Localiser frequency or frequencies (1365).

NOTE: If a continuous carrier is detected on one or more of the channels being examined, the scanning may step over those channels provided that the presence of the carrier on that channel has been recorded.

6.16 **Operational Channel monitoring**

If the equipment can also record interference events on the operational channel. Details shall be provided of:

a) The mask used to remove the ILS signal (1366).

b) The threshold levels used for the noise measurement (1367).

6.17 **Threshold level:**

6.17.1 Threshold 1

Adjustable over the range 2µV to 10µV (1368).

6.17.2 Threshold 2

Adjustable over the range 10 to 20µV (1369).

6.18 **Aerial horizontal response**

Omnidirectional (1370).

6.19 **Aerial polarisation**

Horizontal (1371).

6.20 **Storage of results**

6.20.1 Channel occupancy data shall be sent either directly to a printer or stored on computer disk or both (1372).

6.20.2 Modulation information shall be stored on a suitable audio recording device (1373).

NOTE: Suitable audio devices include such media as standard audio cassettes and solid state digital storage.

6.20.3 **Recommendation.** The results should be stored in a format which will facilitate further analysis (1374).

7 Calibration

7.1 Documented calibration procedures shall be applied to all equipment involved in the measurement of radio noise level (1375). All equipment and standards used in the calibration process shall have traceability to national or international standards (1376).

7.2 When any equipment used is claimed to be self calibrating, the internal processes involved shall be clearly defined (1377). This involves showing how the equipment's internal standard is applied to each of the parameters which it can measure or generate. The internal standard shall have traceability to national or international standards (1378).

7.3 Calibration intervals shall be stated in the calibration records (1379). Evidence shall be available to support the quoted calibration intervals (1380).

8 Standard Settings

8.1 For normal operation, threshold settings shall be:

Threshold 1	4.5µV (1381)
Threshold 2	13µV (1382)

9 Data to be Recorded

9.1 For each scan across the frequency band, when any signal exceeds threshold 1, the following parameters shall be recorded:

a) The date and time (1383).

b) The frequency or channel number of each channel having a signal exceeding threshold 1 (1384).

c) The strength of all signals exceeding threshold 1 (1385).

NOTE: For signals greater than 100µV, the absolute signal strength need not be recorded. It is sufficient to state '>100µV'.

9.2 Where the signal strength exceeds threshold 2 and modulation is present, the detected modulation shall be recorded (1386).

NOTE: Modulation is recorded to assist in identifying an offending transmission.

10 Location of Measuring Equipment

10.1 **Horizontal position:**

10.1.1 If a single measurement point is used for the complete airport, then the aerial shall be located near the mid point of the runway (1387). If an alternative location in the approach area is used, the measurements shall only apply to that particular approach (1388).

10.1.2 Measurements near the mid point shall only be made with equipment that is immune to blocking from the operational localiser (1389).

10.2 **Vertical position:**

The aerial shall be higher than any obstructions in the immediate vicinity (1390) but shall not be an obstruction to aircraft (1391).

11 Electro Magnetic Compatibility

11.1 Radio Equipment and systems at Aeronautical Radio Stations shall comply with the EMC Directive (1392).

NOTE: Further information is contained in Part B Section 4, GEN 04.

12 Measurement Interval and Duration of Measurement

12.1 **Interval:**

The measurement shall be made on each Cat II and Cat III runway at intervals not exceeding one year (1393).

12.2 **Duration:**

The total measurement period shall be a minimum of 350 hours in any one year (1394). The measurement need not be made in one continuous period.

13 Report

13.1 The report shall show the total number of times that each channel has signals present with strengths :

a) Exceeding threshold 1 but not threshold 2 (1395).

b) Exceeding threshold 2 (1396).

13.2 The present acceptance limit is an interference rate equivalent to $< 2 \times 10^{-5}$ events per second. An event being a signal > 13µV. The total rate shall be calculated as an average over the total monitoring time (1397). Submitted results shall show the calculations used in producing the figures for the interference rate (1398).

13.3 Modulation recordings shall be made available on request (1399).

13.4 When measurements show that the interference level exceeds limits, the appropriate SRG engineering inspector must be advised immediately (1400).

13.5 Evidence of the required routine measurements must be available when requested by an SRG engineering inspector (1401).

ILS 10 General Requirements for ILS

Part 1 Preliminary Material

1 Introduction

1.1 The ILS provides precision guidance signals to aircraft in the last stages of approach and landing. For this purpose the equipment needs a high level of integrity, accuracy and reliability. Other auxiliary equipment is used to support the main equipment.

1.2 Instrument Landing Systems are classified as:

1.3 Category I, Category II or Category III; in ascending order of accuracy, integrity and reliability.

1.4 Full definitions of these categories may be found in ICAO Annex 10. Chapter 3.1.1

2 Scope

2.1 This document sets out the minimum equipment requirements for all categories of ILS equipment.

2.2 The scope of this document relates only to the performance of the ILS facility. The overall category of a runway is dependent on many other factors.

Part 2 Requirements

3 Safety Objective

The equipment shall provide a complete, identified, accurate and uncorrupted source of guidance information to aircraft. With levels of integrity and continuity of service which are consistent with the category of service provided (1402).

4 Integrity and Continuity of Service

4.1 The facility shall meet the following levels as defined in ICAO Annex 10, Attachment C to Volume I, Table C2 (1403):

Category	Level
I	2
II	3
III	4

4.2 Evidence that the design achieves the required MTBO shall be provided (1404).

NOTE 1: This may be historic records for identical systems, or a specific trial in the case of equipment new to the UK.

NOTE 2: A method of putting a well established design into Cat I service without an excessive trial period is given in Appendix 2 to this requirement.

4.3 The integrity of the alarm and control system shall be calculated by Failure Mode Analysis, using standard references such as MIL HDBK 217 (1405). The maintenance interval for checking the correct operation of the alarm and control system shall be derived from this analysis (1406).

4.4 If a system has built-in automatic integrity checking, the extent of the circuits which are automatically checked shall be defined (1407).

5 Manufacturer's Quality System

The system shall be designed and manufactured under an adequate quality assurance system (1408).

6 Monitoring Systems

6.1 Monitor Concept

6.1.1 The monitor system shall be independent of the transmitter, including its design concept (1409).

6.1.2 To avoid unnecessary equipment shutdowns, Category II and III systems shall employ multiple active monitor systems for the operational equipment (1410).

NOTE: The passive parts of the monitor system such as aerials, combining systems etc. shall comply with the overall system integrity requirements but need not be duplicated.

6.1.3 The monitor outputs shall be combined by a voting system whose characteristics shall be included in the integrity calculations (1411).

NOTE: Information concerning monitor alarms may be found in ILS 01.

6.2 Near field monitor

6.2.1 Localisers shall have a minimum of one near field monitor measuring the course centreline (1412).

6.2.2 Glidepaths shall have a minimum of one near field monitor measuring either the glidepath angle or the displacement sensitivity (1413).

NOTE: Where multiple monitors are used, the signal from the near field monitor aerial may be split and fed to each set of monitors.

6.3 Far field monitor

6.3.1 Category II and III localiser systems shall be fitted with a far field monitor which measures centreline accuracy and displacement sensitivity (1414).

6.3.2 The monitor shall be installed near the relevant runway threshold (1415).

6.3.3 The far field monitor shall provide alarms to a remote point (1416), but shall not take executive action (1417).

6.3.4 A delay shall be incorporated in the monitor to prevent false alarms due to aircraft movement (1418).

6.3.5 During the time that the ILS is being used to support low visibility procedures, the output of the far field monitor shall be recorded and time stamped (1419). The minimum parameters to be recorded shall be centreline DDM and displacement sensitivity (1420).

6.3.6 **Recommendation:** The far field monitor output should be recorded and time stamped at all times when the ILS is operational (1421).

6.4 Monitor correlation

The measurements made by integral and near field monitors shall correlate with changes in the far field (1422). This correlation shall be demonstrated for each new design of ILS transmitter or monitor system installed in the UK (1423).

7 Serviceability Indicators

7.1 There shall be either:

a) An indicator showing the serviceability status of all elements of an instrument landing system provided for the use of aircraft using the aerodrome (1424), or

b) A method of communicating with the engineer responsible for the serviceability of such equipment (1425). This method of communication is to be detailed in the MATS Part 2 (1426).

7.2 **Failure of communication**

7.2.1 Failure of communication between the ILS equipment and the remote control/ serviceability indicators shall cause an immediate alarm at the remote indicators (1427).

7.2.2 Failure of this communication link shall not cause an immediate ILS close-down (1428).

7.2.3 Following failure of the control lines, only aircraft on final ILS approach shall be permitted to complete the approach (1429). The ILS shall then be withdrawn from service in accordance with a documented procedure (1430). All further aircraft shall be advised that the ILS is not available for use (1431).

7.2.4 If the ILS is configured to close-down the system after a delay following control line failure, the delay must be long enough for the actions in 7.2.3 to be completed (1432).

7.2.5 The configuration in 7.2.4 shall be regarded only as an extra feature (1433). A reciprocal ILS shall not be put into service until the system with faulty control lines is positively disabled (1434).

7.2.6 An ILS shall not radiate or be capable of accidentally radiating, if its operational status and change of status cannot be transmitted to ATC without delay (1435).

NOTE 1: Permitting a communication link failure to shut down the ILS without warning could unnecessarily remove the ILS signal when the aircraft is in a critical phase of the approach.

NOTE 2: The following information is for guidance, alternative methods having an equivalent level of safety may be proposed:

For single-ended systems:

As soon as possible, the site(s) should be visited (1622) and

a) The ILS should be set to local control and disabled until the lines are repaired (1623); or,

b) a technician may be stationed at the ILS building(s) with a suitable means of communication to ATC. The equipment should then operate in local control, supervised by the system monitors (1624). The monitors shall not be overriden or inhibited (1625). ATC must be advised immediately of any change in status of the ILS (1626).

For double-ended systems, similar conditions apply, but are complicated by the interlock. Control line failure may prevent the interlock facility from operating correctly. In addition to the above actions (1627), BEFORE the reciprocal ILS is started (1628), the non-operational system should be disabled in such a way that it cannot accidentally radiate (1629) (by removal of a critical link or circuit board, isolation from power supply, etc.).

Where a central DME is associated with two ILS facilities, care should be taken to ensure that the DME coding remains correct for the runway direction in use.

8 Category and Status Unit

8.1 In addition to the normal remote control and other indications, Category III facilities shall be fitted with a unit that accepts signals from the ILS equipment, its monitors and the runway direction switch, to automatically provide ATC with indications of the operational category of the ILS (1436).

8.2 The unit shall have an integrity of the same order as that of the ILS (1437). This shall be demonstrated by formal mathematical analysis (1438).

8.3 Any change of calculated category shall cause an audible alarm to ATC (1439).

8.4 The unit shall have provision to limit the maximum category output to the display (1440). The set limit shall override the calculated category, where the calculated category is higher than the set limit (1441).

8.5 If an ILS fault causes the calculated category to fall, when the fault is cleared, the category must remain at the lower value until upgraded manually by an authorised person using a reset button or similar (1442).

8.6 The unit shall only automatically upgrade the category at initial equipment switch-on or runway change (1443).

8.7 Access to the manual controls shall be limited to suitably qualified and authorised personnel (1444).

NOTE: The precise method of calculation used by the Category and Status unit will depend on the ILS equipment from which it derives its inputs. Some guidance material is provided in Annex 1.

9 Interlocking

9.1 Where systems are installed at opposite ends of the same runway they shall be interlocked so that only one system may radiate at one time (1445).

9.2 The interlocking system shall be such that the non-operational system cannot be switched on using either the remote or local control switches (1446).

9.3 The interlocking system shall fail-safe (1447). If the communication link between the systems fails, it shall not be possible to make the non-operational system radiate using the local or remote front panel controls (1448).

10 Identity Coding

10.1 The localiser shall radiate an identity code only when it is available for service (1449).

NOTE: Information concerning identity coding may be found in ILS 06.

11 Provision of Standby Equipment

11.1 Category III systems shall have dual equipment so that the system is 'fail operational', regardless of proven MTBO (1450). The non-operational transmitter shall radiate into a dummy load and its critical parameters shall be monitored (1451).

11.2 **Recommendation:** Other categories should have standby equipment with automatic changeover (1452).

NOTE: Information concerning changeover times and delays may be found in ILS 01**.**

12 Standby Power Supplies

12.1 Category II and III systems, including the remote control equipment and status displays shall be provided with a standby battery power supply (1453). In the event of a mains power failure, this shall be capable of sustaining the normal ILS operation for a minimum of 20 minutes (1454).

12.2 **Recommendation:** Category I facilities should have standby batteries (1455).

NOTE: Information displays used only as an aid to maintenance need not have standby power supplies.

13 Localiser Back Beam

Facilities designed to radiate a back beam are not permitted (1456).

14 Offset Localisers

An offset localiser may be installed where terrain constraints prevent the installation of a conventional ILS. Regardless of equipment configuration, such an installation shall always be Uncategorised (1457).

15 Field Test Equipment

The following calibrated field test equipment, of a type approved by the CAA shall be available:

15.1 **Category III systems**

15.1.1 The following equipment shall be available on the airport:

15.1.2 Portable equipment capable of measuring the localiser radiation at the runway threshold (1458).

15.1.3 Equipment capable of measuring localiser centreline bends throughout the length of the runway (1459).

15.2 **Category II systems**

15.2.1 The following equipment shall be available on the airport:

15.2.2 Portable equipment capable of measuring the localiser radiation at the runway threshold (1460).

15.3 **Category I systems**

15.3.1 The following equipment shall be available on demand:

15.3.2 Portable equipment capable of measuring the localiser radiation (1461).

NOTE 1: The measuring equipment for Category I systems need not make the measurement at the threshold – near field measurements are permitted. This does not apply if it is desired to use the measurements in place of flight inspection results. Details of this may be found in ILS 04.

NOTE 2: The measuring equipment may be owned by an independent maintenance organisation and need not be retained on the airfield.

15.3.3 **Recommendation:** Category I airports should retain on the airport: Portable equipment capable of measuring the localiser radiation at the runway threshold (1462).

16 Field Test Points

Points at which field measurements are made shall be clearly and permanently marked. These marks shall not present a hazard to aircraft (1463) and shall be immune to disturbance by such operations as grass cutting and snow clearance (1464).

17 Critical Areas

17.1 Localiser and glidepath critical areas shall be clearly marked and identified. The marking shall be visible day and night (1465) and shall help ensure that no person or vehicle may enter the areas without the permission of air traffic control (1466).

17.2 Where fencing is used to mark the areas, it shall be of a type which will have no effect on the radiated ILS signals (1467).

18 Sensitive Areas

For Category II and III systems, localiser and glidepath sensitive areas shall be defined (1468).

NOTE: These areas will normally be defined by the system operator or manufacturer and endorsed by the CAA. This information is required for positioning of hold points, production of ATC instructions, etc.

19 Computer Simulation

19.1 Where computer simulation is used to define an ILS sensitive area, or to support a case for a system remaining operational during construction work, the following are required:

19.1.1 Proof that the version of software being used is the latest issue, OR recent written confirmation from the software manufacturer that the version being used has no known safety related problems (1469).

19.1.2 Proof that the person making the simulation has received formal training in the use of the simulation programme (1470).

19.2 Due to the difficulty of simulating lattice structures such as cranes, SRG may require confirmatory flight and/or ground inspections during construction work.

20 Electro Magnetic Compatibility

Radio Equipment and Systems at Aeronautical Radio stations shall comply with the EMC Directive (1471).

NOTE: Further information is contained in Part B Section 4, GEN 04.

21 Use of Second Hand Equipment

Second hand equipment may be installed subject to the following conditions:

a) The equipment shall not be used at a service level exceeding Category I (1472).

b) The equipment shall be examined by the manufacturer's quality representative or by an agent designated by the manufacturer (1473). A written declaration shall show:

   i) The equipment is in a satisfactory state for further service (1474).

   ii) There are no outstanding safety-related modifications (1475).

c) Glidepath aerials shall be brand new or factory refurbished and re-tested to the original factory test specification (1476).

d) All aerial feeder cables shall be renewed (1477).

e) Adequate spares and engineering support shall be available (1478).

f) Installation of Localiser systems giving an in-space modulation depth exceeding 60% anywhere within the ± 35° coverage is not permitted (1479).

ILS 10 Annex 1 Guidance Material Relating to the Automatic Calculation of ILS Category

Condition	Display
Failure of Localiser standby transmitter	Cat II
Failure of Glidepath standby transmitter	Cat III
Changeover to Localiser standby transmitter	Cat II
Changeover to Glidepath standby transmitter	Cat III
Far Field Monitor alarm	Cat I
Where a single battery is used:	
Low battery voltage alarm	Cat I
Where each transmitter has its own battery and warning system:	
Low voltage alarm on one battery	Cat II
Low voltage alarm on both batteries	Cat I
Loss or corruption of data for calculation	ILS not available
Where multiple monitor sets are used:	
Disagreement between monitors	Cat III
Reciprocal system on	ILS not available
Status of reciprocal not known	ILS not available
Local control	ILS not available

NOTE 1: This information is not exhaustive since the operation of the CSU is dependent on the monitor system of each type of ILS equipment.

NOTE 2: This information only relates to the displayed category – consequent actions, such as controlled withdrawal from service, are covered by the operator's procedures.

ILS 10 Annex 2 Method of Putting an Established Design of ILS into Category I Service

1 Conditions which must be met for this abbreviated method of approval to be used:

1.1 Many similar systems are in use world-wide.

1.2 They cover the range of environment encountered in the UK.

1.3 They are installed and maintained to specific standards (e.g. manufacturer's installation and commissioning specifications).

1.4 MTBO data is available for many facilities.

1.5 This data can be verified by competent authorities.

1.6 The manufacturer's calculated MTBO is at least 3 times better than the ICAO requirement for Cat I.

1.7 The organisation making the installation has a good quality record and can provide evidence of staff competence.

2 If the above conditions are satisfactory:

2.1 Install and commission, including flight inspection and all necessary tests.

2.2 Run for 24 hours continuously, on either transmitter in the case of dual equipment.

2.3 If no failures, put into service at Cat I (or uncategorised as appropriate).

2.4 Start continuous MTBO monitoring, initialising the figures at 1300 hours with one failure.

2.5 If the ongoing calculated MTBO falls below 1000 hours, repair the fault, remove the facility from service and run for 300 hours cumulative test time before restoring to service.

2.6 Re-allocate the nominal MTBO and failure as in 2.4.

2.7 If a second failure again reduces the calculated MTBO below 1000 hours, the system must be removed from service until the situation has been assessed by an ATSSD Engineering Inspector.

NOTE: 'Failure' in these calculations means a total unplanned loss of signal due to a fault. Automatic changeover to the standby transmitter, after a fixed delay if appropriate, is not classed as a failure for Cat I MTBO calculations. However, since some installations will be destined for eventual Cat III service, it is essential that all faults and remedial actions are recorded for analysis.

FLI 02 The Approval of Flight Calibration Organisations

Part 1 Preliminary Material

1 Introduction

1.1 Article 104 (2) of The Air Navigation Order requires that a navigation aid is 'flight checked by the CAA or a person approved by the CAA, on such occasions as the CAA may require'.

1.2 The purpose of this document is to define the conditions for such an approval.

2 Scope

2.1 This document defines the procedures and requirements for the approval of flight calibration organisations and their equipment.

2.2 It is divided into three sections as follows:

Section 1 – Flight Calibration Organisations – Approval Procedure.

This section defines the procedure to be followed when requesting approval of a flight calibration organisation.

Section 2 – Flight Calibration System – Navigation aids (general).

Section 3 – Annexes specific to each navigational aid.

Part 2 Requirements

NOTE: The requirements in this section apply to the flight inspection of all types of navigational aid. Additional requirements for specific navigational aids are given in the annexes to FLI 02.

3 Flight Calibration Organisations – Approval Procedure

3.1 Safety Objective

An approved applicant shall be capable of using flight inspection techniques to measure accurately the signals in space radiated by those navigational aids which they are approved to inspect (1630).

3.2 Applicants shall submit the required information in a coherent documentary form (1631).

3.3 Applicants shall detail the overall operation in an Exposition document including references to associated documents (1632). See Section 2, paragraph 4 for details.

NOTE: The CAA will examine the submitted documentation and may call for further information on certain subjects. For example, the method used to calculate the measurement uncertainty for certain parameters may need to be examined in more detail.

3.4 The applicant may propose an aircraft or system which is new in concept or not in common use for flight calibration. In such a case, the CAA will seek advice from other expert departments within the Safety Regulation Group and may also initiate a general consultation with the industry.

3.5 If the applicant proposes a new system or aircraft or the organisation does not have a demonstrable history of flight calibration, then practical demonstrations of capability will be necessary.

NOTE: The tests will be in two parts. Applicants may be required to perform either or both parts:

a) A demonstration of position fixing accuracy. This will be evaluated on an established test range. The precise details of this trial cannot be defined until details of the applicant's system are known.

b) A demonstration of overall system performance. For this trial the applicant will make a simulated commissioning inspection of the selected navigational aid. The trial may require several similar flight profiles to be flown to demonstrate the repeatability of measured results.

3.6 The CAA shall evaluate or require evaluation of the results of these trials (1633).

3.7 If special R/T facilities are required during the trials the applicant shall be in possession of the relevant approvals and licences for their use (1634).

3.8 The applicant shall provide the CAA with a build state document of the measuring equipment (1635), a complete and formalised list of the current issues of all relevant documentation (1636) and an Exposition describing the entire operation (1637). The CAA shall retain this documentation and require it to be updated to always reflect the current state of the applicant's flight calibration system operation and organisation (1638). If the applicant proposes to make any changes to a flight inspection system, operation, or organisation, the CAA shall approve these changes before the applicant is permitted to make any further flight inspections (1639).

3.9 Where approval for ILS inspection is granted under this procedure it may be limited to the flight calibration of specific categories of ILS.

3.10 The CAA reserves the right to inspect the flight calibration system or organisation at any time and to request regular flight inspection reports.

NOTE: If the applicant is an organisation which has been making flight inspections for many years under a formal or implicit approval from another Aviation Authority, the submitted documentation may suffice for approval.

3.11 For all applicants the CAA reserves the right to require that a practical demonstration of ability is given.

4 Organisation and Quality

4.1 Safety Objective

Any organisation intending to perform flight inspection of navigation aids shall satisfy the CAA (SRG) that it is competent, having regard to any relevant previous conduct and experience, equipment, organisation, staffing maintenance and other arrangements, to produce accurate and adequate flight inspection results in relation to ATS safety aspects (1480).

4.2 Exposition

An Exposition shall be provided to detail the overall organisation and its intended operation (1481). The following aspects shall be included (or referenced to other documents) in the Exposition, or provided in a coherent documentary system (1482).

4.2.1 Identification

a) Organisation name, document title, reference number.

b) Base location.

c) Amendment status, issue number, date, amendment record.

d) Approval by the accountable manager.

e) Distribution list.

f) Exposition administrator.

g) Contents list.

4.2.2 Organisation

Introduction, Purpose of document, General information on the organisation. Interfaces with other organisations and departments. General statements on organisational policy with respect to ATS safety related aspects.

4.2.3 Undertaking

Scope of tasks. Types of navigational aids to be inspected. (For ILS the applicant must state the categories of ILS which he wishes to calibrate.)

4.2.4 Organisational Chart.

4.2.5 Personnel responsibilities, terms of reference and authority to act.

4.2.6 Procedures for notifying SRG of major organisational changes.

4.2.7 Procedures for notifying SRG regularly of the latest state of the flight inspection programme.

4.2.8 Procedures for notifying SRG of proposed equipment changes and modifications or change of aircraft type.

4.2.9 Details of the aircraft which the applicant wishes to use for flight inspection.

4.2.10 Functional description, technical specification and manufacturer's type number for all major items of the flight inspection system. This shall include details of the equipment used for calibrating the system.

4.2.11 Location, characteristic and type of all measurement aerials on the aircraft.

4.2.12 Technical description of any parts of the system which the applicant has designed or built.

4.2.13 The design authority for all equipment shall be stated.

4.2.14 Procedures for calibration of equipment.

4.2.15 Details of all uses of software and firmware in the measurement system. Also details of software and firmware support.

4.2.16 Details of a log or record system for faults and maintenance of the measuring system.

4.2.17 Spares holding and control.

4.2.18 Documentation Control. List of documents held and produced.

4.2.19 Personnel training, competency and recency checking arrangements.

4.2.20 Details of any internal and external auditing system e.g. auditing of the organisation by any other organisation not associated with the production of inspection results.

4.2.21 Details of the quality management system.

4.2.22 Details of the history of the organisation.

4.2.23 Details of any formal or implicit approvals which the applicant has received from other Aviation Authorities.

4.2.24 A list of any navigation aids which the applicant regularly inspects under such a formal or implicit approval. This will include:

a) Type of navigation aid.

b) Location of navigation aid.

c) Category of navigation aid (if applicable).

4.2.25 Flight calibration operating instructions for the inspector and flight crew.

4.2.26 A typical or test flight inspection report.

4.2.27 A typical or test sample structure measurement for those navigational aids where structure measurements form part of a normal flight inspection.

4.2.28 A statement showing to 95% confidence, the measurement uncertainty which the applicant claims to achieve for each of the measurable parameters.

4.2.29 Details of statistical methods or interpolative techniques which may be applied.

4.2.30 Details of AOC (Air Operator's Certificate) related approvals held in respect of aircraft operations.

4.2.31 Procedures for the control of sub-contractors.

4.2.32 A statement of compliance with the flight inspection requirements of the CAA.

5 Aircraft

5.1 **Safety Objective**

The aircraft used shall be appropriate for the purpose of flight inspection and shall be operated in a way which ensures accurate measurement of all parameters (1483).

5.2 The aircraft shall be a multi-engine type capable of safe flight within the intended operational envelope with one engine inoperative, fully equipped and instrumented for night and instrument flight (1484).

5.3 The aircraft shall be managed by two flying crew members (1485).

5.4 A cross-wind limit shall be set which will allow measurement accuracies to be within the limits required (1486). This limit shall be shown in the operating instructions (1487).

5.5 The aircraft shall have a stable electrical system with sufficient capacity to operate the additional electronic and recording equipment (1488).

5.6 Measures shall be taken to reduce propeller modulation to an acceptably low level (1489).

NOTE: As the aircraft may be required to fly abnormal procedures during an inspection, it is normal practice to add markings and/or lights which will increase the visibility of the aircraft against all normal backgrounds.

6 Equipment

6.1 **Safety Objective**

The purpose of the navigation aid flight inspection is to verify that all parameters of the navigation aid meet the requirements specified in Annex 10 to the Convention on Civil Aviation and any other specific requirements of the CAA. The equipment fitted in the aircraft must be capable of measuring all these parameters (1490).

6.2 The navigation aid measuring equipment shall not interfere with the operation or accuracy of the aircraft's normal navigation and general avionics equipment (1491).

6.2.1 The flight inspection measurements shall be adequately protected against the prevailing EMC environment internal or external to the aircraft (1492). Abnormal interference effects shall be clearly identified on the inspection results (1493).

6.3 The inspection system shall have the facility for listening to the identity modulation of the navigation aid being inspected (1494).

6.4 **Position Fixing and Tracking Equipment**

The flight inspection system shall include equipment which can determine and record the aircraft's position in space relative to a fixed reference point (1495). The uncertainty of measurement must be commensurate with the parameter being inspected (1496).

6.5 **Recording Equipment**

6.5.1 The flight inspection system shall include equipment which can record the measured parameters of the navigation aid being inspected (1497).

6.5.2 All recordings shall be marked so that they can be correlated with the aircraft's position at the time of the measurement (1498).

6.5.2.1 **Recommendation:** Where possible the flight inspection should comply with the guidance and recommendations given in ICAO Doc 8071 Vol II (1499).

6.5.2.2 **Recommendation:** As far as is reasonably possible the flight inspection equipment, including associated aerials should be totally independent from the aircraft's operational avionics fit (1500).

6.6 Aerials

6.6.1 The aerials shall be positioned in such a manner that they are not obscured from the signal during any normal inspection flight profiles (1501).

NOTE: To achieve this may require the use of more than one measuring aerial for one particular function. If duplicated navigation aid measuring receivers are used they may use a common aerial.

6.6.2 The aerials to be used for tracked structure measurements shall be positioned with due regard to the tracking reference on the aircraft (1502). If the aerials and the reference are not in close proximity, this error must be addressed in the measurement uncertainty calculations and in setting the operational crosswind limit. Alternatively, the errors may be corrected using information from the aircraft's attitude sensors and data concerning movement of the aerial's phase centre (1503).

6.7 Spectrum Analyser

NOTE: It is useful if a spectrum analyser is available for investigating equipment malfunctions and sources of interference. The analyser should have a method of image storage.

7 Measurement Uncertainty

7.1 Safety Objective

The measurement uncertainty for any parameter must be small compared with the operational limits for that parameter (1504).

7.2 The measurement uncertainty to 95% probability must be calculated for each of the parameters to be measured (1505). The method of calculation and any assumptions made must be clearly shown (1506).

7.3 Many measurements are a combination of receiver output and aircraft position. In these cases the figure required is the sum of all the errors involved in the measurement, including aircraft position.

7.4 Where several measurements are combined to produce a single result, these errors should be added by the RSS method (the square-root of the sum of the squares), to give the overall expected measurement uncertainty (1507).

NOTE: For certain ILS system parameters, the maximum permitted measurement uncertainty depends on the category of the ILS being inspected.

7.5 For measurements which can only be derived from recordings, the accuracy and resolution of the recording equipment shall be included in calculating the expected measurement uncertainty (1508).

7.6 When modifications are made which will affect the uncertainty of measurement of any parameter, new calculations shall be submitted (1509).

7.7 **Temperature Stability**

7.7.1 The uncertainties stated in section 3 shall be maintained under the specified environmental conditions for a flight inspection procedure (1510). The operator shall define the environmental conditions (temperature range, humidity range, etc.) (1511).

7.7.2 Details of measurement uncertainty with respect to temperature shall be available for all the measuring equipment (1512). This may be in the form of test results made by the operator, or manufacturer's specifications. If manufacturer's specifications are quoted, the proposer shall be prepared to produce manufacturer's test results as evidence (1513).

7.7.3 If the measuring equipment requires any warm-up or cooling time, this shall be clearly indicated in the operating instructions (1514).

NOTE: If necessary, any temperature dependent apparatus may be fitted in a temperature controlled enclosure. An indicator/alarm shall be fitted to inform the navigation aid inspector of any error in temperature (1515).

7.8 **Position Marking of Flight Inspection Data**

The accuracy of marking shall be commensurate with the accuracy required in the final figure (1516). Specific requirements are given in paragraph 7.2 of the appropriate annex to FLI 02.

8 Calibration Procedures and Standards

8.1 **Safety Objective**

All measuring equipment used for flight inspection shall be calibrated to defined standards (1517).

8.2 Clearly defined calibration procedures shall be applied to all equipment involved in the measurement of parameters in paragraph 6 of the appropriate annex of FLI 02 (1518). All equipment and standards used in the calibration process shall have traceability to national or international standards (1519).

8.3 When any equipment used is claimed to be self calibrating, the internal processes involved shall be clearly defined (1520). This involves showing how the equipment's internal standard is applied to each of the parameters which it can measure or generate. The internal standard shall have traceability to national or international standards (1521).

8.4 Details of calibration intervals required shall be contained in the calibration records (1522). The proposer shall be prepared to produce evidence in support of the quoted calibration intervals (1523).

9 Software - Refer to SW01

10 Operating Instructions

10.1 **Safety Objective**

The operating instructions shall ensure that all measurements are made to defined and documented procedures (1524).

10.2 This documentation will include concise details of:

a) The flight profile to be used for each individual measurement (1525).

b) Pre-flight calibration of measuring equipment (1526).

c) Siting of any necessary ground tracking or position fixing equipment (1527).

d) Scheduled maintenance and calibration of the measuring equipment (1528).

e) Operation of the measuring equipment (1529).

f) Production of the flight inspection report (1530).

g) Certification (1531).

h) The method of calculating any results which are not directly output by the measuring equipment (1532).

11 Personnel Training and Qualification Requirements

11.1 **Safety Objective**

All personnel concerned with the flight inspection shall be adequately trained and qualified for their job functions (1533).

11.2 The proposer must show that all personnel concerned with the flight inspection are adequately qualified for their job functions (1534).

11.3 The proposer must be prepared to submit CVs for all personnel directly concerned with the flight inspection, from which each person's experience and suitability can be determined (1535).

11.4 The organisation must have a procedure for ensuring the competence of its personnel (1536). This procedure must have provision for regular assessment of competence (1537).

11.5 Particularly for the inspection of precision approach aids, the flight crew's familiarity with each location to be inspected is considered to be of importance. The proposer's procedures and instructions must include details of training and familiarisation which will apply to the flight crew (1538).

12 Flight Inspection Report

12.1 **Safety Objective**

The flight inspection report shall clearly and accurately document the measured performance of a navigational aid (1539).

12.2 All flight inspection results shall be documented to a report format agreed with the CAA (1540). The minimum information to be provided on the report shall be (1541):

a) Station name and facility designation.

b) Category of operation.

c) Date of inspection.

d) Serial number of report.

e) Type of inspection.

f) Aircraft registration.

g) Manufacturer and type of system being inspected.

h) Wind conditions.

i) Names and functions of all personnel involved in the inspection.

j) Results of all measurements made.

k) Method of making each measurement (where alternatives are available). These may be referenced to the operating instructions.

l) Details of associated attachments (recordings, etc.).

m) Details of extra flights made necessary by system adjustments.

n) An assessment by the aircraft captain of the navigational aid's performance.

o) Comments by the navigation aid inspector/equipment operator.

p) Details of any immediately notifiable deficiencies.

q) Statement of conformance/non-conformance.

r) Navigation aid inspector's signature.

s) Pilot's signature.

t) Signature of the individual who is legally responsible (if different from (r) or (s)).

13 Records and Graphs

13.1 **Safety Objective**

Records and graphs shall be produced in a manner which ensures that system parameters may accurately be deduced from them (1542).

13.2 If recordings or graphs are used to derive figures for the inspection report, the scales shall be commensurate with the permitted measurement uncertainty limits (1543).

NOTE: If the recordings or graphs are only used to show that results are within designated tolerances, they may be presented on a reduced scale.

13.3 The data from which these recordings and graphs are made shall be stored with sufficient accuracy that expanded scale plots can be provided on demand (1544).

13.4 For flights where parameters are evaluated by comparison of the received signal and the output of a tracking device, only the final result need be presented for a normal inspection unless other data has been requested by the customer. Position data and raw signal data shall be recorded or stored and provided on demand (1545).

NOTE: This will be necessary in cases where further analysis of the results is required. For example, to assess marginal performance or to assist in identifying causes of multi-path reflections.

13.5 **Identification**

The minimum identification on each record and graph shall be (1546):

a) Serial number.

b) Date.

c) Description of type of flight.

d) Name of airport.

e) Designation of facility being inspected.

13.6 **Retention of data**

The applicant shall provide for Authority approval, details of the arrangements to be made for archiving data from flight inspection results (1547).

14 AOC Aspects

14.1 Applicants seeking an approval to become a flight calibration organisation may need to hold an Air Operator's Certificate (AOC) unless they are intending to provide air transport services. Flight inspection is normally regarded as aerial work which on its own does not require an AOC.

14.2 Applicants already holding an AOC will be subject to the supervision of the CAA when engaged in calibration work and are advised to contact the Assigned Inspector as soon as is practical to discuss the matter.

15 Legal Requirements

Any general legal requirements will be advised in consultation with the CAA Legal Department. Applicants must comply with all such requirements (1548).

Annexes Specific to Individual Navigation Aids

NOTE 1: The annexes in this section contain requirements specific to the flight inspection of individual navigation aids. They must be read in conjunction with Section 2 of this document.

NOTE 2: To facilitate cross-referencing, the paragraphs in the annexes have the same numbers as the relevant paragraphs in FLI 02, Part 2.

Annex 1 - Instrument Landing System

5 Aircraft

5.1 Manual flight control using only the mandatory navigation instruments is not considered sufficiently accurate for calibration of the following types of ILS:

- Category III systems.
- Category II systems.
- Category I systems, which the operator wishes to use for autoland in good visibility.

5.2 For calibration of the above systems the aircraft shall be fitted with equipment which will provide repeatable following of the required path (1549). Systems considered suitable to this purpose include telemetry of the ground based tracking system's output to a separate instrument in the aircraft, or an autopilot. If an autopilot is used the CAA shall be satisfied that it is capable of safe operation down to 50 feet above the threshold elevation (1550).

6 Equipment

6.1 Measurement and Recording Equipment

6.1.1 A normal ILS/DME inspection system shall be capable of measuring and recording the following parameters (1551):

a) Localiser Field strength.

b) Localiser Modulation Sum (SDM).

c) Localiser Difference in Depth of Modulation (DDM).

d) Glidepath Field strength.

e) Glidepath Modulation Sum (SDM).

f) Glidepath Difference in Depth of Modulation (DDM).

g) Marker Beacon Field strength.

h) Marker Beacon Fly-through Time.

i) DME Field strength.

j) DME Distance.

k) Radio Altimeter height.

6.1.2 The recording equipment shall be capable of recording any of the ILS parameters listed in paragraph 6.1.1 (1552). The equipment shall measure and record beam structure by comparison of tracking data and the ILS signal, from a distance of at least 4 NM from the runway threshold (1553).

6.1.3 It shall be possible to annotate the recordings with comments and any other necessary information at the time of making the recording (1554).

6.1.4 For beam bend measurements, the total time constant of the measuring and recording equipment shall be 92.6/V seconds where V is the aircraft velocity in kilometres per hour (1555).

6.1.5 If digital sampling/storage is used, the sampling rate shall be compatible with this time constant but never less than 4 samples per second for all parameters which are continuously measured (1556).

6.1.6 The equipment shall be capable of recording a minimum of 4 parameters simultaneously (1557).

NOTE: Post inspection processing may be necessary to achieve the required accuracy for certain parameters.

7 Measurement Uncertainty

7.1 Maximum permitted measurement uncertainty at 95% confidence level (1558).

NOTE: Throughout the following tables, the figure of 2dB for field strength is the permitted uncertainty for repeatability of measurement. It is not a requirement for absolute field strength measurement.

7.1.1 **Localiser (1559)**

	Cat I	**Cat II**	**Cat III**
Alignment (average) (related to threshold)	2.0m	1.0m	0.7m
Recommendation: The uncertainty should not exceed the figures below			
	1.0m	0.7m	0.3m
Displacement sensitivity (of the actual figure)	4.0%	4.0%	2.5%
Recommendation: The uncertainty should not exceed the figures below			
	1.7%	1.7%	1.0%
Field strength (relative)	2dB	2dB	2dB
Off course clearance	3%	3%	3%
Course/clearance ratio	1dB	1dB	1dB
Course structure	1μA	1μA	1μA
Modulation sum	0.4%	0.4%	0.4%
	(absolute mod depth)		
Polarisation	1.5μA	1.0μA	1.0μA
Modulation balance (CSB)	1.0μA	1.0μA	1.0μA

7.1.2 Glidepath (1560)

	Cat I	Cat II	Cat III
Angle	0.5%	0.3%	0.3%
	(of the glidepath angle)		
Displacement sensitivity	2.5%	2.0%	1.5%
	(of the actual figure)		
Field strength (relative)	2dB	2dB	2dB
Clearance	3%	3%	3%
	(of the actual figure)		
Course structure	3µA	2µA	2µA
Modulation sum	0.5%	0.5%	0.5%
Modulation balance (CSB)	1.0µA	1.0µA	1.0µA

7.1.3 Marker Beacon (1561)

Field strength (relative)	2dB
Fly-through time	1 second (at 96 knots)

7.1.4 Associated DME (1562)

Field strength (relative)	2dB
Distance	60 metres at threshold and point A

Recommendation: The uncertainty of DME distance measurement should not exceed 35 metres at threshold and point A (1563).

7.2 Uncertainty of Position Marking of Flight Inspection Data

7.2.1 Approach Toward a Facility (1564)

±0.1 NM for markings at each nautical mile.

±0.1 NM for marking at ILS point A.

±0.05 NM for marking at ILS point B.

±0.05° for marking glidepath slice at 1.8 x (glidepath angle).

±20 metres for marking the threshold crossing.

±20 metres for marking any other points along the runway.

7.2.2 **Orbital Flights (1565)**

±1.5 Degree.

NOTE: A marking accuracy of ±1.5° applies to clearance and coverage inspection, it is not sufficient for measuring displacement sensitivity.

13 Records and Graphs

Where chart recordings are used for parameter evaluation, they shall have sufficient resolution for this purpose (1566). The minimum requirements are given below.

13.1 **Structure Stability Recordings (deviation current) (1567)**

13.1.1 **Localiser**

Minimum sensitivity of 1 mm per μA.

13.1.2 **Glidepath**

Minimum sensitivity of 0.5 mm per μA.

13.2 **Structure Measurements (corrected recordings)**

13.2.1 **Localiser (1568)**

Minimum sensitivity of 1mm per μA.

13.2.2 **Glidepath**

Minimum sensitivity of 0.5mm per μA for the initial part of the recording. For Category II & III systems, it must be possible to show the signal characteristic down to threshold crossing (1569). This may require reduced sensitivity depending on available chart width.

13.3 **Other Measurements**

Many other recordings will need sensitivity changes during the recording to obtain optimum resolution at all times. The chart produced must be capable of displaying at least 450 μA of deflection current without saturation. Sufficient different sensitivities of display must be available to allow signal characteristics to be measured accurately (1570).

13.4 **Position Annotation**

Records and graphs must be annotated to show the position of the aircraft at the time of making the measurement (1571). The minimum requirements are given below. Required accuracies of annotation are given in paragraph 7.2.

13.4.1 **Approaches Towards a Facility**

Every nautical mile (referenced to 0 NM at the threshold), ILS points A, B & C, Threshold.

13.4.2 **Glidepath Level Flight (on localiser centreline) (1572)**

Every nautical mile (referenced to 0 NM at the threshold), and 1.8 x (glidepath angle).

13.4.3 **Orbital Flights (1573)**

Every 5 degrees.

Annex 2 - Microwave Landing System

5 Aircraft

5.1 Manual flight control using only the mandatory navigation instruments is not considered sufficiently accurate for MLS calibration.

5.2 For MLS calibration the aircraft shall be fitted with equipment which will provide repeatable following of the required path (1574). Systems considered suitable to this purpose include telemetry of the ground based tracking system's output to a separate instrument in the aircraft, or an autopilot. If an autopilot is used SRG shall be satisfied that it is capable of safe operation down to 50 feet above the threshold elevation (1575).

6 Equipment

6.1 Receiver

6.1.1 The receiver used for MLS flight inspection shall:

a) Have a log video output (1576).

b) Have an oscilloscope trigger for all angle functions (1577).

c) Have independent Azimuth and Elevation flag outputs (1578).

d) Be capable of operating with the transmitter basic data word *2 set to 'on test' (1579).

e) Be capable of being calibrated to 0.005° for Azimuth and Elevation (1580).

f) Have a frame flag output (1581).

6.1.2 The equipment shall be capable of measuring and recording the relative signal levels of each component (scanning beam, clearance, multipath, OCI, preamble) within a function (1582).

NOTE: This measurement may be made by examining the receiver output or by the use of separate measuring equipment such as a spectrum analyser.

6.1.3 An oscilloscope shall be provided (1583). This shall be capable of being triggered from the receiver and examining the receiver's log video output (1584).

6.1.4 The equipment shall record frame flag information from the receiver (1585).

6.2 Measurement and Recording Equipment

6.2.1 An MLS inspection system shall be capable of measuring and recording the following parameters (1586):

Azimuth	PFE.
Azimuth	PFN.
Azimuth	CMN.
Azimuth	Field strength.
Elevation	PFE.
Elevation	PFN.
Elevation	CMN.
Elevation	Field strength.

6.2.2 The equipment shall be capable of measuring and recording PFE by comparison of tracking data and the MLS signal, from a distance of at least 4 nautical miles from the runway threshold (1587).

6.2.3 The MLS inspection system shall be capable of decoding and displaying the contents of all basic and auxiliary data words (1588).

6.2.4 It shall be possible to annotate the recordings with comments and any other necessary information at the time of making the recording (1589).

NOTE: PFN and CMN may be derived and recorded using appropriate filters, but need not make reference to the position tracking device.

6.2.5 The minimum data sampling rate shall be 5 Hz (1590).

6.2.6 The filters used for measurement of PFE, PFN & CMN shall be designed using guidance given in ICAO Annex 10, Vol 1, Attachment G, Figure G II (1591). The filter design shall be compatible with the digital data sampling rate (1592).

6.2.7 The equipment shall be capable of recording a minimum of 4 parameters simultaneously (1593).

NOTE: Post inspection processing may be necessary to achieve the required accuracy for certain parameters.

7 Measurement Uncertainty

7.1 Maximum permitted measurement uncertainty at 95% confidence level

Azimuth (1594)

PFE	0.5 metres at reference datum
PFN	0.5 metres
CMN	0.5 metres
At all other places where these parameters are measured, the uncertainty shall not exceed	0.01°
Relative signal levels	1.0 dB

Elevation (1595)

PFE	0.2 metres at reference datum
PFN	0.1 metres
CMN	0.1 metres
At all other places where these parameters are measured, the uncertainty shall not exceed	0.01°
Relative signal levels	1.0 dB

NOTE: Relative signal levels above refer to measurement of the difference in signal level between the individual components of an MLS signal for a specific facility.

The measurement uncertainty for a specific parameter at successive inspections shall be less than 2 dB (1596).

7.1.1 **Associated DME (1597)**

Field strength (relative)	2dB
Distance	60 metres at threshold and point A

Recommendation: The uncertainty of DME distance measurement should not exceed 35 metres at threshold and point A (1598).

7.2 **Uncertainty of Position Marking of Flight Inspection Data**

7.2.1 **Approach Toward a Facility (1599)**

±0.1 NM for markings at each nautical mile.

±20 metres for marking the threshold crossing.

±20 metres for marking any other points along the runway.

7.2.2 **Orbital Flights (1600)**

± 1.5 Degree.

NOTE: A marking accuracy of ±1.5° applies to clearance and coverage inspection, it is not sufficient for measuring displacement sensitivity.

13 Records and Graphs

Where chart recordings are used for parameter evaluation, they shall have sufficient resolution for this purpose. The minimum requirements are given below.

For PFE, PFN and CMN: 0.05° per cm (1601).

13.1 **Position Annotation**

Records and graphs must be annotated to show the position of the aircraft at the time of making the measurement (1602). The minimum requirements are given below. Required accuracies are given in paragraph 7.2.

13.1.1 **Approaches Towards a Facility (1603)**

Every nautical mile (referenced to 0 NM at the threshold), ILS points A, B & C, Threshold.

13.1.2 **Orbital Flights (1604)**

Every 5 degrees.

Annex 3 - GNSS Non-Precision Approach

6 Equipment

6.1 **Receiver**

6.1.1 The receiver(s) shall have a RAIM algorithm compliant with TSO C129 A (1605).

6.1.2 The receiver shall provide the following outputs to the recording equipment (1606):

a) No. of SVs visible

b) No. of SVs tracked

c) Carrier to noise density for all SVs visible

d) HDOP

e) GNSS position

f) Date and time

g) RAIM flag.

6.2 **Recording equipment**

6.2.1 In addition to the parameters listed in 6.1.2, it shall be possible to record from other sensors (1607):

a) Radio altimeter height

b) Aircraft attitude

6.2.2 The update rate of all recorded parameters shall be stated (1608).

6.3 **Aerials**

6.3.1 The aerial used for GNSS measurement shall be an approved type with known polar diagram, permanently mounted on the outside of the aircraft (1609).

6.3.2 **Recommendation:** An additional GNSS aerial should be mounted on the underside of the aircraft for interference investigation (1610).

6.4 **Spectrum analyser**

The spectrum analyser shall be capable of verifying the standard ICAO GNSS interference mask with the aircraft stationary (1611).

6.5 **Prediction software**

6.5.1 The prediction software shall be capable of verifying that the minimum SV geometry will be met for the duration of the flight inspection (1612). (This allows a clearer distinction between alarms triggered by insufficient SV coverage and those caused by interference).

6.6 **Position fixing system**

NOTE: An independent position fixing system is not mandatory for GNSS NPA inspection.

6.6.1 **Recommendation:** An independent position fixing system should be available for investigating anomalies found during inspections (1613).

13 Records and Graphs

13.1 All parameters listed in 6.1.2 and 6.2.1 shall be printed at each waypoint (1614).

13.2 On request, a continuous plot of radio altimeter height and aircraft attitude throughout the approach shall be provided (1615).

13.3 On request, a complete record of all parameters listed in 6.1.2 and 6.2.1 shall be provided (1616).

13.4 The records shall show any infringement of the ICAO interference mask found during spectrum checks on the airfield (1617).

NAV 01 Engineering Requirements for Instrumented Runway Visual Range (IRVR) Systems

Part 1 Preliminary Information

1 Introduction

Under the terms of the Air Navigation Order, all aeronautical ground radio installations intended for use at civil airports within the United Kingdom require approval by the CAA. IRVR is considered as part of the Instrumented Landing System for the purposes of this Article.

2 Scope

2.1 This document details the performance criteria and safeguarding of IRVR equipment installed in the UK intended for use in the provision of an Air Traffic Service.

2.2 The purpose of this document is to ensure that consideration has been taken of those aspects that affect the safety of services provided and supported by an IRVR facility.

Part 2 Requirements

3 Safety Objective

The equipment shall enable the provision of an accurate representation of the runway visual range to be available to the pilot during the take-off and landing phases of flight (1641).

4 Technical Requirements

4.1 Instrumented Runway Visual Range (IRVR) shall be measured, over the range defined for the approach categorisation, to a minimum accuracy of (1642):

±10 Metres from 50 metres to 400 metres.

±25 Metres from 400 metres to 800 metres.

±10 per cent above 800 metres.

4.2 All systems shall meet these accuracy requirements over background luminance levels in the range 5 to 30,000 $Cd.m^{-2}$ (1643).

4.3 For calculating the IRVR value, 20 per cent of the peak beam on axis intensity of the runway light (rounded to the nearest 100 cd) shall be used (1644).

4.4 The sensor output shall be sampled at a minimum rate of once per second (1645).

4.5 The equipment shall average the recorded extinction coefficient over a period of 1 minute, to effect atmospheric smoothing (1646).

4.6 The reported IRVR shall be rounded down to the nearest increment specified in 8.7 (1647).

4.7 When RVR is increasing, a hysteresis of 1.5 increments shall be used to prevent unnecessary fluctuations in the displayed IRVR (1648).

4.8 The equipment integrity and reliability shall be such that the number of safety-related failures shall be no more than 10^{-5} per operating hour (1649).

5 Equipment Calibration

The proposed maintenance and calibration policy and facilities necessary to maintain performance shall be defined (1650).

6 Equipment Interfaces

6.1 Technical justification that all non-passive interfaces installed in or connected to other equipment shall demonstrate that the safe operation of the equipment is not compromised (1651).

NOTE: The un-approved connection of the IRVR system to any existing approved equipment may cause the approval of that equipment to be invalid and therefore reassessment may be necessary.

6.2 All interfaces between the IRVR system and other systems shall be designed, constructed, installed and tested to an integrity standard suitable for these systems (1652).

6.3 The interfaces to the lighting systems shall be fed with tell-back information only (1653).

6.4 The IRVR interface to the lighting system shall report error warnings in the event that the lighting interface receives multiple tell-back indications or conflicting information (1654).

6.5 The IRVR system shall be provided with a time source which shall be synchronised with the main station time source to a tolerance of within ± 5 seconds (1655).

7 Monitoring

7.1 All IRVR systems shall be self monitoring (1656).

7.2 **Recommendation:** Displays should indicate the status of the system and/or any error that may occur (1657).

8 Displays

8.1 Displays shall present the RVR data:

a) In an alphanumeric format with indication of marked discontinuities and trend over successive readings, as **Recommended** in ICAO Annex 3 (Amd. 72), Chapter 4 paragraph 4.7.18 (1658).

b) With any changes in system status or RVR reported within 15 seconds, with or replaced by an indication of system or input faults (includes blanking) (1659).

8.2 Where the IRVR interfaces with other display systems, all operational ATC positions shall provide data in the standard alphanumeric format (1660).

8.3 All displays shall be provided with a method of testing the display and backed by procedures to ensure compliance with the stated criticality (1661).

8.4 The display shall provide an indication of data reception / processing (1662).

8.5 The software used in the display system shall be developed to meet the requirement in 4.7 (1663).

8.6 Where data is transmitted off station, the ICAO station ident shall be included (1664).

8.7 The data shall be displayed with the following resolution:

a) 25 metre intervals from 50 to 400 metres (1665).

b) 50 metre intervals from 400 to 800 metres (1666).

c) 100 metre intervals from 800 to 1500 metres (1667).

9 Recording

9.1 To meet legal requirements, the primary method of recording information shall be in the form of a printout, time stamped against the station clock and stored for a period of 30 days (1668). Readable magnetic or optical recording devices may be used for secondary or backup purposes.

9.2 The RVR and status information shall be recorded in the event of the following:

a) Change in RVR or trend from any site (1669).

b) System self test (1670).

c) On detection of change of serviceability status (including nature of the fault) (1671).

d) Change of runway in use (1672).

e) Change in runway lighting intensity (1673).

9.3 **Recommendation:** Change in law used to calculate the given visibility should be recorded (1674).

9.4 **Recommendation:** Transmittance, Illuminance Threshold (Et) and software version should be recorded (1675).

10 Siting Criteria

10.1 **Safety objective**

Sensor measurements are representative of the pilot's perspective of the visibility along the runway(1676).

NOTE: Differences may be acceptable but a detailed assessment of the likely effects on the operational performance of the facility should be carried out.

10.2 **Recommendation:** IRVR sensors should be positioned not more than 120 metres laterally from the runway centreline, but not infringing the obstacle-free zone for precision approach runways. For touch-down zone, units should be 300 metres along the runway from the threshold or a site agreed with ATSSD (1677).

10.3 Runways with automated systems, operating to CAT I shall have a minimum of one IRVR measuring system installed alongside the runway representing Touchdown (TDZ) area (1678).

10.4 Runways operating to CAT II with a runway length of less than 2000 metres Landing Distance Available (LDA), shall have a minimum of two IRVR measuring systems positioned alongside the runway representing TDZ and STP (1679).

10.5 Runways with automated systems, operating to CAT II with greater than 2000 metres LDA, shall have a minimum of three RVR measuring systems positioned alongside the runway representing TDZ, MID and STP (1680).

10.6 Runways operating to CAT III shall have a minimum of three IRVR measuring sites positioned alongside the runway representing TDZ, MID and STP respectively (1681).

NOTE: Particular attention should be paid to the design and location of the sensor heads to ensure an effective representation of the required coverage area.

10.7 The sensor housing shall not affect the accuracy of the atmospheric measurement (1682).

10.8 Summary of System Requirements Under Normal Operating Conditions (1684):

RVR Assessment Site (LDA – Landing Distance Available)	Category II Rwy less than 2000m LDA	Category II Rwy 2000m or more LDA	Category III All Runways
TDZ	Required	Required	Required
MID	Recommended	Required	Required
STP	Required	Required	Required

NAV 02 Engineering Requirements for MF Non-Directional Beacons

Part 1 Preliminary Material

1 Introduction

Under the terms of Article 104 of the Air Navigation Order all Civil MF Non-Directional Beacon (NDB) installations, intended for use in the provision of an Air Traffic Service require approval by the ATS Standards Department (ATSSD) of the Safety Regulation Group (SRG), being part of the Civil Aviation Authority.

2 Scope

2.1 This document sets out the Engineering requirements for MF Non-Directional Beacons (NDBs) intended for use in the provision of an Air Traffic Service. This document applies to NDBs and NDBs associated with published Instrument Approach Procedures, also known as Locators, promulgated as NDB(L).

2.2 The purpose of this document is to ensure the Applicant has considered and taken account of those aspects that affect the safety of such a facility.

Part 2 Requirements

3 Safety Objective

The system shall radiate a signal which complies with the standard operating parameters and provides correct guidance to users within its rated coverage.

4 Standard Operating Parameters

4.1 Transmission Characteristics

4.1.1 Radiated Frequency

The equipment shall only transmit on the frequency assigned by the CAA and as appears in the schedule to the radio licence issued under the Wireless Telegraphy Act. The assigned frequency shall be maintained within plus or minus 0.01 per cent.

4.1.2 Power Output

This shall be adjusted to give a vertical field strength of 70 micro volts/metre at the limit of the rated coverage, and be maintained within a tolerance of plus 2 dB and minus 3 dB.

4.1.3 Spurious Emission

There shall be no spurious frequency component greater than 40 dB below the carrier power.

4.1.4 Emission Type

The type of emission shall be '850HA2AAN' ITU Radio Regulations, i.e. an uninterrupted carrier identified by the on/off keying of an amplitude modulating tone.

4.2 Modulation Characteristics

4.2.1 Identification

4.2.1.1 Each NDB shall be individually identified by a two or three letter international Morse code group as assigned and transmitted at a rate corresponding to approximately 7 words per minute. The complete identification shall be transmitted at least 3 times in each 30 second period, equally spaced within that period.

4.2.1.2 The facility Identification shall be suppressed when the NDB is not available for operational purposes, e.g. under maintenance.

4.2.2 Modulation Frequency

The frequency of the modulating tone for identification shall be 400 Hz plus or minus 25 Hz.

4.2.3 Depth of Modulation

The depth of modulation shall be maintained as near to 95% as practicable. It shall not fall below 85 per cent.

4.2.4 Change of Carrier Power during modulation

The carrier power of an NDB shall not fall by more than 0.5 dB when the identification signal is being radiated.

4.2.5 **Unwanted Modulation**

Unwanted audio frequency modulations shall total less than 5 per cent of the amplitude of the carrier.

4.3 **Monitoring**

4.3.1 **Executive Monitor Action**

An executive site monitor shall be provided to switch off the equipment in use and, if applicable, change over to the standby system if:

a) There is a change in radiated carrier power of more than plus 2 dB or minus 3 dB of that required for the rated coverage.

b) A malfunction or failure of the means of self monitoring of executive parameters occurs.

The occurrence of any of the above shall cause beacon shut-down or changeover in less than 1 minute.

4.3.2 **Non-Executive Alarm**

A Non-Executive Alarm will be generated within three minutes, if the NDB fails to transmit the correct identification code. This alarm should be available for all new or replacement equipment.

4.4 **Status Indication**

4.4.1 A clear and unambiguous indication of the operational status of the NDB shall be available to the NDB service provider during the hours of service of the associated Air Traffic Service.

5 General Design Requirements

5.1 The equipment shall be subject to good design practices.

5.1.1 **Note**:

These should include:

a) The existence of appropriate detailed design specifications for the equipment.

b) Suitable design procedures within the supplier's organisation that ensure the design process is traceable and follows an orderly flow from concept to production models.

c) The existence of test and validation documentation including the results of the required performance testing undertaken to ensure compliance with the equipment specification.

d) The equipment design and layout should be such that RF radiation is confined to the antenna.

5.2 **Standby equipment**

The choice of single or dual transmitter and monitor equipment shall be determined by taking into consideration the need to ensure continuity of service appropriate to the level of the service provided. Service Providers should refer to manufacturer's data with regard to product reliability.

5.3 **Standby Power Supply**

5.3.1 An NDB shall be provided with suitable power supplies and means to ensure continuity of service appropriate to the needs of the service provided.

5.3.2 An NDB associated with published instrument approach procedures shall be equipped with an alternative power source to ensure continued operation for a minimum of 30 minutes after failure of the primary supply.

5.3.3 An indication of a change to secondary supplies shall be made to the NDB Service Provider.

5.4 **Earthing**

To avoid the performance of the beacon being subject to climatic changes, the earth system shall be appropriate taking into account local ground conditions.

6 Siting Guidance

6.1 Attention should be given to the possible effects on the polar diagram due to:

a) Steel towers, pylons or steel cables within two km.

b) Underground services such as gas, water or electricity within the earth plane region.

c) Railway lines in or close to the earth plane region.

6.2 **Site Safeguarding**

6.2.1 In the absence of manufacturer's data, refer to the Technical Safeguarding section, CAP670 Part B, for appropriate guidance.

7 Commissioning and Maintenance Requirements

7.1 It shall be confirmed during Commissioning and subsequent maintenance that the NDB achieves and continues to meet the Standard Operating Parameters. Pertinent figures are to be recorded.

7.2 The method by which the Standard Operating Parameters are confirmed is to be notified to ATSSD during the ANO Approval process.

7.3 NDB operators must regularly record the field strength of their NDB, as measured at a remote location. Remote measurement of field strength can take place at any point where the NDB ground wave is consistently established.

7.4 Measurement of field strength should be achieved using calibrated equipment.

7.5 Measurement of field strength at a non-rated range remote location is acceptable if correlation to measurement at rated range is traceable.

7.6 The normal periodicity of field strength measurement shall be monthly. However periodicity intervals of up to six months may be agreed upon application to ATSSD who will grant increased time intervals based upon acceptance of the following:

a) The submission of seven consecutive monthly field strength and aerial current readings whose stability meets the requirements of Doc 8071.

b) If adequate remote measurement arrangements are not available, a regular flight check may be requested by ATSSD. This may be in conjunction with regular aerial current and other local measurement arrangements as proposed in mitigation of remote measurement, by the NDB operator.

7.7 The frequency of the equipment maintenance checks shall be based upon appropriate analysis, e.g. reliability analysis or FMECA.

7.8 Unless mitigation under the ANO is granted, through submission to this department, annual flight confirmation of the radiated performance of NDBs is required.

Mitigation guidance:

The following suggested areas should be considered as part of a balanced submission to justify mitigation of the requirement for flight inspection:

- *A statement of the current method for the recording of NDB field strength.
- *The Service Providers method of confirming that the equipment meets the Standard Operating Parameters, in accordance with the Provider's maintenance system.
- Evidence of original commissioning flight inspection.
- User feedback from local Pilots (ideally Instructor rated) to NDB Service Provider – this to positively identify disapproval of the quality of the NDB and to indicate normal pilot interpreted acceptable operation.
- Monitoring of MORs.

*These inputs must be supplied.

7.9 Commissioning and any Annual flight checks shall be carried out by an approved Flight Calibration aircraft. Additionally if ATSSD becomes concerned that the NDB may no longer be operating in accordance with these requirements or the Service Provider's stated mitigation, ATSSD may request a flight check of the NDB, at the Service Provider's expense, by an approved Flight Calibration aircraft.

7.9.1 Commissioning, Annual and Pilot interpreted flight check tolerances:

a) The airborne ADF needle swing shall not exceed plus or minus 10 degrees at ranges up to or at the rated range, with respect to bearing towards the NDB.

b) The ADF swing shall not exceed plus or minus 5 degrees while following all established ADF approaches.

c) The identification shall be checked for correctness, clarity and proper tone throughout the flight check.

Additionally Flight Calibration aircraft will:

a) Record relative field strength of the NDB at the rated range.

b) Observe correct needle reversal overhead the NDB.

NOTE: Checks performed by the calibration aircraft should be limited to pertinent coverage areas.

7.10 Throughout the tests the possible effects due to weather such as thunderstorms should be taken into account.

7.11 **Post commissioning inspections and on-going operational maintenance**

The owner of the facility must establish an adequate maintenance system and provide qualified maintenance staff to maintain the facility at the level achieved and recorded at commissioning.

8 Off-Shore Requirements

8.1 The installation, monitoring and maintenance practices shall be adequate.

NOTE: The environment off-shore may place possible restrictions on the ability to meet the above requirements.

8.2 Particular attention shall be given to the design and location of the beacon antenna to ensure an effective coverage pattern.

8.3 The beacon shall be capable of operating on the frequencies laid down in the UK AIP ENR, Chapter 1.15, Off-shore Operations, for both mobile and fixed operations. As frequencies are shared for mobile installations it is imperative that any commissioning or testing of the NDB shall be carried out with due regard to preventing interference to other users.

8.4 Procedures shall exist to prevent simultaneous operation with other co-channel beacons.

8.5 A method to comply with the requirements of this document shall be agreed between ATSSD and representatives of the Offshore Industry. Such compliance will be subject to ATSSD audit.

9 Electro Magnetic Compatibility

Radio transmitting equipment must comply with the EMC Regulations.

NOTE: Further information is contained in Part B Section 4, GEN 04.

NAV 04 Engineering Requirements for Conventional and Doppler VHF Omni-Directional Range (CVOR/DVOR) Beacons

Part 1 Preliminary Material

1 Introduction

Under the terms of Article 104 of the Air Navigation Order all VHF Omni-Directional Range Beacon (VOR) installations intended for use in the provision of an Air Traffic Service in the United Kingdom require approval by the CAA.

2 Scope

This document sets out the Engineering Requirements for all Conventional and Doppler VHF Omni-Directional Range Beacons (CVOR/DVOR) intended for use in the provision of an Air Traffic Service.

Part 2 Requirements

3 Safety Objective

The Beacon system does not radiate a signal which falls outside standard operating tolerances or provide false guidance over its Designated Operational Coverage area (DOC).

3.1 **Transmission Characteristics**

3.1.1 **Radiated Frequency**

The equipment shall transmit only on the frequency assigned by the CAA and as appears in the schedule to the radio licence issued under the Wireless Telegraphy Act.

3.1.2 **Channel Spacing**

The equipment shall radiate on the assigned 50 kHz channel, within the frequency band 108.000Mhz to 117.975 Mhz.

3.1.3 **Radiated Frequency Stability**

The radiated frequency shall be maintained within plus or minus 0.002% of the nominal frequency.

3.1.4 **Power Output**

A minimum horizontal field strength of minus 107 dBW/m^2 (90 micro volts/metre) at the limit of the DOC shall be maintained. The DOC will be specified by the CAA for each individual installation.

3.1.5 **Emission**

The emissions shall be horizontally polarised. The vertically polarised component of the radiation shall be suppressed to the lowest possible level.

3.1.6 **Beacon Accuracy**

The accuracy of the horizontal polarised radiation from the beacon shall be plus or minus 2 degrees, at elevations between 0 and 40 degrees measured from the centre of the beacon, at a distance of:

a) Approximately four wavelengths from the centre of the installation for a CVOR.

b) Approximately 300 metres from the installation for a DVOR.

3.2 **Modulation Characteristics**

The reference and variable signal phase modulations shall be in phase along the magnetic reference meridian through the station and produce instrumental indications in the aircraft representing equal angular deviations, degree for degree from magnetic North as measured from the location of the VOR.

3.2.1 **FM Signal Modulation**

3.2.1.1 This shall be a subcarrier signal of 9960 Hz ± 1% and:

a) Of constant amplitude.

b) Modulated at 30 Hz ±1%.

c) Have a deviation ratio of 16 ±1.

d) A modulation depth of 30% ± 2%.

These levels shall be maintained at elevations up to 5 degrees above counterpoise level.

3.2.1.2 The sideband level of the harmonics of the 9960 Hz component shall comply with the levels specified in ICAO Annex 10 Chapter 1 for 50 kHz VOR channel spacing.

3.2.1.3 For a conventional VOR, the amplitude modulation of the 9960 Hz subcarrier shall not exceed 5%.

3.2.1.4 For a Doppler VOR, the amplitude modulation of the 9960 Hz subcarrier shall not exceed 40% when measured at a point at least 300 metres from the VOR.

NOTE 1: For a conventional VOR the FM signal is fixed without respect to azimuth and is radiated omni-directionally (the 'reference phase').

NOTE 2: For a Doppler VOR the FM signal varies with respect to azimuth in an anti-clockwise direction (the 'variable phase').

3.2.2 AM Signal Modulation

This shall be a 30Hz plus or minus 1% amplitude modulated signal measured:

a) At a distance of not less than four wavelengths for a CVOR.

b) Using a carrier feed sampler or counterpoise edge / far field monitor aerial for a DVOR.

NOTE 1: For a conventional VOR this signal results from a clockwise rotating field pattern, the phase of which varies with respect to azimuth (the 'variable phase').

NOTE 2: For a Doppler VOR this signal is of constant phase with respect to azimuth and is radiated omni-directionally (the 'reference phase').

3.2.3 Identification

3.2.3.1 Each VOR shall be individually identified by a two or three letter international Morse Code group as assigned and transmitted at a rate corresponding to approximately 7 words per minute. The complete identification shall be transmitted at least 3 times in each 30 second period, equally spaced within that period. The characteristics of emission during identification shall be such as to ensure satisfactory identification at the edge of the DOC.

NOTE: If there is an associated DME, the ident transmission shall be 3 VOR idents followed by 1 DME ident. No preference is specified as to master and slave keyer; however the slave equipment must be able to switch to independent ident in the event of a fault occurring.

3.2.3.2 The Ident shall be suppressed or radiate 'TST' when the VOR is not available for operational purposes, e.g. under maintenance.

3.2.3.3 The frequency of the modulating tone for identification shall be 1020 Hz plus or minus 50 Hz.

3.2.3.4 The depth of ident modulation shall not exceed 20% on the horizontally polarised carrier frequency.

3.2.3.5 The depth of ident modulation shall be 5% plus or minus 1% when voice messages (ATIS) are broadcast.

3.2.4 **Speech Modulation**

3.2.4.1 With the exception of ATIS, no other voice communication channel shall be transmitted via the VOR system.

3.2.4.2 The peak modulation depth of the speech and ident shall not exceed 30%.

3.2.4.3 The audio frequency characteristics of the speech channel shall be within ±3 dB relative to the level at 1000 Hz over the range 300 Hz to 3000 Hz.

3.2.4.4 The transmission of speech shall not interfere with the basic navigational function.

3.2.4.5 When speech is being transmitted, the identification code shall not be suppressed.

3.2.4.6 **Recommendation:** When speech is being transmitted, the identification code should not obliterate the ATIS broadcast.

3.3 **Immunity to VHF FM Broadcasts**

The monitoring system shall provide adequate immunity to interference from two signal, third order intermodulation products caused by VHF FM broadcasting in accordance with the specifications laid down in ICAO Annex 10 Chapter 1 paragraph 3.3.8.

3.4 **Monitoring**

3.4.1 **Monitor Configuration**

3.4.1.1 A minimum of 2 independent monitors shall be used for monitoring a Doppler VOR.

3.4.1.2 Each monitor shall detect the radiated azimuth information using an external monitor antenna.

3.4.1.3 The failure of each and any of the radiating antennas or their associated circuits, shall cause an alarm to be generated.

3.4.1.4 A VOR with dual monitors shall be configured in the 'OR' mode when the main transmitter is radiating.

3.4.1.5 A VOR with dual monitors shall be configured in either the 'OR' or 'AND' modes when the standby transmitter is radiating.

3.4.1.6 The configuration of a DVOR equipment shall not allow single monitor operation.

3.4.2 **Monitor Action**

3.4.2.1 An executive site monitor shall be provided to switch off the equipment in use and, if applicable, change over to the standby system within 5 seconds if:

a) The correct identification signal is not transmitted.

b) The radiated bearing changes by more than 1 degree at the monitor site.

c) There is a change in the radiated 30 Hz amplitude modulated and/or 9960 Hz subcarrier of more than 15%.

d) A notch appears in the radiated DVOR pattern (a gap appearing in the radiated sideband pattern due to the failure of two opposite sideband aerials).

e) A malfunction or failure of the means of self monitoring occurs.

3.4.2.2 A subsequent change to the above parameters 3.4.2.1 (a) to (e) while operating on the standby transmitter shall cause the beacon to shut down.

3.4.3 **Status Indication**

3.4.3.1 A clear and unambiguous indication of the operational status of the VOR shall be reported to each Air Traffic Service Unit making use of it.

3.4.3.2 A change in status of the beacon shall be clearly reported to an appropriate location within the ATS unit in an optimum time depending on the type of service provided by and the categorisation of the beacon.

3.4.3.3 If a VOR is used for the Inbound, Initial or Intermediate stages of an instrument approach procedure, information on any change in status shall be available to ATC within 2 minutes.

3.4.3.4 If a VOR is used for the final approach and/or departure phase of an instrument procedure, information on any change in status shall be available to ATC without delay.

3.5 The equipment shall operate within the tolerances stated (3.1 to 3.4.2.2.) above when operating on a standby supply.

4 General Design Requirements

4.1 The equipment shall be subject to good design practices.

4.1.1 **Recommendation:** These should include:

a) The existence of appropriate detailed design specifications for the equipment.

b) Suitable design procedures within the supplier's organisation that ensure the design process is traceable and follows an orderly flow from concept to production models.

c) The existence of test and validation documentation including the results of the required performance testing undertaken to ensure compliance with the equipment specification.

4.2 **RF Hazards**

4.2.1 **Recommendation:** The equipment design and layout should be such that RF radiation is confined to the antenna system. A good station signal earth should be provided and every effort made to eliminate unintentional radiation from transmission lines and equipment.

4.3 **Power Supply Failure**

4.3.1 A VOR associated with published instrument approach procedures shall be equipped with an alternative power source to ensure continued operation for a minimum of 4 hours after failure of the primary supply.

4.3.2 An indication of a change to secondary supplies shall be made to the controlling authority (see 3.4 above).

5 Siting Criteria

5.1 The VOR siting shall comply (where possible) with the requirements of ICAO Annex 10, Attachment C, Part 1.

5.2 **Site Safeguarding**

5.2.1 In the absence of manufacturer's data, refer to the Technical Safeguarding section, CAP670 Part B, for appropriate guidance.

6 Commissioning and Maintenance Requirements

6.1 Ground Measurements

6.1.1 The following ground tests shall be carried out during commissioning and during subsequent routine maintenance.

6.1.2 The frequency of the following checks shall be based upon appropriate analysis, e.g. reliability analysis.

6.1.3 Ground Check Requirements

Ground check requirements are summarised in the following table:

Requirement	Standard
Carrier Frequency	Nominal Frequency.
Carrier Power	As set at commissioning or as required by flight inspection.
Field Strength	As set at commissioning or as required by flight inspection.
Modulation Frequency(s)	As set at commissioning or as required by flight inspection.
Modulation Depths	As set at commissioning or as required by flight inspection.
Sideband Power(s)	As set at commissioning or as required by flight inspection.
Monitor Aerial Azimuth Reading(s)	As set at commissioning or as required by flight inspection or flight inspection following pattern rotation (magnetic North adjustment).
Standard Monitor Parameters	Within manufacturer's specifications and readings set at commissioning or as the result of a flight check.

6.2 Monitor System

The following monitor parameters / alarms shall be tested:

a) Alarm delays.

b) Azimuth / Bearing alarms.

c) Phasing alarm / modulation frequency.

d) Reference / variable signal modulation depth alarms.

e) Failure of identification.

f) Constant ident tone and loss of identification (see master/slave requirements).

g) Carrier power alarm.

h) Sideband power alarms.

i) Carrier and sideband antenna VSWR and fault alarms.

j) Antenna notch alarms (DVOR only).

6.2.1 Executive alarms (6.2 (a) to (i)) shall cause the system to change over or fail within 5 seconds.

6.2.2 **Monitor Integrity**

6.2.2.1 All monitors shall perform a self test to ensure beacon integrity. The failure of the monitor self test or the detection of a monitor fault shall cause the beacon to shut-down or changeover in less than 30 seconds.

6.2.2.2 For dual monitor systems, the operation of each monitor shall be checked by the other. Failure of one or other of these checks shall result in the beacon shutting down within 30 seconds.

6.2.2.3 If the monitor integrity check displays an 'alarm' condition and the system is restored to operate using one monitor, the appropriate level of down grading shall be applied to the aid (i.e. NOTAM of station on reduced redundancy).

6.3 **Effective Coverage of the Beacon**

This will be determined as part of a standard flight check during the commissioning of the VOR.

VDF 01 Requirements for Flight & Ground Inspection of VHF Direction Finding (VDF) Systems

Part 1 Preliminary Material

1 Introduction

Approval under Article 104 of the ANO may be granted for a VDF used in support of ATC operation providing Navigation assistance for aircraft under their control.

2 Scope

This document details the minimum requirements for the flight inspection of VDF systems. Additional checks may be required due to poor or difficult siting conditions.

Part 2 Requirements

3 Safety Objective

The VDF equipment shall provide indications of known accuracy to ATC of the magnetic bearing to or from the VDF site of aircraft transmitting on associated aerodrome communication frequencies.

4 Functional Requirements

4.1 **Introduction**

4.2 To achieve the safety objective the accuracy and useful service area of the VDF installation shall be demonstrated by Flight Inspection.

4.3 VDF Flight Inspection shall be undertaken on Commissioning of new equipment, replacement of aerial system, relocation of equipment or other major adjustment or modification which may cause the accuracy of the equipment to be compromised, or at any other time as required by an ATSSD Engineering Inspector.

NOTE: The method of flight inspection is not specified in this publication, only the parameters to be measured. Examples of methods of flight inspection include:

a) A suitably equipped flight inspection aircraft, using an automatic or semi-automatic positioning or tracking system.

b) Positioning an aircraft over previously surveyed ground checkpoints.

c) Use of a theodolite, sympathetically positioned at the VDF antenna in order to minimise reception induced errors, tracking the target aircraft.

d) Use of Radar positioning of the aircraft in combination with ground surveyed checkpoints.

e) Use of GPS equipped aircraft, in combination with ground surveyed checkpoints.

4.4 Use can be made of any suitable method, providing that the positioning accuracy of the aircraft is better than the required accuracy of the VDF by a factor of 5, i.e. Class A / 5 = ± 0.4° aircraft positioning accuracy.

5 Required Procedures

5.1 The following activities shall be carried out during the commissioning of the VDF.

5.2 **Ground checks**

Checks to confirm the bearing accuracy shall be carried out using suitable test oscillator(s) or portable radio equipment, at previously surveyed ground points around the VDF antenna.

NOTE: Establishment of accurate test points is necessary in order to provide confidence that the alignment of the VDF is correct prior and subsequent to, flight inspection.

Recommendation: Unless otherwise advised by the VDF manufacturer, ground test points should be located every 10 degrees around the VDF antenna.

Recommendation: Periodic confirmation of the bearing accuracy, using ground checks, should be undertaken in accordance with the equipment manufacturer's recommendations.

5.3 **Checks using Aircraft**

5.3.1 The flight calibration aircraft shall complete an orbit of the VDF, measuring the actual magnetic bearing from the VDF, which shall be compared with those indicated by the direction finder display.

NOTE: It may be necessary to complete orbit flights in both directions in order to eliminate any 'lag error'.

5.3.2 The height and radius for the flight inspection is dependent on the required operational coverage for the VDF. The flight check shall take place at the limit of the required operational coverage and be at an altitude which will maintain radio line of sight, whilst observing any minimum safe altitude criteria.

5.3.3 Where the operational coverage is not specified then the limits of the VDF, with its associated communications equipment, shall be established.

NOTE: Ground and Air checks may need to be repeated if the equipment is adjusted in order to eliminate errors.

5.3.4 Areas where out of tolerance errors cannot be corrected or where VHF communication was not of sufficient quality shall be subject to further investigation. Any subsequent limitations to coverage shall be published in the UK AIP.

5.4 **Approach Procedures**

Any proposed VDF Instrument Procedures shall be flown, with confirmation obtained that the indicated bearing is within tolerance throughout the approach.

5.5 **Frequencies**

5.5.1 The foregoing 'Required Procedures' shall be carried out on the primary VDF frequency.

5.5.2 Bearing accuracy spot checks and full approach procedures shall be carried out on all other communication frequencies associated with the VDF.

5.6 **Standby power**

Checks at the ground check points shall be repeated using the standby power source, if installed.

6 Site Safeguarding

In the absence of manufacturer's data, refer to the Technical Safeguarding section, CAP670 Part B, for appropriate guidance.

7 VDF Categorisation

7.1 The results shall be assessed for categorisation using the following criteria. (ICAO Doc. 9426, Air Traffic Services Planning Manual, refers.)

Category	Range of Bearing Error
Class A	± 2 degrees.
Class B	± 5 degrees.
Class C	±10 degrees.

7.2 The results and supporting evidence shall then be submitted to ATSSD for acceptance and Approval of the facility.

Part C, Section 3 - Surveillance

1 Introduction

Section 3 of Part C contains engineering requirements for surveillance equipment and systems including aerodrome radar flight trials. Engineering and operational requirements for meteorological equipment and systems are included in this section. These documents should be used in conjunction with the Generic Requirements and Guidance contained in Part B as appropriate.

2 Scope

The 'RAD' documents cover guidelines for approval, primary, secondary and surface movement radar systems and associated equipment, including sensors, external monitor, markers, displays, video maps, and recording. Flight trials are covered by FLI 03.

The 'MET' documents cover design requirements, displays, communications, measurements and operational requirements for the observation and dissemination of meteorological information.

RAD 01 Guidelines for Radar System Approval

Part 1 Preliminary Material

1 Introduction

1.1 All ATC radar systems intended for use at civil aerodromes in the United Kingdom require approval under Article 104 of the ANO. Prior to approval the Authority require applicants to carry out a range of assessments. The scope and degree of any assessment will depend on the following aspects:

a) The complexity of the proposed system.

b) The experience and credentials of the equipment supplier and the user.

c) The safety classification of the system.

d) The 'track record' of the equipment.

e) The Operational Requirement (OR).

1.2 The Authority may supplement the requirements outlined in this document, throughout the project lifecycle, with requests to elaborate on various aspects. The Applicant is free to enquire about these at any time.

2 Scope

This document applies to all radar sensor equipment providing data for an Aerodrome ATS and requiring approval under Article 104 of the ANO. It sets out the project phases requiring the involvement of the Authority during the lifecycle of radar equipment and the requirements that the equipment must meet.

Part 2 Requirements

3 Project Lifecycle Milestones

3.1 The following stages in a radar project involve decisions which affect the final system. At these stages the Applicant should forward the documentation raised to the Authority for stage assessment:

a) Operational requirements (302).

b) Requirements capture (303).

c) Project management (304).

d) System hazard analysis (305).

e) Frequency allocation (306).

f) Design and theoretical assessment (307).

g) Radio site clearance (308).

h) Post installation support assessment (309).

i) Flight trial (310).

4 Requirements of Applicant

4.1 **Ownership**

The Applicant shall identify the ownership of and operational responsibilities for the equipment (311).

4.2 **Project responsibilities**

The following posts and lines of communication require definition.

4.2.1 **Applicant**

4.2.1.1 The person to whom the Authority will issue the approval (312).

4.2.1.2 The Applicant shall identify an appropriate contact at the Aerodrome through whom the Authority would channel requests for information (313).

4.2.2 **ATS Provider**

This person is the holder of the ANO Article 88 approval to provide the ATS service at the facility (314).

5 Hazard Analysis

5.1 The Applicant shall produce a model of how the function of the equipment is to fit within the ATC environment (315). This will consider the effects resulting from a failure or loss of integrity of the equipment and its implications for ATC safety. Such a model would derive the critical components, determine the resultant failure modes and the results of such failures. From such a model, determine the following aspects:

a) The required reliability and integrity of the system (316).

b) Maintainability requirements; e.g mean time to repair (MTTR) (317).

c) Degree of design assurance required (318).

d) The accuracy and resolution requirements of the system (319).

e) Coverage requirements (320).

f) Data handling capacity (321).

g) The Target Level of Safety (TLS) for the operational service (322).

6 Frequency Allocation and Clearance to Transmit

6.1 At this point it is usual to make a request for frequency allocation. This takes place in two parts:

a) Primary. (Frequency)

b) Secondary. (Clearance to transmit)

6.2 The Authority coordinate the allocation of codes, PRF and frequency along with the National IFF/SSR Committee and AP 8.

7 Tender Analysis

The Authority cannot, as the regulatory authority, give advice on the choice of equipment to be purchased.

8 Equipment Design Aspects

8.1 The Authority will review the documentation raised and procedures followed during the original design lifecycle.

8.2 **Functional Description**

This shall explain the function of the equipment (323) and will cover:

8.2.1 System interconnections and interconnections to items outside the sub-systems (324).

8.2.2 Performance requirements (325).

8.3 **Design Description**

This shall explain how the discrete elements of the system carry out their function (326). At this stage the assessment will ensure that integrity of the data is maintained throughout the system. Such an assessment would cover an appraisal of both the hardware and software design and include;

8.3.1 Decomposition of the design from functional description to module level. This ensures the verification of functions (327).

8.3.2 An evaluation of hardware reliability (328).

8.3.3 An evaluation of failure modes: for example, overload situations, handling of non specified inputs etc (329).

8.3.4 Description of how design decisions are derived from, or refer to, the Preliminary Hazard Analysis (330).

NOTE: The level of assessment carried out by the Authority will vary, depending on the novelty and complexity of the system. It is likely, however, that all systems will require assessment at the level of the manufacturer’s design documentation.

8.4 **Testing Regime**

Another aspect of ensuring data integrity is the testing of the system as individual packages and at various stages of integration. This assessment shall cover:

8.4.1 Testing of specified inputs for correct output (331).

8.4.2 Testing of correct operation in fault conditions (332).

8.4.3 Testing for correct handling of corrupt or non specified data (333).

8.4.4 Any testing philosophy used. For example boundary testing, path testing, branch testing etc (334).

NOTE: It will normally be necessary to evaluate the testing to the level of what tests were undertaken and assessing the results of such tests. The depth of required assessment will reflect the results of the Hazard Analysis.

9 Site Safeguarding

In the absence of manufacturer’s data, refer to the Technical Safeguarding section, CAP670 Part B, for appropriate guidance.

10 ANO Article 104(1) Approval

At this stage the Authority would normally issue ANO Article 104(1) Approval. Such approval is subject to any provisos that may result from preliminary stages. This allows pursuit of the project to the installation phase and to transmit.

11 Post Installation

Prior to entering operational service the Regional Inspector will carry out a site inspection.

12 Flight Trials

Prior to entering operational service, a flight trial is required to confirm that the radar achieves its OR (335).

NOTE: For information on the requirements for a Radar Flight Trial see FLI 03 Aerodrome Radar Flight Trial Requirements.

13 ANO Article 104(2) Approval

After the above steps, final Approval will be given under Article 104(2) of the Air Navigation Order. The approved operational purpose will be set out in the final approval document.

RAD 02 Radar Sensor Engineering Requirements

Part 1 Preliminary Material

1 Introduction

The approved use of any radar depends on various factors, including training, experience, system accuracy and system resolution. This document sets out safety requirements.

2 Scope

The following requirements cover radar sensor performance and siting aspects and apply where the sensor is to provide data for Air Traffic Services purposes.

Part 2 Requirements

3 Safety Objective

The radar sensor shall provide a complete, accurate and uncorrupted source of radar data.

4 Site Requirements

4.1 Site Effects

4.1.1 After equipment installation, possible site effects and their impact on coverage shall be assessed (336).

4.1.2 Local site obstructions shall be shown to be acceptable for the required coverage (337).

4.1.3 **Recommendation:** This should be provided by a 360 degree representation giving the elevation (in degrees) of any obstruction versus bearing and a 'line of sight' coverage chart for several target heights based on these radar obstructions and using the Radar earth curvature (338).

4.1.4 To provide Surveillance Radar Approach (SRA) procedures the radar head shall be within 37 km of the Missed Approach Point, for each runway (339).

4.2 Site Safeguarding

In the absence of manufacturer's data, refer to the Technical Safeguarding section, CAP670 Part B, for appropriate guidance.

5 Site Restrictions

Access to the radar and associated equipment shall be restricted such that the availability of the Air Traffic Service is not compromised accidentally or otherwise (340).

6 Aerial Support Structure

6.1 The stability of the aerial tower affects the system performance, especially clutter reduction and radar return position accuracy. The aerial stability limits allocated to the tower shall be justified (341). An analysis of the tower structure must show that limits are met at the stated operating wind speed and ice loading (342). The assessment method chosen shall be in accordance with the relevant standards and requirements in force (343).

6.2 **Recommendation:** The aerial support structure should be constructed to survive the excesses of once in 50 years wind speed (344).

7 Environmental Conditions

7.1 The design and testing regime shall demonstrate that the equipment operates as required in the chosen environment (345).

7.2 **Recommendation:** All radar transmission equipment should be located in a controlled environment with appropriate heat dissipation and dust control (346).

8 Transmitter Requirements

8.1 Primary Frequency Bands

8.1.1 The following bands shall be used (347):

590 MHz to 598 MHz (50 cm)	medium/long range radar services.
1215 MHz to 1365 MHz (23 cm)	medium/long range radar services.
2700 MHz to 3100 MHz (10 cm)	short/medium range radar services.
9000 MHz to 9200 MHz and 9300 MHz to 9500 MHz (3 cm)	short range radar services.
15.4GHz to 15.7GHz (GMR)	very short range radar services.
34.5GHz to 35.5GHz (ASMI)	very short range radar services.

8.2 Primary Frequency Tolerance

8.2.1 The following stability tolerances shall be applied (348):

Frequency Band	Stability Tolerance
590 MHz–1365 MHz	within 500 ppm
2700 MHz–9500 MHz	within 1250 ppm
15.4 GHz–35.5 GHz	within 5000 ppm

8.2.2 Details of transmitter frequency stability shall be stated (349). A temperature chamber shall be used to exercise the transmitter over the full specified temperature range (350). A practical trial of ageing effects shall show that the inspection intervals are consistent with the required stability (351).

8.3 SSR Frequency Bands

The frequency of the SSR transmitter shall be 1030 MHz (352).

NOTE: The transmitting frequency of the transponder (air to ground or from a SSR Site Monitor) is 1090 MHz.

8.4 SSR Frequency Tolerance

8.4.1 The output transmitter carrier frequency shall have a tolerance of ±0.2 MHz (353).

8.4.2 The carrier frequencies of the control transmissions and each of the interrogation transmissions shall not differ from each other by more than 0.2 MHz (354).

NOTE: The transponder output carrier frequency tolerance (ground to air or from SSR Site Monitor) is ±3 MHz.

8.5 **Allowable Spectrum**

8.5.1 For Primary radar, the level of any spurious component shall be either 50dB down on the mean power in bandwidth or less than 100 mW, whichever results in the least spurious output (355).

NOTE: A spurious component is one outside the necessary bandwidth.

8.5.2 The bandwidth required shall be justified (356).

NOTE: A theoretical or practical evaluation of the frequency components of the output pulse could take the form of a Fourier transform of the theoretical output waveforms or a practical trial based on a spectrum analysis. In either case the evaluation should include the effects of tolerances on pulse spacing and duration and system non-linearity.

8.5.3 The equipment shall generate the output pulse patterns to minimise the bandwidth required (357).

8.5.4 The emission classification as defined in the ITU Radio Regulations Article 4 shall be stated (358).

8.5.5 For SSR, the spurious radiation of CW shall not exceed -76 dBW (359).

8.6 **Radio Frequency Interference**

8.6.1 Existing services have operating priority. The existing electromagnetic environment in which the equipment is to operate shall be assessed to ensure that the proposed equipment will comply with all requirements (360).

NOTE: If, after installation, a new service experiences interference from an existing service, modification of the new service must normally take place. The only exceptions are if the other service voluntarily agrees to change, or is in itself deficient and was installed after the EMC Directive 89/336/EMC came into force.

8.6.2 **Recommendation:** All reasonable steps should be taken to reduce the effect of interference (361).

8.6.3 For SSR, ICAO Annex 10, Vol. 4 Chapter 2 requires the incorporation of sidelobe suppression under paragraph 2.1.2.4.1 and 2.1.2.4.2 (362).

9 Spurious Return Reduction

9.1 All spurious return reduction techniques shall be defined and justified (363).

NOTE: Spurious returns include clutter, garble, spurious reflections etc.

9.2 For SSR, the response of SSR ground equipment to signals not within the receiver pass band shall be at least 60dB below the normal sensitivity (364).

10 Accuracy

10.1 **General**

10.1.1 When used for surveillance radar approach (SRA) purpose (i.e. primary only), the accuracy shall be better than 1 degree of bearing and 55 Metres, + 5% of target range (365).

10.1.2 When used for radar separation, the intended minimum separation standard shall be justified (366).

10.1.3 To ensure that the equipment provided can support this requirement, the radar accuracy distribution shall be defined and justified (367).

NOTE 1: Accuracy requirements are based on the Target Level of Safety (TLS) concept. These are in constant development by the ICAO General Concept of Separation Panel. The requirements in this document will be maintained in line with ICAO requirements.

NOTE 2: The TLS concept requires the determination of the probability distribution of target position. The TLS then relates how the distributions from two targets overlap. The probability of overlap should be less than the target level of safety. For information purposes Figure 1 shows the relationship between the accuracy distribution and this portion of the TLS.

10.1.4 The worst combination of error distributions shall achieve the TLS (368).

NOTE: For the system configurations covered by this document the required TLS, expressed as the probability of horizontal overlap due to loss of accuracy, is generally accepted to be 7×10^{-7} per event (i.e. two adjacent targets) which uses the radar separation minimum. The TLS depends on the operational purpose of the system.

10.2 Accuracy Determination

To assess a radar system using Figure 1, several aspects shall be determined:

10.2.1 The systems that produce the radar data used for separation shall be assessed (369).

10.2.2 For a remote secondary surveillance radar (SSR) used in conjunction with a local primary the following errors shall be assessed:

a) Error in slant range correction, if applied (370).

b) Error in prediction of position due to differing scan rates (427).

c) Error due to the curvature of the earth when transferring the centre of one volume to another centre (428).

d) Stability and accuracy of original plots (429).

e) Tolerance error in detected position of site marker (430).

f) Provision of SSR and/or Primary marker (431).

g) Allowable error in combination box (432).

h) The plot delay shall be acceptable in respect of the Operational Requirement (OR) (433). This assessment shall consider both the mean delay and the distribution of the delay (434).

10.2.3 **Recommendation:** The error in range and bearing between the following should be less than ± 2 degrees in azimuth and ± 3% of target range:

a) The aircraft position reported by SSR and primary radar (435).

b) The reported SSR monitor position and the video map (436).

c) The reported SSR monitor position and the known monitor position (437).

10.2.4 **Recommendation:** The maximum time in store for the radar data should not exceed the time taken for 90 degrees of aerial rotation (438).

10.3 Plot extractor effects

10.3.1 The algorithm chosen to determine the centre and run time of the target shall be defined and justified (439).

10.3.2 The effect of the plot extractor on resolution and the accuracy error budget together with theoretical justification shall be defined (440).

NOTE: This is not necessary where the intention is to use the SSR purely as an overlay for height separation purposes.

10.3.3 The processing precision shall be sufficient to meet the error budget for the system accuracy and resolution (441).

10.3.4 If plot processing is used (i.e. to decrease the effect of garbling and reflection) any effect on detection shall be defined and justified (442).

10.3.5 The position of the radar relative to the coverage volume desired shall be justified (443).

NOTE: If the radar head is not at the centre of the desired cover the error may differ in each sector.

10.3.6 The distribution of any misalignment errors between two sensors shall be justified (444).

10.3.7 Where two sensors are not co-sited (for example, assigned services) the analysis shall include the position conversion error (445).

10.4 Radar System Beamwidth

10.4.1 A system beamwidth plot ±10 degrees of bore-sight or 40 dB down on peak power, whichever the plot reaches first, shall be developed (446).

10.4.2 In systems that rely on multiple beam patterns, the plot shall show the interaction of the beam patterns (447).

10.4.3 In systems that have user adjustable beamwidth, methods recommended for the assessment of changes shall be stated (448).

10.4.4 **Recommendation:** Demonstration of the beam patterns should be carried out on a test range (449).

10.4.5 The effect of beamwidth on accuracy, resolution, system loading and garbling shall be defined and justified (450).

10.5 Rotation Rate

10.5.1 The effect of rotation rate on system performance shall be defined and justified (451).

10.5.2 A primary radar providing the positional data for the following services shall rotate at the following effective minimum turning rates:

a) General TMA Zone and approach work, a rotation rate of 5 RPM (452).

b) SRA to 2 NM, a rotation rate of 10 RPM (453).

c) SRA to 1 NM, a rotation rate of 15 RPM (454).

d) SRA to 0.5 NM, a rotation rate of 20 RPM (455).

11 Resolution

For 3 NM separation the equipment shall resolve two targets at 1 NM separation and for 5NM separation the equipment shall resolve two targets at 3NM, both to a probability of 95% or greater throughout the required azimuth and range as defined in the OR (456).

NOTE: It is likely that any areas not meeting this figure are the result of the relative location of the Radar Sensor to the traffic pattern. Such degradation can only be permitted if special rules are proposed for the separation of traffic for these areas.

12 Coverage

12.1 General

12.1.1 Coverage defines the areas that can support the provision of radar services to aircraft as defined in Manual of Air Traffic Services Part 1 (CAP 493). These areas shall be in the OR (457).

12.1.2 The radars shall have a theoretical coverage, in the areas of the OR, which corresponds to 80% detection of the returns from a $1m^2$ target. This increases to 90% for areas providing SRA procedures. For primary targets this theoretical cover shall assume Swerling case 1 targets (458).

NOTE: This coverage requirement applies to both primary and SSR sensors if separation standards between primary, reinforced and SSR only plot positions are applied.

12.1.3 Primary and SSR sensors shall have their performance continuously monitored (459). An alarm shall be raised when coverage cannot be met (460).

12.1.4 Where the use of the primary radar system includes SRA approaches the coverage shall be suitable for the termination distance (461).

12.1.5 **Recommendation:** The radar service coverage should extend as shown in Figure 2 (462).

12.2 SSR Coverage

12.2.1 For services that use SSR for separation purposes a formal coverage specification shall be constructed (463).

NOTE: Where the provision of the SSR service is for an overlay only service, to aid target identification, no formal coverage specification is required.

12.2.2 The output power of SSR or primary radar shall not exceed the approved level (464).

12.2.3 For the secondary radar system details of the link power budget shall be defined (465). This link budget shall show that the system achieves coverage in both range and elevation (466).

12.2.4 Where interrogation side lobe suppression (ISLS) is used, the amplitude of P2 shall be between 0dB and +3dB above the nominal greatest sidelobe level (467). The amplitude of P2 shall be greater than 9dB below the nominal level of P1 in the main beam (468).

12.2.5 Where improved interrogation sidelobe suppression (IISLS) is used, in addition to the requirements of 12.2.4, the level of P1 shall be within 3dB of P2 (469).

12.2.6 The control channel response shall be greater than 3dB above the response of the interrogator channel outside the nominal boresight angle for receiver sidelobe suppression (RSLS) (470).

12.2.7 The pulse spacing shall comply, where appropriate, with Section 3.1.1.4 and Section 3.1.2 of ICAO Annex 10, Vol. IV, Chapter 3 (471).

12.2.8 Where the equipment uses reflection suppression, the effects of this on system performance shall be defined and justified (472).

12.2.9 The de-garble capacity and performance of SSR extractors for the amount of traffic and the separation standard required shall be justified (473).

13 Data Handling Requirements

13.1 Data Storage Capacity

13.1.1 The OR shall consider the required processing load in terms of:

a) The number of aircraft targets expected (474). This shall be based on overall load and sector peaks (475). This load shall include all targets within the coverage of the sensor (476).

b) The worst case weather conditions (477).

c) Any roads within the radar coverage (478).

d) Any fixed clutter patterns (479).

13.1.2 During operational trials the equipment shall monitor the processor and memory loading distribution of each sub-system (480).

13.1.3 **Recommendation:** The probability of 100% processing load in any sub-system should be less than 0.01 (481).

13.2 Data Precision

13.2.1 The data precision used shall be consistent with the positioning performance required from the system (482).

13.2.2 **Recommendation:** ASTERIX format is recommended for data interchange (483).

NOTE: ASTERIX format is mandated by EUROCONTROL for data interchange between centres.

13.3 Data Integrity

13.3.1 The system data shall achieve the operationally required level of integrity (484).

13.3.2 The equipment shall contain error detection systems to ensure appropriate data integrity during operation (485).

NOTE: An integrity loss has the effect of reducing the accuracy of the presented information.

13.4 Radar Source Identification

13.4.1 To ensure that any radar data processing equipment connected to the sensor can correctly identify the source of the data, the chosen data transmission standard shall support source identification (486).

13.4.2 Identification codes shall be unique (487).

NOTE: The allocation of identification codes is entirely at the discretion of the Applicant, with regard to the codes already in use in the system.

14 Radar Recording

Any radar service used in first line Distress and Diversion shall be fitted with radar recording equipment (488).

15 Default Parameters

All default values shall be stated (489).

NOTE 1: Default settings control such items as filter settings, clutter level defaults, fixed arithmetic offsets, feedback loops etc.

NOTE 2: This does not apply to arithmetic constants fixed in the equipment design.

16 Monitoring Requirements

16.1 All radar systems shall have methods available to determine the alignment (490).

16.2 For an analogue primary radar the system shall use appropriate video outputs to check the range/bearing error based on Permanent Echoes (PE) (491). The controller or maintenance engineer shall check such figures at suitable intervals (492).

16.3 The system shall identify at least three PE, each separated by more than 60 degrees (493). Each PE must be at a range greater than one third of the standard display range (494). In addition the separation of each PE from other permanent features must be at least 3 degrees in azimuth and ±0.5 nautical mile in range (495).

16.4 Where an analogue only channel is not provided and therefore PEs cannot be displayed, an active test target (MTI runway marker) shall be used for alignment checking (496).

16.5 The position of any active test target (MTI runway marker) shall be as near to threshold as practical (497).

NOTE: For systems that use SSR in conjunction with primary, there are further options. First, that the SSR system has an independent site monitor. Second, that there is a procedure in place to determine the collimation error between the secondary and the primary data. This procedure can take the form of the ATC operator checking the errors on screen, or equipment that checks the error. Such a check could be part of the Plot Assignor/Combiner equipment.

16.6 The SSR site transponder and monitoring system shall monitor those radar parameters which affect detection, performance, accuracy or resolution (498).

17 Remote Control & Monitoring System (RCMS)

17.1 Annex 11 to the International Convention on Civil Aviation (ICAO) requires that a procedure be in place that informs ATS units of the operational status of the equipment used for controlling take-off, departure and approach to land. The system shall report any failures that will put restrictions on the performance or abilities of the equipment (499). How the system achieves this shall be defined and justified (500).

NOTE: An electronic system or a procedural reporting method from the maintenance department or to ATC can be used.

17.2 If a failure of a sub-system occurs, the remote control and monitoring system or the manual reporting system shall record a hard copy of the event (501). It shall indicate, where possible, the cause of the event (502).

17.3 The RCMS information required depends on the configuration, and the ATS providers intention to provide service in reduced redundancy. However, the following minimum information shall be available:

a) An indication of present operating configuration (503).

b) An indication of unavailable sub-systems (504).

17.4 The RCMS shall enable the operator to select the correct course of action. The intended operating procedures shall be submitted for approval (505).

17.5 Any configuration changes undertaken by remote control shall not conflict with local control (506).

18 Reliability

18.1 General

18.1.1 The reliability of the radar sensor as appropriate to the OR shall be justified (507).

18.1.2 The expected reliability either from theoretical analysis or a practical trial shall be demonstrated (508). This reliability assessment shall extend to the power supplies and landlines (509). The reliability analysis shall be combined with a hazard analysis to produce a functionally based reliability analysis (510).

18.1.3 The reliability assessment shall state the method chosen and the chosen environment (511).

19 Mean Time to Repair (MTTR)

19.1 The mean time to repair shall be specified and justifiably appropriate to the OR (512).

19.2 **Recommendation:** Mean time to repair of 1 hr (513).

19.3 When operating in reduced redundancy the system provider shall show that adequate safety mechanisms exist (514), including:

a) Equipment identifies that no standby is available (515).

b) Maintenance procedures identify the priority for repair that must occur (516).

c) Operating procedures identify the smooth transition to another service type in the case of loss of remaining equipment (517).

19.4 The documentation and skills/training necessary to achieve repair times shall be defined (518).

19.5 The maximum time taken to establish full operating conditions following a power supply interruption shall be justified (519).

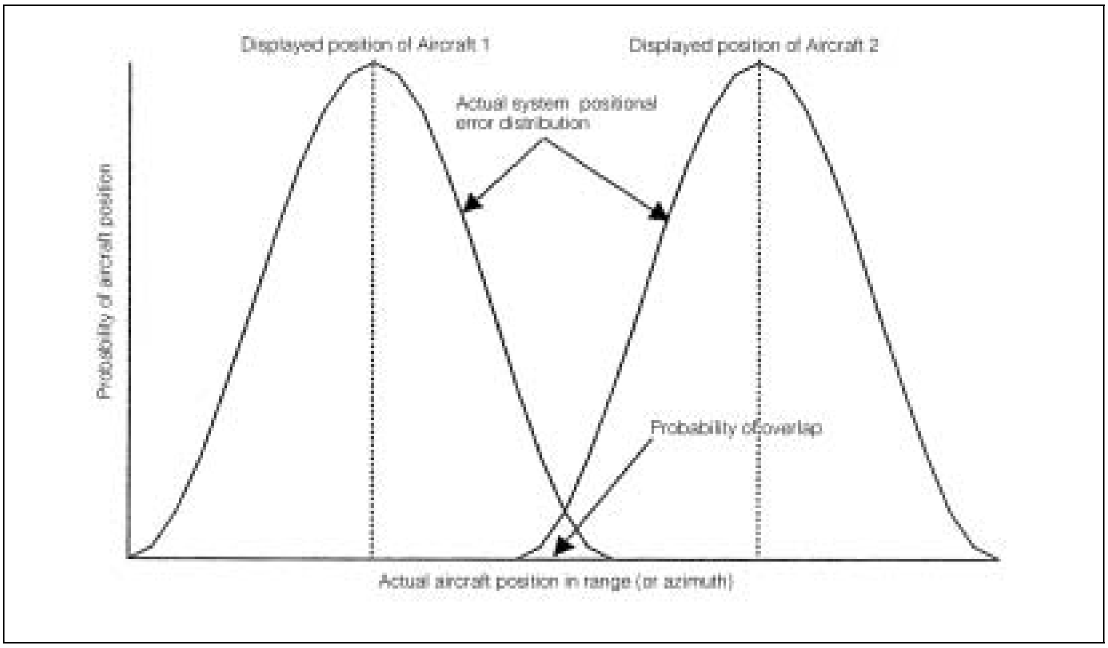

Figure 1 Accuracy Distribution and the Target Level of Safety

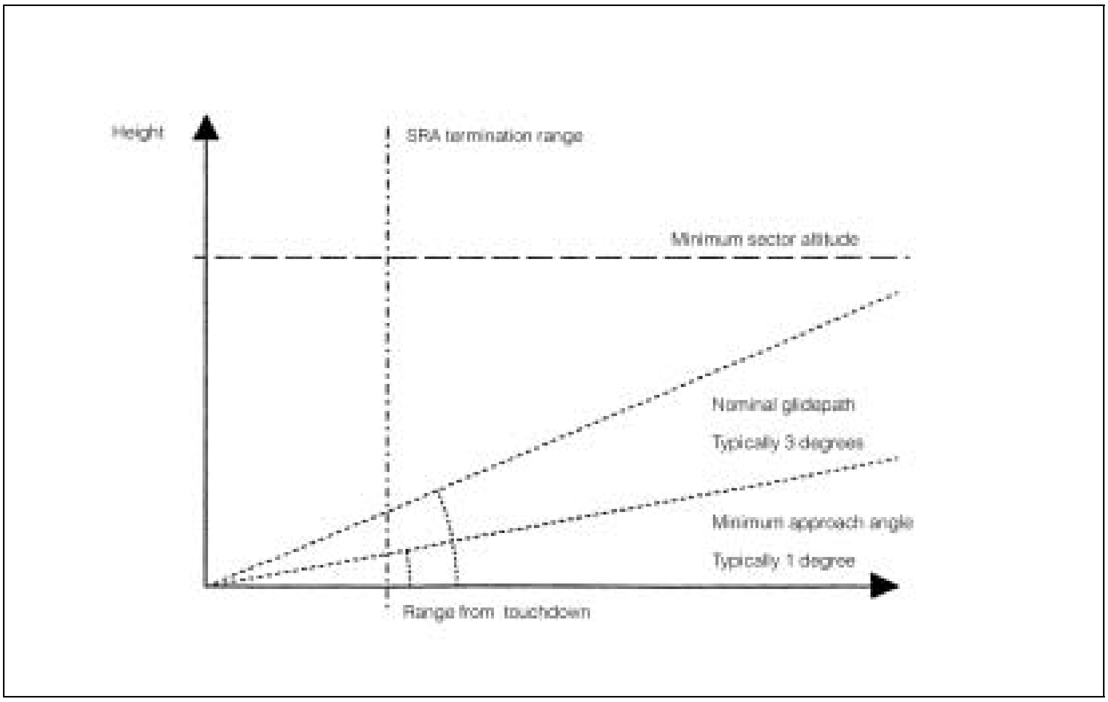

Figure 2 SRA Vertical Coverage

20 Electro Magnetic Compatibility

20.1 Radio transmitting equipment must comply with the EMC Regulations (520)

20.2 Please refer to Part B Section 4, GEN 04 for further information.

RAD 03 SSR External Monitor Engineering Requirements

Part 1 Preliminary Material

1 Introduction

An external SSR monitor may be required for range and accuracy checking of the SSR transmissions, as determined by ICAO Annex 10 Vol. IV, Chapter 3 Section 3.1.1.10 (521).

2 Scope

This document sets out the required functions, positioning and operating conditions of SSR external monitoring equipment.

Part 2 Requirements

3 Safety Objective

The external monitor shall provide accurate reference information to test the transmission, reception and decoding characteristics of the SSR service in conjunction with the range and azimuth accuracy of the ground interrogator (1710).

4 Functional Requirements

4.1 If the SSR service is to be used without a primary radar, an external site monitor shall be provided (522).

4.2 The external monitoring equipment shall continuously monitor those radar parameters which affect detection performance, accuracy or resolution (523).

NOTE: This includes parameters such as the following:

a) Target bearing.

b) Target range.

c) Peak power.

d) Side Lobe Suppression.

e) Pulse spacing.

5 Siting Requirements

5.1 The positioning of the SSR monitor will depend on the use of the equipment.

5.1.1 **Recommendation:** Where the controller uses the monitor to assess collimation errors the monitor should be sited within the range that the ATS operators can view. The bearing chosen should correspond to an area of airspace commensurate with the operational situation; the position should not conflict with operationally sensitive areas (524).

NOTE: This does not imply that the controller should continuously check the position. Merely that a suitable range setting be available to the controller.

5.1.2 **Recommendation:** Where an equipment sub-system, under the control of the user, uses the monitor to assess collimation errors, the monitor shall be within the nominal coverage of the radar. If the monitor is at a range greater than the normal range displayed to the controller, a reporting procedure shall be in place (525).

5.1.3 **Recommendation:** Where a sub-system, not under the control of the user, uses the monitor to assess collimation errors, the monitor shall be within the nominal coverage of the radar. If the monitor position is outside the normal defined area displayed to the remote controller, a reporting procedure shall be in place. This procedure shall report alarms from the system provider to the service user. The originator of the service, not the remote user, shall identify and notify the remote users of any collimation errors determined (526).

5.2 **Recommendation:** The SSR monitor should be located at a range greater than 4 km from the radar head, unless otherwise justified (527).

5.3 **Recommendation:** The monitor should be set up to report its true position in range. This allows easier co-ordination with other users. Where operational considerations make this undesirable, the monitor should not be visible from any other operational radar service (528).

NOTE: If this is not possible, a written agreement to the installation shall be obtained from the owners of the affected systems (529).

5.4 The Mode A code for the SSR Site Monitor shall be 7777 unless specific approval is granted for a different code (530).

RAD 04 Primary Approach Radar Markers Engineering Requirements

Part 1 Preliminary Material

1 Introduction

When a primary airport radar is intended to be used for Surveillance Radar Approaches (SRA), a particular configuration of fixed returns or markers is required (531). This document sets out the requirements for siting of these markers.

2 Scope

This document applies to all radar sensor equipment providing data used at an Aerodrome for SRA procedures and requiring approval under Article 104 of the ANO.

Part 2 Requirements

3 Safety Objective

To confirm the correct position of the SRA approach line (1711).

4 Marker Requirements

Any radar fitted with a processor to extract fixed clutter will not see passive targets, therefore, one of the following shall be provided:

a) A raw radar feed for calibration purposes. This feed shall be independently aligned with the processed radar feed (532).

b) An active test marker (533).

c) Areas of radar coverage which are inhibited from processing (534).

5 Required Marker Siting

5.1 There are no requirements for extra markers for an SRA with termination range of 2 NM or greater from threshold (535).

5.2 For approach radar services providing SRA less than 2 NM but not less than 1 NM, bracket markers are not required. However, centreline markers, as described in 5.3.1.1, shall be provided (536).

5.3 For approach radar services providing SRA less than 1 NM, two sets of markers shall be provided (537):

5.3.1 A set of centreline markers (538).

5.3.1.1 Centreline Marker Siting

There shall be two non-permanent markers available (539). These shall be located as follows:

a) Within 2 degrees of the applicable approach centreline (540).

b) Between 3 and 6 NM of the applicable touchdown point (541).

c) Not within 1 NM of each other (542).

NOTE: For airports with reciprocal approaches, one permanent marker on each approach path may be used.

5.3.2 A set of bracket markers (543).

5.3.2.1 Bracket Marker Siting

There shall be two permanent markers available that enable the identification of runway touchdown point (544). These permanent markers shall be positioned equidistant from the runway centreline at the instrument touchdown point (545). The distance from the runway edge shall be the minimum commensurate with runway operations but not closer than 15 metres from the runway edge (546).

5.3.2.2 As this site is within the clear and graded area, the support structure shall be frangible and less than 0.9 metres high above local ground level (547).

6 Use of Markers

6.1 The sets of markers shall allow the controller to confirm the correct position of the SRA approach line (548).

6.2 **Recommendation:** The marker system should contain an active monitor that checks the primary radar performance (549).

Such primary radar monitors should evaluate:

a) Primary radar spectrum (550).

b) Primary radar power level (551).

c) Primary radar beamwidth (552).

RAD 05 Radar Display Engineering Requirements

Part 1 Preliminary Material

1 Introduction

1.1 When a radar display is intended for use for Air Traffic Control purposes it must comply with safety standards.

1.2 This document sets out the technical requirements relating to those safety standards that are concerned with the approved use of radar displays by Air Traffic Control units.

2 Scope

This document applies to all display equipment used for the presentation of radar derived position and identification data used for the provision of Air Traffic Services.

Part 2 Requirements

3 Safety Objective

The radar display system shall preserve the accuracy, availability and integrity of the input data and reproduce it in an unambiguous and clear manner (1712).

4 Display Characteristics

4.1 The following shall be assessed to determine suitability/appropriateness for the operational requirement:

a) Screen area and corresponding displayed range (553).

b) The number of display lines (554).

Recommendation: The number of lines should be greater than 1000*1000 (555).

c) Linearity and screen astigmatism (556).

d) Frame refresh rate (557).

Recommendation: Frame refresh should be 75 Hz (or greater), non-interlaced (558).

e) Selection of synthetic phosphor decay (559).

f) Ability to display system status information (560).

g) The chosen display brightness and luminance and their variation (561).

h) The ambient lighting (562).

i) The colour set shall be assessed as appropriate for the operational requirement (563).

Recommendation: Some colours should be reserved for future requirements (564).

j) A system shall be in place that allows the colour set to be calibrated (565).

k) Colour calibration checks shall be carried out at intervals appropriate to the system stability (566).

5 Symbology

5.1 The symbology set selected shall be assessed for suitability to the OR (567).

NOTE: The on-screen positioning of menu selection and video map symbology is of particular importance.

5.2 **Recommendation:** The equipment should not display any symbol indicating the position of particular filtered targets (568).

5.3 **Special Purpose Codes**

5.3.1 The equipment shall draw the attention of the controller by flashing the associate label if it detects one of the emergency codes listed below (569):

7700 : SOS

7600 : RT FAIL

7500 : HIJACK

5.3.2 **Recommendation:** An audible alarm should also be sounded (570).

5.3.3 **Recommendation:** The equipment should display both the emergency code and the previous callsign or code if unconverted (571).

5.4 Symbol Size

Recommendation: The symbol size should not vary with displayed range (572).

NOTE: Some features, map features for example, will be scaled according to their significance on the displayed ranges.

5.5 Leader Lines

Where the display automatically moves the labels to various positions (to prevent label overlapping) the equipment shall provide leader lines (573).

5.6 Contrast Control

Recommendation: The display contrast control should not be made available to ATC staff (574).

NOTE: The adjustment should be available to Engineering staff.

6 Engineering Design

6.1 The display specification shall be related to the operational requirement both in functional and performance terms (575).

6.2 Allowable error budgets for the display system shall be calculated and justified (576).

6.3 System Parameters

6.3.1 The following parameters shall be specified and justified in relation to the OR, technical specification and hazard analysis, as appropriate:

a) Resolution (577).

b) Accuracy (578).

c) Precision (579).

d) Max/Min ranges (580).

e) Data load ('analogue' plus 'synthetic') and processing time. If the equipment is subjected to a high data load the operator shall be given a warning of the data that is shed (581).

Recommendation: For systems using remote SSR data for overlay, data discard should take place progressively from long range (582).

f) MTBF (583).

g) MTTR (584).

h) Input type. Analogue, data formats, data transmission rates (585).

i) Environmental performance (586).

j) EMC performance (587).

k) Quality standards applicable to equipment design, both hardware and software, shall be stated (588).

l) Correct identification of radar source by validating radar source code (589).

m) Identification of appropriate data input faults. This information shall be indicated within one radar scan interval (590).

7 Functional Parameters

7.1 Input Selection

The system shall be capable of showing the source of all data that the controller has selected for display on the radar display (591).

7.1.1 **Recommendation:** If a remote SSR data source is used the radar identification code should be decoded and displayed on the screen (592).

7.1.2 Return to default settings shall be achievable via the 'top level' menu (593).

7.2 The region of the boundary where composite picture processing is being used shall be indicated (594).

NOTE: This is to indicate the area where track wander may occur.

7.3 Display of QNH

7.3.1 The display shall be capable of displaying QNH values (595).

7.3.2 Any manual changes to this value shall be validated by double entry (596).

7.3.3 When it is possible to change the QNH remotely, the equipment shall require the change to be drawn to the controller's attention and confirmed on all other displays (597).

7.4 Target Filtering

7.4.1 When the equipment can filter out targets by area, type or height, the equipment shall be capable of displaying the parameters of such filters (598).

7.4.2 **Recommendation:** Equipment should be fitted with a filter override allowing all targets to be displayed quickly (599).

7.5 Brightness

7.5.1 The brightness range, both overall and for individual screen elements, shall be restricted to the range determined in the colour assessment trial (600).

NOTE: It should not be possible to delete radar targets completely by use of this control.

7.5.2 **Recommendation:** Target and map brightness should be independently variable (601).

7.6 **Recommendation:** The equipment should have the following operator functions:

a) Selection of display ranges (602).

b) Display off centre (603).

c) Choice of maps (604).

d) Range rings on/off (605).

e) Choice of leader line length, SSR label block rotation and positioning (606).

f) Prediction data, code/callsign selectivity (607).

g) Choice of character size (608).

h) Menu selection/positioning (609).

i) Acceptance of error/alert messages (610).

7.7 Data Recording Facilities

Recommendation: The equipment should be fitted with facilities to record the data and display settings in line with the requirements detailed in RAD 09 (611).

RAD 06 Aerodrome Traffic Monitor Safety Requirements

Part 1 Preliminary Material

1 Introduction

The aerodrome traffic monitor equipment must be approved by the CAA under Article 104 of the ANO (612). The aerodrome traffic monitor is also known as the Distance From Threshold Indicator (DFTI).

2 Scope

This document applies to all radar sensor equipment providing data for an aerodrome ATS. The following requirements are applicable for the installation and use of equipment provided for the aerodrome traffic monitor. This document covers all systems using local or remote data.

Part 2 Requirements

3 Safety Objective

The aerodrome traffic monitor shall provide accurate and uncorrupted data for the confirmation of aircraft position and identity (1713).

4 Performance Requirements

4.1 **Range**

In normal operation the aerodrome traffic monitor shall not display traffic more than 20 miles and not less than 10 miles from the runway touchdown (613).

NOTE: The system may operate at longer ranges only for a 'quick look' function.

4.2 **Accuracy**

The radar position displayed shall be within 0.5 NM of the true aircraft position (614).

4.3 **Coverage**

The radars used for display shall detect targets down to at least 200 feet below the minimum sector altitude. In the runway approach zone the radar shall detect targets down to 100 feet below the nominal glide angle to the terminating range (615).

5 Functional Requirements

5.1 **Runway Selection**

5.1.1 **Recommendation:** The system should be capable of automatic adjustment of range and centre on runway change (616).

5.2 **Video Maps**

5.2.1 The display shall show the runway centreline (617).

5.2.2 **Recommendation:** The system should indicate ranges from the radar touchdown in 1 NM increments (618).

5.2.3 The video map shall indicate the threshold position (619).

5.3 **Data Source**

NOTE: The aerodrome traffic monitor may obtain data from any combination of remote/local/secondary radar that meets the coverage and accuracy requirements.

5.3.1 **Recommendation:** If labelled aerodrome traffic monitor is provided, handover procedures should positively identify all targets (620).

5.4 **Resolution**

5.4.1 The equipment shall resolve two targets at 1 NM separation (621).

5.4.2 The labels shall not cross at 2 NM separation (622).

5.5 **Track Guidance**

Recommendation: Prediction vectors or trail dots should be used to indicate approach speed (623).

6 Display

6.1 Display Size

Recommendation: A screen size capable of displaying a circle of at least 6 inches (15 cm) diameter (624).

6.2 Readability

6.2.1 The display shall be readable in all ambient light conditions (625).

6.2.2 The display shall be readable over a range of viewing angles, both vertically and horizontally (626).

6.2.3 **Recommendation:** Displays requiring viewing hoods should not be used (627).

NOTE: High intensity daylight viewing displays and/or brightness controls fitted to the equipment can achieve the same effect.

6.3 Colour Display

6.3.1 Colour shall not be used for information coding (628).

NOTE: Displays may use colour but only in conjunction with brightness and symbology to aid de-cluttering of screen information.

6.3.2 **Recommendation:** Where displays use colour for decluttering, it should be ensured that the contrast control is not available in normal use (629).

6.4 Position

6.4.1 The aerodrome traffic monitor equipment shall be positioned so that the operational controller can easily note and act on the information shown (630).

6.4.2 **Recommendation:** The screen should be located at the operational position (631).

6.5 Display Orientation

NOTE 1: The orientation of the picture in relation to the view from the VCR will depend on the tasks carried out by the Controller.

At a unit where the controller has clearly defined and fairly narrow tasks to perform the orientation is to be such that the runway on the aerodrome traffic monitor is aligned with the view of the runway from the control position (632).

NOTE 2: At units where the task is broader in nature, the large number of factors having an effect on the alignment of the aerodrome traffic monitor requires each case to be considered on its merits. Advice on orientation should be sought from the Authority (633).

RAD 07 Ergonomic Aspects for Radar Display Systems

Part 1 Preliminary Material

1 Introduction

1.1 All radar systems require an input device to enable the operator to configure the display as required (634).

1.2 This interface clearly affects the efficiency of the operator and can affect the safety of operation. An assessment must be carried out to confirm the adequacy of the chosen design (635).

2 Scope

The following document explains a suitable method of specifying and testing the adequacy of the Human Machine Interface (HMI). It applies to all displays used for presenting Air Traffic Service's (ATS) radar data at aerodromes and subject to approval under Air Navigation Order Article 104.

Part 2 Requirements

3 Safety Objective

To ensure operation of radar displays is unambiguous and does not compromise the safety of the Air Traffic Service (1714).

4 The Specification of the Radar Display HMI

4.1 **Operational Requirement**

The specific operational requirement (OR) for the equipment shall be defined (636).

4.2 **Evaluation**

4.2.1 A formal ergonomic evaluation shall be carried out to ensure that the safety of the ATS is not compromised (637).

4.3 **HMI Definition**

The following stages are recommended in the definition of an HMI. In each case, the impact on ATC should be assessed and justified with respect to the OR and the Safety Objective (638).

4.3.1 **Recommendation:** The activities that the system should perform should be defined (639).

4.3.2 **Recommendation:** The events that can occur that require a cognitive or perceptive response should be defined (640).

4.3.3 **Recommendation:** The tasks that the system should accomplish in order to respond to the events and activities should be defined (641).

4.3.4 **Recommendation:** The tasks should be ranked in order of priority according to the OR (642).

5 Functional and Performance Requirements

5.1 **Confirmation of Activation**

5.1.1 The input device shall give immediate confirmation of selection (643).

NOTE: This does not mean that the equipment shall carry out the function selected immediately.

5.2 **Selection Time**

5.2.1 The selection time shall correlate with the priority level (644).

NOTE: This is defined as the time between first confirmation of activation and function available.

5.2.2 **Recommendation:** The following are recommended:

a) Less than 1 sec for high priority (645).

b) Less than 5 sec for medium priority (646).

c) Not defined for low priority (647).

NOTE: Other times may be justified as appropriate to the specific OR.

5.3 **Wait Indication**

5.3.1 The system shall indicate its indeterminate state during the time between confirmation of activation and function available (648).

5.3.2 **Recommendation:** All input should be prohibited, except cancellation, during this wait period (649).

5.4 **Traceability of Device Specification**

Recommendation: The mechanical performance of all input devices should be specified to a recognised test standard (650).

6 Input Devices Technical Requirements

6.1 **Safety Objective**

The input devices shall not mislead or hinder the operator or be capable of unintended action (651)**.**

6.2 **General**

The following requirements and recommendations are made in respect to specific input devices. These devices shall be appropriate to the task, have consistent performance characteristics and facilitate ease of use (652).

6.3 **Recommendation:** All input devices on the workstation should have appropriate characteristics. Specific regard should be made to the following:

a) Size of input device (653).

b) Separation between input devices (654).

c) Feedback method – aural, tactile or visual, as appropriate (655).

d) Displacement, e.g. push distance (656).

e) Labelling (657).

f) Actuating force (658).

g) Suitability to task (659).

h) Response time (660).

6.4 **Recommendation:** The equipment should not use rotary selection switches to select more than 10 discrete positions (661).

6.5 **Recommendation:** The equipment should not use thumbwheels for high or medium priority controls (662).

6.6 **Recommendation:** Non-tactile switches should activate on the first activation. This is equivalent to the down stroke (663).

NOTE: Non-tactile switches that have no displacement feedback: Examples include infra-red touch-panels, magnetic pick-up, capacitive pick up etc.

6.7 **Recommendation:** Equipment should not use lever switches to select more than 3 discrete positions (664).

6.8 **Menus**

6.8.1 All menus shall be appropriately positioned (665).

6.8.2 **Recommendation:** Menus should not impede the primary task (666).

6.8.3 **Recommendation:** Equipment should locate each high priority function not lower than the second page of any menu (667).

6.8.4 **Recommendation:** Equipment should locate each medium priority function not lower than the third page of any menu (668).

6.8.5 **Recommendation:** Each page should have an available selection to return up one level, return to top level and exit (669).

6.8.6 **Recommendation:** All functions should be by positive selection (670).

RAD 08 Video Map Generation Equipment Requirements

Part 1 Preliminary Material

1 Introduction

1.1 All radar display systems have a method of providing the controller with reference information. This allows a controller to determine the relationship between aircraft position and ground or airspace positions.

1.2 Although such systems can take various configurations, the procedures surrounding the systems will all take the same form.

2 Scope

2.1 This document applies to all radar display equipment providing data for Air Traffic Services (ATS) and requiring approval under the Air Navigation Order (ANO).

2.2 This document covers all equipment used to produce or display information making up the fixed radar video map. This includes overhead projection, etched plates, independent video map generators or on-system video maps.

2.3 This document also covers the following areas:

a) Procedures for the update control of video map data.

b) Responsibilities for the update of video map data.

c) Recommendations for the co-ordinate system used for transfer of data.

Part 2 Requirements

3 Safety Objective

The video map generation equipment shall provide complete and accurate reference data for ATS (1715).

4 Procedure for Production and Update of Video Maps

4.1 Video map generation shall be subject to formal configuration management (671).

4.2 Each map or generation of map shall be given a unique identifying label (672). The map as displayed on the equipment shall display this label (673). In addition, documentation shall use this label to show the origin and contents of the information used on the map (674).

4.2.1 **Recommendation:** A suitably qualified engineer should carry out this function (675).

4.3 The individual elements to be included on the map shall be identified and documented in the Operational Requirement (676).

4.3.1 **Recommendation:** The definition of such elements should be in terms of ATS requirements. These elements should include the following:

a) Visual reporting points (677).

b) Adjacent airfields (678).

c) Adjacent areas of flying activity. For example, hang gliding sites, parachuting sites, etc (679).

d) Danger areas, prohibited areas etc (680).

e) Limits of controlled airspace (681).

f) Runway extended centrelines (682).

g) Map north marker (683).

NOTE: For certain ATS units additional points may be required.

4.3.2 **Recommendation:** A member of the ATC Department should carry out Step 4.3 and 4.3.1 (684).

4.3.3 The identified features shall be referenced to defined geodetic coordinates (685). In addition, the procedure shall state the geodetic system used to define these geographical locations (686).

4.3.4 **Recommendation:** The procedure should define the conversion of the geographical co-ordinates to the system geometry. It should also state the algorithms or processes used to convert this data (687).

4.3.5 **Recommendation:** A suitably qualified engineer should carry out Steps 4.3.3. and 4.3.4 (688).

4.4 **Verification**

4.4.1 Provisions shall be made to check the displayed data for accuracy and completeness (689).

4.4.2 The original production or change request shall be compared with the resulting map information (690).

4.4.3 **Recommendation:** This should include a procedure for checking the absolute accuracy of the displayed maps (691).

4.4.4 **Recommendation:** A member of the ATC Department should carry out the verification (692).

4.5 **Validation**

4.5.1 The final user shall evaluate the whole map prior to introduction to service (693).

4.5.2 **Recommendation:** A member of the ATC Department should carry out the validation (694).

4.6 A procedure shall exist to ensure that the map always contains all operationally significant information (695).

5 Responsibilities for Control of Video Maps

The video map documentation shall identify all posts responsible for the control of the video maps (696).

6 Tolerances on Video Map features

6.1 For a display used for SRA, all features used in the SRA zone shall be accurate to within 5% of range scale +55 metres (180 feet) in range and within 1 degree measured from the airfield reference point (697).

6.1.1 **Recommendation:** For raster scan display systems, all features should be accurate to within the resolution of the display (698).

6.2 For all other features accuracy shall be within 450 metres (0.25 NM) (699).

7 Evaluation of Video Maps

7.1 **New Video Maps**

7.1.1 At least three features of new video maps shall have the accuracy assessed as part of the flight trial for the equipment. (700) The tolerance on this accuracy shall be better than 900 metres (0.5 NM) (701).

7.1.2 **Recommendation:** These features should, wherever possible, be in three quadrants of the display (702).

NOTE: A new video map has no predecessor. Sites which have new radar or map generation equipment produce new maps.

7.1.3 **Recommendation:** The accuracy assessment should ensure that the features shown correspond identically to those displayed at adjacent ATC units (703).

NOTE: Co-ordination between adjacent units is an important ATC function.

7.1.4 **Recommendation:** Coordination should be evaluated whenever opportunity occurs (704).

7.2 **New Surveillance Radar Approach (SRA) Maps**

7.2.1 New SRA maps shall be assessed for bearing and range error at 6 NM, 3 NM, 2 NM, 1 NM and 0.5 NM as appropriate to the intended SRA termination range (705). The assessment shall be by use of an aircraft with independent positioning equipment on board an aircraft or fixed ground mounted reflection sources (706).

7.2.2 **Recommendation:** Internal or external positioning equipment may be used to determine aircraft position, for example, theodolite or INS etc (707).

7.3 **Updated Video Maps or SRA Maps**

Recommendation: Methods independent of the original source should be used for proof of changes which are independent of the original source (708).

8 Consideration on Mapping Co-ordinate System

NOTE: When producing video maps the aim is to place the feature at the position where the radar sensor would place a co-located target. However, as the radar calculates by range and angle, this will not account for the change in angle between grid north and magnetic north. In addition all systems use published geographical co-ordinates to derive the feature position in range angle. Use of a different system to convert the geographical co-ordinates from that used to derive the original geographical co-ordinates, will produce an error. The procedures in Sections 4, 6 and 7 will evaluate these errors.

Recommendation: The video maps should be in WGS84 format (709).

RAD 09 Radar Recording Equipment Requirements

Part 1 Preliminary Material

1 Introduction

The use of radar recording equipment falls into three areas:

a) The provision of data for post accident or post incident investigation.

b) To provide location data in the event of search and rescue.

c) For use in testing the performance of the radar sensor, processor and display system .

2 Scope

This document applies to all radar sensor equipment providing data for ATS and where radar recording equipment is required under Article 104 of the ANO.

Part 2 Requirements

3 Safety Objective

To provide data to assist with the maintenance or improvement of safety (1716).

4 System Performance

4.1 The data recording system used shall not degrade the performance of the radar display and processing system (710).

NOTE: Degradation includes any effect on the data integrity, the update rate, plot delay or plot handling capacity.

4.2 **Time source**

Radar recording equipment shall have an accurate time source fitted (711).

4.2.1 **Recommendation:** This time source should be synchronised with the main station time source and thus to Universal Time (Coordinated)(UTC time) (712).

4.2.2 The radar recording time source shall be synchronised with the main station time source to a tolerance of within ± 5 seconds (713).

4.3 **Data recording**

4.3.1 The radar recording equipment shall record both primary and secondary radar data (714).

NOTE: This applies whether the data is analogue or plot extracted.

4.3.2 The radar recorder shall record the following data as received from the radar sensor:

a) The plot position relative to a known datum (715).

b) Mode A, C and S data, where appropriate (716).

c) Type of plot, for example PRI only, SSR only, combined or assigned (717).

d) Time of plot (718).

e) Radar source (719).

4.3.3 **Recommendation:** The recorder should incorporate features to ensure continuity between recordings (720).

4.4 **Data integrity**

4.4.1 The device used for radar recording shall not be capable of erasing any recorded data (721).

4.4.2 **Recommendation:** Erasure equipment should be separate from the recording apparatus (722).

4.4.3 The error rate of the recording equipment shall be defined and justified (723).

NOTE: The recording system may use any suitable recording medium that meets the storage time and data interval time specified in this document.

4.4.4 **Recommendation:** The reading and verification of data recorded should detect record errors (724).

4.5 Radar Recorder Storage Procedures

The following operating procedures shall be in place at sites where radar recorders are mandatory:

4.5.1 The recorded data shall be kept for a minimum of thirty days after the end of the recording, or longer periods as directed (725).

4.5.2 Suitable storage precautions shall be taken for the prevention of the deterioration, theft, damage or tampering with the stored data (726).

4.5.3 Suitable measures shall ensure that:

a) No recording is erased within 30 days (727).

b) All access to the stored data is recorded (728).

c) Authority under which any recorded radar data leaves the site for replay or duplication is recorded (729).

d) The identity of the person or organisation taking charge of the recorded radar data is recorded (730).

4.6 Access to Original Records

The appropriate requirements and guidance are contained in Manual of Air Traffic Services Part 1.

5 Playback Functions and Facilities

5.1 **Recommendation:** The radar recording and radio telephone (RTF) recording equipment should be integrated to allow synchronised play-back (731).

5.2 **Recommendation:** Radar recording and play-back equipment should be integrated into the display equipment (732).

5.3 **Recommendation:** The data recorded should allow the replay equipment to replicate the overall data presented to the controller. This includes the following:

a) Map in use (733).

b) Range in use (734).

c) Display brightness (735).

d) Error messages (736).

e) Display windows (737).

f) System settings, character size (738).

g) Range offsets in use (739).

h) Display orientation (740).

5.4 **Recommendation:** Equipment should be provided to allow replay and duplication of recorded data. Duplicate copies must be marked clearly to this effect (741).

5.5 The use of replay and duplication functions shall not cause a break in the recording (742).

5.6 **Recommendation:** The play-back equipment should be capable of producing hard copy of the recorded aircraft tracks (743).

5.7 **Recommendation:** Provisions should be included that enable the replay of recorded radar data near to the control position within a short interval of an event occurring. Actual times may vary with the event and a strategy should be devised to ensure that an appropriate response can be made (744).

NOTE: To enable, for example, the use of recorded data for search and rescue purposes.

RAD 10 Surface Movement Radar Systems Requirements

Part 1 Preliminary Material

1 Introduction

This document refers to the equipment requirements and operational usage of the Surface Movement Radar (SMR) element. A SMR is usually a form of specialised primary radar with the option of secondary surveillance radar (SSR) elements or dynamic tracking with manual labelling.

2 Scope

This document only relates to those SMR systems based around the use of a suitable single sensor primary radar. The requirements apply to all equipment approved under Article 104 of the Air Navigation Order.

Part 2 Requirements

3 Safety Objective

To provide clear and unambiguous radar data to aid in the guidance and control of airport surface traffic (1717).

4 The Surface Movement Guidance and Control (SMGC) System

4.1 The SMGC system comprises the following elements:

a) Visual and non-visual aids.

b) Radio telephony communication.

c) Operating procedures.

d) Control and information facilities.

4.2 **Recommendation:** All elements of the SMGC should be located at the SMR control position (745).

5 Performance Requirements for SMR

5.1 **Display Functions**

5.1.1 The display shall be usable in a daylight environment (746).

5.1.2 **Recommendation:** SMR systems should display the 'raw' radar return to show the traffic position (747).

5.1.3 **Recommendation:** All display systems should give historical trail information, with the amount of 'trail' appropriate to the OR (748).

5.1.4 **Recommendation:** The equipment should display ranges between 1 NM and 6 NM and have range offset controls (749).

5.1.5 **Recommendation:** The equipment should suppress information from non-operational areas (750).

5.1.6 **Recommendation:** The display size should allow discrimination between targets spaced at one quarter of the minimum visual feature size (751).

NOTE 1: The display may use colours to aid discrimination between:

a) Moving and stationary targets and

b) True data and overlaid information (maps etc).

NOTE 2: The use of colour for information coding is not allowed (752).

5.2 **Coverage**

5.2.1 The coverage shall extend over a range and azimuth sufficient to cover the manoeuvring area (753).

5.2.2 The vertical coverage shall be suitable for monitoring all airport traffic on the ground (754).

5.3 **Target Detection**

5.3.1 The system shall be capable of detecting targets as necessary within the coverage as defined in the OR (755).

5.3.2 **Recommendation:** The system should provide a detection capability of 90%. A target size should be chosen appropriate to the size of traffic found in the manoeuvring area and the target orientation distribution. A target size of 1 m^2 is recommended (756).

NOTE: All practical systems will exhibit some areas of poor detection capability. Such areas are allowed if the training of staff and the operating procedures account for them.

5.4 **Shadowing**

5.4.1 Any radar shadowing shall be mapped and verified (757).

5.4.2 **Recommendation:** Operational use should take account of both dynamic and static shadowing (758).

5.5 **Resolution**

Recommendation: The system should resolve two targets located at a distance equivalent to one quarter of the minimum visual feature size (759).

5.6 **Accuracy**

Recommendation: The radar should establish the position of a target to within one quarter of the minimum visual feature size (760).

5.7 **Mapping**

Recommendation: The system should provide calibrated maps that indicate the location of the following airport features:

a) Stop bars (761).

b) Block junctions used for holding airport traffic (762).

c) Runway LVP protected areas (763).

d) ILS critical areas (if relevant) (764).

e) Radio Site restriction areas (if relevant) (765).

f) Location of fixed obstructions (766).

g) Alignment marks (767).

h) The manoeuvring area (768).

i) Areas next to the manoeuvring area (769).

5.8 **Information Rate**

5.8.1 The information update rate shall be appropriate to the speed of airport traffic and the minimum visual feature size (770).

5.8.2 **Recommendation:** The aerial rotation rate should be at least 60 RPM (771).

5.9 **Data Delay**

Recommendation: The equipment should present the data to the controller within a period equivalent to one quarter of the revolution rate of the aerial (772).

5.10 **Weather**

5.10.1 The radar shall achieve the required performance in the worst weather in which routine operations are likely to continue (773).

5.10.2 **Recommendation:** The equipment should be specified to survive the '1 in 50 years' extremes of weather (774).

RAD 11 Airport Remote Radar Feeds Engineering Requirements

Part 1 Preliminary Material

1 Introduction

1.1 For the provision of particular radar data, for example, secondary surveillance radar (SSR), it may be appropriate to use shared data sources. This data is termed 'onward routed radar data'. Such data can be used, for example, to provide additional coverage.

1.2 The equipment used to convey this remote data from source to destination is termed a radar data link.

2 Scope

2.1 This document details the aspects that must be considered before installing a radar data link system.

2.2 The requirements apply to the following data elements:

a) Target identification.

b) Target position.

c) Target type (where appropriate, for example vehicles, 'angels' etc.).

d) System configuration information. This includes, as appropriate:

   i) Selected polarisation.

   ii) Radar channel selected.

   iii) Pulse length selected.

   iv) Radar antenna tilt.

e) Radar monitoring and fault indication.

Part 2 Requirements

3 Safety Objective

The remote radar feed shall provide complete and uncorrupted data so that the safety of the Air Traffic Service utilising it is not compromised (1718).

4 Radar Data Links General Requirements

4.1 General parameters

The suitability of the link shall be assessed against the operational requirement (OR) (775) and shall include the following aspects:

a) Link integrity and interference (776).

b) Link data rate and capacity (777).

c) Link distortion and effect on accuracy (778).

d) Link delay (779).

e) Link reliability (780).

f) Data resolution on link (781).

4.1.1 **Recommendation:** The actual performance as regards bit rate, bit error rate, transmission delay and availability should be defined and justified when compared with the required acceptable performance in the Operational Requirement (782).

5 Availability, Integrity and Interference

5.1 Availability

5.1.1 The availability of the equipment shall be defined and justifiable for the air traffic service being provided (783).

5.1.2 **Recommendation:** Duplicate data paths should be implemented to increase the availability (784).

5.1.3 **Recommendation:** A Failure Modes and Effect Criticality Analysis (FMECA) should be carried out to ensure that the design meets the overall reliability requirement set out in the OR (785).

5.2 Radio Link

5.2.1 Where radio links are used, the 'line of sight' path of the link shall be safeguarded (786).

5.2.2 **Recommendation:** Radio links should not cross active runways, taxi-ways, railways or roadways. This is due to the change of path characteristics in the presence of aircraft or large service vehicles (787).

5.3 Data Integrity

The possibility of integrity errors arising during any reformatting by the encoder or conversion of the data at a data link interface shall be determined (788).

5.4 **Interference**

5.4.1 The effects of pick-up of false signals including radio frequency interference, magnetic and electrostatic fields shall be determined (789).

5.4.2 **Recommendation:** The occurrences of false targets should not exceed once per revolution (790).

5.4.3 **Recommendation:** Error detection and correction algorithms should be used to check for data corruption (791).

5.5 **Status Indications**

5.5.1 The system shall provide warning indications for line loss and system status (792).

5.5.2 **Recommendation:** The equipment should send to the remote user all data link fault reports and warnings that are sent to the local user (793).

NOTE: This includes the status of the radar data link equipment and the status of the radar providing the radar information.

5.6 **Reconfiguration of Remote Services**

Procedures shall be in place that require the remote supplier to supply details to the recipient of any optimisation or planned outages of the source radar system that may affect the supplied data (794). Any changes shall be assessed formally to determine the effect on the OR (795).

NOTE 1: It is likely that the owner of the remote service will optimise the system for their own purposes.

NOTE 2: Approval may be required before these changes are implemented or used operationally.

6 Link Data Format, Rate and Capacity

6.1 Correct operation of all data transformations shall be tested under all data formats used (796).

6.2 **Data Format and Overflow**

6.2.1 **Recommendation:** It is recommended that the format of data control messages follows the proposed ASTERIX EUROCONTROL Standard (PES) SUR.ET1.ST05.2000-STD-01-01 (797).

6.2.2 The system shall be capable of detecting an overload situation on the link (798). The system shall provide information that allows the display or other system to advise the controller of this situation (799).

NOTE 1: The overload detection system may be manual or automatic. A typical manual system would require the controller to log the number of data overload warnings. A typical automatic system would monitor the number of digital words on the link or messages queued on the link.

NOTE 2: The digital data link may be used for transmission of other data such as telephone traffic or CCTV. In such circumstances the plot load assessment should consider all these services.

6.3 **Data Capacity**

The link bandwidth shall be determined and shown that it has sufficient capability of transmitting the data required to satisfy the OR (800).

7 Link Distortion and Effect on Accuracy

7.1 Video Signal Stability

The offset drift and dynamic range of the link shall be compatible with the data level (801).

7.2 Link Delay

The worst case data delay through the system shall be defined and be justified as being acceptable (802).

FLI 03 Aerodrome Radar Flight Trial Requirements

Part 1 Preliminary Material

1 Introduction

Aerodrome radar systems require flight trials testing to be carried out before an Air Navigation Order (ANO) Article 104 Approval can be granted (803). The following document details the requirements for such flight trials.

2 Scope

This document applies to all radar sensor equipment providing data for an aerodrome Air Traffic Service (ATS) and requiring approval under Article 104 of the ANO.

Part 2 Requirements

3 Safety Objective

To test in a practical manner that the aerodrome radar system meets its Operational Requirement (OR) (1719).

4 General Requirements

4.1 The system performance as defined in the OR shall be confirmed using an aircraft 'target' and a general traffic study (804). As the system provides a large coverage volume, tests shall be conducted to prove the basic volume, with detailed analysis in operationally significant areas (805).

NOTE: Such significant areas will include, as appropriate:

a) Radar handover areas.

b) Holding areas.

c) Typical airway routes.

d) Areas with clutter or reflection problems.

e) Upper and lower bounds of operational cover.

f) The approach.

4.1.1 **Recommendation** Standard manoeuvres and manoeuvres that test the boundaries of allowable procedures should be included (806).

4.2 The flight trial shall assess the radar sensor in all the configurations intended for Operational use (807).

NOTE: Such configurations may include main/standby transmitters, diversity/non-diversity, polarisation settings, etc.

4.2.1 **Recommendation** The flight trials should consist of dedicated flying and a general traffic study (808).

NOTE 1: Such flying may require the applicant to consider:

a) The flight profiles.

b) The recording conventions used with illustrative examples.

c) The responsibilities of all those involved. For example the assessing pilot, controller etc.

d) The co-ordination with other ATC units for the flying profiles selected.

NOTE 2: Co-ordination ensures the minimum of disruption to the required profiles.

4.3 The flight trial shall determine the accuracy and resolution of the system (809).

5 Coverage check

5.1 Basic Coverage Check

5.1.1 The flight trial shall contain an appropriate series of slices to demonstrate the vertical lobe structure of the radar (810).

5.1.2 **Recommendation:** The Applicant should include slices at 1000, 2000, 4000, 6000, 10000, 20000 ft above the aerodrome reference point and as appropriate to the OR (811).

5.1.3 **Recommendation:** A 360-degree orbit at a suitable range should be carried out at a level equivalent to the base of required coverage. Any tangential fade should be recorded (812).

5.1.4 **Recommendation:** Target returns registered in each block of airspace should be recorded and analysed in order to identify areas of anomalous replies (813).

6 Accuracy Assessment

6.1 General Accuracy Requirements

6.1.1 The flight trial shall assess the accuracy of the system in the areas of operational significance (814).

6.1.2 The errors in the collection and recording of data shall be calculated and justified (815).

NOTE: This may include:

a) The resolution error in any recording devices.

b) The error in the equipment used to determine the aircraft position.

6.1.3 **Recommendation** The flight trial should produce at least five error profiles in each of the following areas:

a) The Approach (816).

b) Each Holding Area (817).

c) Each radar handover area (818).

6.1.4 In areas requiring separation standards the flight trial shall demonstrate that the appropriate Target Level of Safety (TLS) can be achieved for the required separation standards (819).

NOTE: The radar sensor specification document (RAD 02) details the method of determining the TLS.

6.2 Accuracy Assessment for SRA Procedures

6.2.1 2 NM SRA

There are no additional accuracy requirements.

6.2.2 0.5 NM or 1 NM SRA

The following accuracy assessment is required for any radar intended for use for such procedures:

a) Angular error shall be less than ±1 degree (820).

b) Range error shall be less than ±55 + 0.05R metres where 'R' is the range of the respective range check point (821).

6.2.2.1 For each SRA procedure intended, a minimum of 3 aircraft or helicopter tracked approaches shall be carried out (822).

6.2.2.2 Where 0.5 NM SRA is proposed, for each approach the target position shall be recorded at threshold, 0.5 NM, 1 NM, 2 NM and 3 NM from touchdown and compared against the controller reported position (823).

6.2.2.3 **Recommendation:** For SRAs terminating at 1NM or greater, for each approach the target position should be recorded at 0.5 NM, 1 NM, 2 NM and 3 NM from touchdown and compared against the controller reported position (824).

NOTE 1: To assist in the selection of appropriate range points these ranges can be ± 0.25 NM.

NOTE 2: The following is a suitable method for obtaining the aircraft position:

a) Bearing by use of theodolite tracking of a suitably equipped aircraft using trained operators from an approved flight check organisation.

b) Range checking by use of visual reporting points.

6.3 Assessment of Maps and Permanent Echoes (PE)

6.3.1 As part of the flight trial the accuracy of the video maps and PE shall be confirmed (825). In the case of the maps a number of significant map features shall be chosen and a suitable reference shall be determined for each feature (826).

6.3.2 **Recommendation:** PE should be selected taking the following factors into account:

a) There should be at least 3 PE, each separated by more than 60 degrees (827).

b) Each PE should not extend over more than 2 degrees of bearing (828).

c) Each identified PE should be at least 5 degrees away from other fixed clutter (829).

d) Each identified PE should be at greater than one third the standard displayed range (830).

7 Resolution Assessment

7.1 The flight trial shall assess the resolution capability of the system in terms of the minimum separation standards as required in the OR (831).

7.2 The resolution capability of the system shall be evaluated in both 'standard' areas and areas of clutter and reflections (832).

MET 01 General Engineering Design Requirements for Meteorological Equipment

Part 1 Preliminary Material

1 Introduction

This document provides general requirements and recommendations covering all meteorological systems installed on UK aerodromes. The content is designed to ensure that any meteorological installation meets the requirements of its safety objective, when used in combination with the accompanying MET engineering requirement documents.

2 Scope

2.1 This document details the performance criteria and safeguarding of meteorological equipment installed in the UK and intended for use in the provision of an Air Traffic Service.

2.2 The purpose of this document is to ensure the Applicant has considered and taken any appropriate action on those aspects that affect the safety of services provided and supported by a facility.

Part 2 Requirements

3 Safety Objective

To provide accurate and reliable meteorological forecasts.

4 General Design Requirements

4.1 **General**

The equipment installed shall have been designed following good design practices.

These shall include:

a) The existence of appropriate detailed technical design specifications for the equipment.

b) The presence and use of suitable design procedures within the supplier's organisation that ensure the design process is traceable and follows an orderly flow from concept of design to production.

c) Calibration standards traceable to an International Standard.

d) The existence of test and validation documentation including the results of the required performance testing, undertaken to ensure compliance with the equipment design specification.

4.2 Wherever possible the system shall be designed to detect internal or systematic faults and shall fail to a safe state.

4.3 **Environmental Operating Conditions**

4.3.1 Systems shall recover to their calibrated specifications from specified meteorological extreme conditions that may occur in the UK, but which are outside the norm for airfield operations.

4.3.2 Sensors and equipment installed within the environment to be measured, shall operate within and recover to the tolerance values specified in their engineering requirements over the following range of environmental conditions and safety/ operating requirements (unless stated within the appropriate requirement document):

Environmental Condition	In Tolerance Operating Range	Recoverable Range
Temperature	minus 25° C to plus 50° C	minus 30° C to plus 70° C
Pressure	900 to 1050 mb (hPa)	850 to 1200 mb (hPa)
Humidity	5 to 100% RH condensing	0 to 100% RH condensing
Windspeed	0 to 100 knots	0 to 130 knots
Rain intensity	150mm.hours-1 (with a 40 knot wind)	200mm.hours-1 (with a 50 knot wind)

Safety/Operating Requirements	Standard / Performance
Electromagnetic Compatibility	Emissions EN61000-6-3 #1 Immunity EN61000-6-2 #2
Protection	IP65 #3 IP54 #4
Lightning Protection	EN60570

NOTE: #1 EN50081-1 will be superseded by EN61000-6-3 but can continue to be used until the date of withdrawal.
#2 EN50082-2 will be superseded by EN61000-6-2 but can continue to be used until the date of withdrawal.
#3 For electronic enclosures where the sensor element may be mounted externally.
#4 For enclosures protected from the environment by an external shield or enclosure.

4.3.3 Equipment installed inside buildings shall operate within and recover to the tolerance values specified in their engineering requirements over the following range of environmental conditions and safety/operating requirements (unless stated within the appropriate requirement document):

Environmental Condition	In Tolerance Operating Range	Recoverable Range
Temperature	0 to +40°C	-10 to +60°C Ambient air temperature in direct sunlight
Pressure	900 to 1050 mb (hPa)	850 to 1200 mb (hPa)
Humidity	0 to 90% RH non-condensing	

Safety/Operating Requirements	Standard / Performance	Recoverable Performance
Lightning Protection	EN60570	
Electromagnetic Compatibility	Emissions EN61000-6-3 #1 Immunity EN61000-6-2 #2	
Vibration	0.25G @ 1 to 500 Hz	0.5G @ 1 to 500 Hz

4.3.4 The instrument housing shall be designed to prevent atmospheric influences and radiation errors from affecting the parameters measured by the installed sensor(s), whilst allowing a free flow of air across the sensor(s), to enable the sensor to represent the ambient environment.

5 Installation & Maintenance Requirements

5.1 The equipment shall operate, and be maintained, in a manner which fulfils the defined operational purpose in all respects.

5.2 The frequency of calibration checks, replacement and servicing intervals shall be specified and based on reliability analysis data and the operating environment.

5.3 Re-calibration shall be traceable through a recognised accreditation scheme such as NAMAS.

6 Off-Shore Environment

The installation shall meet the 'I.E.E. Recommendations for the Electrical and Electronic Equipment of Mobile and Fixed Off-shore Installations', Latest Edition.

NOTE: The off-shore environment may place restrictions on the equipment and its ability to meet the above requirements. Applicants should seek guidance from the Met. Authority and if necessary dispensation from the Authority (CAA) under these circumstances.

7 Meteorological Information Records

7.1 Where automated (or semi-automated) observing systems are in use, the equipment shall be capable of producing a printed record of observation reports produced during the preceding 30 days.

7.1.1 The equipment shall be capable of producing a printed post-incident meteorological report in compliance with MATS Part 1, Section 6, Chapter 1, Paragraph 5.

7.1.2 In order to assist in incident investigation, the equipment shall be capable of producing a report of the meteorological conditions prevailing during the preceding 30 days.

The data shall be recorded at intervals of no greater than 60 seconds.

MET 02 Engineering Requirements for Ground Based Meteorological Displays

Part 1 Preliminary Material

1 Introduction

It is a requirement that all meteorological displays installed on UK aerodromes meet the operational requirements of the system and preserve the integrity of the data.

2 Scope

2.1 This document details the performance criteria and installation of meteorological display equipment in the UK, intended for use in the provision of an Air Traffic Service.

2.2 The purpose of this document is to ensure the Applicant has considered and taken account of those aspects that affect the safety of services provided and supported by a facility.

Part 2 Requirements

3 Safety Objective

The equipment shall provide a timely, accurate and uncorrupted display of meteorological information to aid in the safe and expeditious flow of civil air traffic.

4 Display Performance Requirements

4.1 Displays (General)

The display device shall be designed in such a way as to draw the attention of the operator to significant changes in the displayed meteorological information. (A significant change is defined within the relevant sensor engineering requirements.)

4.2 Integrated Multi-Function Displays

4.2.1 On aerodromes with multiple wind sensors, the display shall clearly indicate the sensor or location from which the meteorological information is derived.

4.2.2 Numeric or graphical displays used to display other forms of meteorological information shall provide a clear indication of function and assignment.

4.2.3 A suitable method for indicator testing and controlling display luminance shall be provided.

4.2.4 Fully integrated multi-function displays used in connection with safety related equipment shall show station time to within plus or minus 5 seconds.

NOTE: An area of the screen may be made available for the display of supplementary information. Examples are listed in ICAO Annex 3 Chapter 4.

5 Siting Criteria

The display equipment shall be installed in a position such that it remains readable in all ambient light levels.

MET 03 Engineering Requirements Meteorological Site Communications

Part 1 Preliminary Material

1 Introduction

It is a requirement that all meteorological communication equipment installed on UK aerodromes meet the operational requirements of the system.

2 Scope

2.1 This document details the performance criteria and safeguarding of meteorological equipment installed in the UK and intended for use in the provision of an Air Traffic Service.

2.2 The purpose of this document is to ensure the Applicant has considered and taken account of those aspects that affect the safety of services provided and supported by a facility.

Part 2 Requirements

3 Safety Objective

The equipment shall facilitate a timely, accurate and uncorrupted source of valid meteorological information to aid in the safe and expeditious flow of civil air traffic.

4 Communications Performance Requirements

4.1 The communication system shall have error checking mechanisms in place to verify in a timely manner the reliability and availability of real-time data transmitted by an appropriate technique.

NOTE: For example: parity checks (Hamming code or similar) for digital systems.

4.2 Where the system is considered to provide safety related information, the cabling and connection systems shall be of a suitable standard. All other systems shall show due regard for communication integrity.

4.3 Where data is transmitted via radio links, frequency protection, data encryption and interference protection techniques shall be addressed as part of the system integrity studies.

MET 04 Engineering Requirements for Surface Wind Speed and Direction Measurement

Part 1 Preliminary Material

1 Introduction

It is a requirement that all surface wind measurement sensors installed on UK aerodromes meet the requirements of ICAO Annex 3 and CAP 670 and their defined operational requirements.

2 Scope

2.1 This document details the performance criteria and safeguarding of surface wind measurement equipment installed in the UK and intended for use in the provision of an Air Traffic Service.

2.2 The purpose of this document is to ensure the Applicant has considered and taken account of those aspects that affect the safety of services provided and supported by a facility.

2.3 The purpose of this document is also to ensure that the reports disseminated off the airport in METAR code are in compliance with ICAO Annex 3 requirements and the information used by ATC for landings and take-offs are in compliance with the requirements in CAP 670.

Part 2 Requirements

3 Safety Objective

The wind speed and direction measuring equipment shall have a level of performance which is able to provide an accurate and uncorrupted representative measurement of wind speed and direction.

3.1 Wind Speed & Direction Sensor Accuracy

3.1.1 The wind speed measurement shall be to an accuracy of within plus or minus 1 knot (or plus or minus 10 per cent for wind speeds in excess of 10 knots) of the actual wind speed (whichever is the greater) over the range 3 to 100 knots.

3.1.2 With wind speeds in excess of 3 knots, the wind direction system shall be capable of producing an overall accuracy better than plus or minus 10 degrees, including 'dead band'.

3.1.3 The sensor shall be sampled at a minimum sample rate of four per second.

3.1.4 If wind variation information is processed at the sensor head or in a remote processing unit, samples / averages shall be transmitted at a minimum rate of once per second.

3.1.5 Systems relying on polled sampling, shall ensure the complete data word from the remote sensor is sampled at a minimum of once every second.

3.1.6 The equipment shall measure a 3 second gust as a rolling average of the wind speed samples.

3.1.7 The equipment shall produce 2 and 10 minute rolling averages of the wind speed and direction.

3.1.8 The algorithms used for the production of the averages shall be defined.

3.1.9 The average direction displayed shall take regard of the numerical discontinuity at North.

NOTE: METAR data is referenced to True North, not Magnetic North as used by ATC.

3.2 Wind Speed & Direction Sensor Resolution for Analogue & Digital Systems

3.2.1 Resolution shall be greater than 1 knot, as sent to the display device and 1 knot, rounded to the nearest knot, on the display.

3.2.2 The sensor shall produce a minimum resolution of 6 degrees.

4 Monitoring

4.1 Monitoring Action

The equipment shall be self monitoring and shall provide a suitable indication of equipment status and serviceability.

4.2 Monitor and Monitoring Configuration

4.2.1 The display shall present a clear and unambiguous indication of the operational status of the sensor system to the user, in a format applicable to the proposed installation.

4.2.2 The system shall be designed to fail safe.

5 Displays

5.1 The display device shall be designed in such a way as to draw the attention of the operator to significant reportable changes in the displayed surface wind information.

5.2 The display shall provide information compliant with the ICAO Annex 3 Chapter 4.5.5 requirements for marked discontinuity, wind variation and wind speed (gusts).

5.3 On aerodromes with multiple runways, the display shall indicate the sensor selected (or indicate the runway selected on dedicated displays) and display the surface wind information relevant to the active runway(s).

5.4 If wind direction and deviation is displayed as a circle, the display shall have a resolution of at least 10 degrees.

5.5 The combined numeric and analogue display shall be linked so that both display the same information relevant to the chosen display mode.

6 Recording

Refer to MET 01 for current recording requirements.

7 Siting Criteria

7.1 If the anemometers installed at the runway threshold do not provide a representative measurement of the wind across the aerodrome, an additional anemometer site shall be installed for METAR purposes.

7.2 Sensors shall be located at a vertical height to represent the wind flow between 6 and 10 metres above the runway. For METAR use, a correction factor shall be added to the mean measurement if the sensor is mounted at 7 metres or below, and subtracted if the sensor is mounted above 13 metres.

MET 05 Engineering Requirements for Ground Based Pressure Measurement Equipment

Part 1 Preliminary Material

1 Introduction

It is a requirement that all air pressure measurement sensors installed on UK aerodromes meet the requirements of ICAO Annex 3 and their defined operational requirements.

2 Scope

2.1 This document details the performance criteria and safeguarding required for meteorological equipment installed in the UK and intended for use in the provision of an Air Traffic Service.

2.2 The purpose of this document is to ensure the Applicant has considered and taken account of those aspects that affect the safety of services provided and supported by a facility.

Part 2 Requirements

3 Safety Objective

The equipment shall provide a timely, accurate and uncorrupted source of air pressure information to aid in the safe and expeditious flow of civil air traffic.

NOTE: The following requirements relate to the basic measurement of pressure and any derived values such as QNH, QFE, etc.

4 Pressure Sensor Performance Requirements

4.1 No airfield observing system shall be dependent upon a single sensor for pressure measurement. A minimum of 2 co-located sensors shall be used with an integrity within 0.5mb (hPa) of each other.

4.2 The measurement system shall provide a pressure reading to an accuracy of ±0.5mb (hPa) or better over a range of at least 900 to 1050mb (hPa).

4.3 The sensor shall provide an output with a minimum system resolution of 0.1 mb (hPa).

4.4 For automated systems, the sensor shall be sampled at a minimum rate of once a minute.

5 Displays

5.1 The display device shall be designed in such a way as to draw the attention of the operator to a change of 1 mb or more from the previous reading to 1 decimal place (e.g. 998.4 mb to 997.4 mb).

5.2 The display shall provide the indication of pressure to the nearest tenth of a millibar in compliance with MATS Part 1.

5.3 On aerodromes with multiple runways and sensor systems, the display shall indicate the sensor selected (or indicate the runway selected on dedicated displays) and display the pressure information relevant to the active runway(s).

5.4 Where a combined numeric and analogue display is used, they shall be linked so that both display the same information relevant to the chosen display mode.

6 Recording

Refer to MET 01 for current recording requirements.

7 Siting Criteria

7.1 The equipment shall be installed so that the sensor measurements are suitable for the operational purpose and free of external influences such as air conditioning.

7.2 If the equipment is installed away from the airfield reference point, it shall be given a correction factor, in order to produce readings with respect to the reference point.

7.3 Where sensors are installed indoors, the correct venting method shall be employed to isolate the sensor from the internal environment.

MET 06 Engineering Requirements for Ground Based Temperature and Dew-Point Measurement

Part 1 Preliminary Material

1 Introduction

It is a requirement that all temperature sensors installed on UK aerodromes meet the requirements of ICAO Annex 3 and their defined operational requirements.

2 Scope

2.1 This document details the performance criteria and safeguarding required for meteorological equipment installed in the UK and intended for use in the provision of an Air Traffic Service.

2.2 The purpose of this document is to ensure the Applicant has considered and taken account of those aspects that affect the safety of services provided and supported by a facility.

Part 2 Requirements

3 Safety Objective

The equipment shall provide a timely, accurate and uncorrupted source of meteorological information to aid in the safe and expeditious flow of civil air traffic.

4 Sensor Performance Requirements

4.1 Accuracy

4.1.1 The equipment shall be capable of measurement to an accuracy better than plus or minus 0.5 degree Celsius for air temperature and dew-point, over the operating range -30 to +50 degrees Celsius.

4.1.2 The sensor(s) shall be sampled at minimum of once per minute.

NOTE: Dew-point must be displayed for temperatures below zero. Frost point should not be displayed.

4.2 Resolution

Temperature & Dew-point measurements shall be measured to a resolution of 0.1 degrees Celsius.

5 Recording

Refer to MET 01 for current recording requirements.

6 Siting Criteria

6.1 Safety objective

The equipment shall be installed in a position such that the sensor measurements are suitable for the operational purpose.

6.2 The sensors shall be mounted at an appropriate height, above an earth/grass surface, and in a position on the airport where they will not be degraded by anomalous temperatures and will be protected from the exhaust fumes of aircraft.

6.3 The sensors shall be exposed in an instrument housing which provides protection from atmospheric radiation and water drops either as precipitation or fog.

MET 08 Engineering Requirements Runway/Taxiway Surface Condition Measurement Equipment

Part 1 Preliminary Material

1 Introduction

It is a requirement that all surface condition measurement equipment installed on UK aerodromes meet the requirements of ICAO Annex 3 and their defined operational requirements.

2 Scope

2.1 This document details the performance criteria and safeguarding required for meteorological equipment installed in the UK and intended for use in the provision of an Air Traffic Service.

2.2 The purpose of this document is to ensure the Applicant has considered and taken account of those aspects that affect the safety of services provided and supported by a facility.

Part 2 Requirements

3 Safety Objective

The equipment shall provide a timely, accurate and uncorrupted source of valid meteorological information to aid in the safe and expeditious flow of civil air traffic.

4 Sensor Performance Requirements

4.1 Equipment shall be designed to measure accurately the surface condition, contamination levels and/or indicate the onset of surface icing under differing meteorological conditions.

NOTE: If moisture sensors are used to determine braking action on grass runways, the system will display the readings from touchdown, mid point and stop end sensors; or, alternatively, the poorest reading from the three.

4.2 Sensors shall not alter the surrounding surface condition (no use of heating / cooling procedures) and shall have similar radiation characteristics to those of the runway surface.

4.3 All systems shall measure temperature.

4.4 All systems shall be capable of detecting the following conditions:

a) Dry surface.

b) Wet surface.

c) Snow.

d) Ice.

e) De-icing chemicals.

5 Monitoring

5.1 **Monitoring Action**

5.1.1 The equipment shall be self monitoring and shall provide a suitable indication of equipment status and serviceability.

5.1.2 **Recommendation** If a standby system is available, the system should be capable of changing over to the standby system automatically when a fault occurs. This change of state must be indicated on the displays.

5.2 **Monitor and Monitoring Configuration**

5.2.1 The configuration of the monitoring system to be used with the weather station shall be specified.

5.2.2 Where data is transmitted outside the aerodrome, the serviceability status of the system (or parts of the system) shall be included.

5.2.3 A change in status of the weather station shall be clearly reported to an appropriate location within the ATS unit and be available to ATC without delay.

6 Displays

6.1 Refer to MET 02 for general display design requirements.

6.2 **Recommendation:** The meteorological information displayed should provide an indication of 'trend'.

6.3 The display shall indicate the sensor selected.

7 Siting Criteria

Surface condition or ice monitoring equipment shall be installed at relevant positions along the runway and taxiways as recommended according to climatological knowledge or following a detailed thermal / visual site survey.

MET 09 Requirements for the Observation and Dissemination of Meteorological Observations

Part 1 Preliminary Material

1 Introduction

1.1 Meteorological information is necessary to assist an ATC unit at an aerodrome to:

1.1.1 provide an air traffic control service; and/or

1.1.2 provide information to pilots prior to take-off or landing.

1.2 The generation of meteorological observations has historically been considered external to the provision of an air traffic control service. Recent developments within Industry have resulted in changes in the way that meteorological observations are made, the task often involving ATC staff.

1.3 The availability and standard of meteorological information has also been identified as a factor in recent aircraft accidents and incidents.

1.4 Where meteorological information is provided to ATC by another agency the Provider of ATC should endeavour to ensure that the following requirements are met. It is recommended that a Service Level Agreement or similar formal arrangement be reached between the meteorological information provider and ATC.

2 Scope

2.1 This document details the requirements associated with the observation and dissemination of meteorological reports made by ATC units at aerodromes.

2.2 The purpose of this document is to ensure that meteorological information used by ATS units and provided to aircraft and other agencies is timely and accurate.

Part 2 Requirements

3 Safety Objective

Timely and accurate meteorological information shall be available to aircraft operators and ATS providers.

4 Meteorological Observations

4.1 A meteorological report shall normally contain the following items of information:

4.1.1 Identification of the type of report (e.g. METAR)

4.1.2 Location indicator

4.1.3 Time of Observation, in UTC

4.1.4 Surface wind direction and speed

4.1.5 Visibility

4.1.6 Runway visual range (where applicable and equipment/procedures have been approved at the unit)

4.1.7 Present weather

4.1.8 Cloud amount (and type, if applicable) and height of base

4.1.9 Air temperature and dew-point temperature

4.1.10 QNH and, where applicable, QFE

4.1.11 Supplementary information (e.g. additional remarks/information from observer, controller or pilot report)

4.2 The operationally desirable accuracy of measurement or observation for meteorological observations can be found at ICAO Annex 3 Attachment B.

4.3 At aerodromes used by Public Transport aircraft, routine meteorological reports shall be produced at 30 minute intervals during the hours of opening of the aerodrome.

4.3.1 At other aerodromes, routine meteorological reports shall be produced at intervals agreed between the ATS Provider and the UK Meteorological Authority.

4.4 During any period that routine meteorological reports are being produced, special reports shall be produced if appropriate. Unless otherwise agreed by the UK Meteorological Authority, the criteria for the production of a special report shall be those included in the Manual of Air Traffic Services Part 1 (MATS Part 1).

5 Dissemination of Observations

5.1 MATS Part 1 describes the elements of a meteorological report that are routinely required to be passed to pilots by ATC.

NOTE: Where the passing of meteorological information increases ATC workload to the extent that the provision of the ATC service is affected, the Provider of ATC should consider the broadcast of meteorological reports on ATIS or VOLMET.

5.2 Where meteorological reports for an aerodrome are broadcast by ATIS, procedures shall be in place to update the broadcast message as soon as practicable following the production of a subsequent routine report or special report.

5.2.1 For the period that the content of an ATIS broadcast message differs from the information presented to ATC (and passed to pilots by the controller) a procedure shall be in place to ensure that the controller is aware that the broadcast message is no longer valid and to identify those elements of the report which have changed.

5.3 Meteorological reports should be disseminated beyond the aerodrome in a manner agreed between the ATS Provider and UK Meteorological Authority.

NOTE: This is normally achieved by the transmission of routine reports to the Meteorological Office by AFTN.

6 Contingency Arrangements

Providers shall identify the effect of equipment failure or staff unavailability on the production of meteorological observations and assess the impact on meteorological information users and the provision of an ATC service. Wherever practical, alternative sources of information or other mitigation measures shall be identified and associated operational procedures documented.

7 Qualification of Observers

7.1 ATS Providers shall ensure that meteorological observations are made by suitably qualified staff.

7.2 A method to ensure the initial and continuing competence of observing staff shall be established.

NOTE: The Meteorological Office is the only organisation which currently offers recognised observer training. A provider wishing to utilise an alternative training organisation is advised to consult the Authority to ascertain the suitability of the training scheme.

7.2.1 A method to ensure that observing staff are aware of, and competent in, local observing and reporting procedures shall be established.

NOTE: Local observing and reporting procedures include the way in which observations are recorded and disseminated both within and beyond the aerodrome.

7.2.2 A method to ensure that observing staff are sufficiently familiar with all meteorological phenomena that can reasonably be expected to occur at the aerodrome so as to permit their competent observation and reporting shall be established.

8 United Kingdom Meteorological Authority

8.1 The United Kingdom Meteorological Authority is:

Meteorological Services
Directorate of Operations and Customer Service
National Air Traffic Services Ltd
CAA House
45-59 Kingsway
LONDON
WC2B 6TE

Telephone: 020 7832 5470

Contents to Part D

Part D **Human resources**

Section 1 **Unit Staffing and Rostering**

Staffing Requirements and Duty Hours 1
Watch Rosters 3
Ancillary Tasks 3
Operational Support Staff 3
Management Functions & Responsibilities 4
Air Traffic Control Licences 4

Section 2 **Scheme for Regulation of the Hours of Civil ATCOs in the UK**

Purpose 1
Definitions 1
Limitations 1
Modification of Limitations 2
Review of Modifications 3
Notification of Roster Details 3

Annex A **Operational Duty in Excess of SRATCOH**

Annex B **Revised Scheme for Regulation of the Hours of Civil ATCOs in the UK (effective from November 2005)**

Purpose 1
Definitions and Associated Limitations 1
Additional Limitations 3
Modification of Limitations 4
Review of Modifications 5
Notification of Roster Details 5
Guidance on Minimum Rest Facilities 5

Part D Human resources

Section 1 Unit Staffing and Rostering

1 Staffing Requirements and Duty Hours

1.1 The number of operational positions, period of operation and limitation of duty hours dictate the minimum number of validated controllers required at a unit.

1.2 The CAA must be satisfied that the unit maintains sufficient qualified controllers to provide safe air traffic control services. Consideration will be given to the regularity of the Air Traffic Control Service in determining whether a service is safe. There must be no possibility that users will be confused as to which service they are receiving because the type of service changes from day to day or hour to hour. Careful consideration will also be given to the provision of more than one service simultaneously before approving a unit.

1.3 Although conditions at different units may vary an approximation for the calculation of the minimum number of controllers required is given using the following formula:

$$\text{Total number of valid controllers, } C = \frac{ND}{365 - R} \text{ rounded up to whole number}$$

Where N = Number of controllers required to attend for duties, including a relief to give breaks, each day. This will depend on the number of operational positions and the period for which they are scheduled to open.

D = Number of days the unit provides services in a year.

R = Number of days a controller is not available for duty,

i.e. rest days
annual leave
public holidays in lieu
allowance for sickness
training etc.

Example 1

A unit comprising Aerodrome Control and a combined Approach and Approach Radar Control open seven days a week between 0600 hrs and 2200 hrs. Both positions manned at all times.

N = 6 (i.e. 2 early duties
2 late duties
2 relief duties)

D = 365

R = 120 (i.e. rest days – 3 x 2½ x 12 = 90
leave = 21
public holidays = 9)

Therefore $C = \frac{6 \times 365}{365 - 120}$ = (8.9) 9 controllers

Example 2

A small unit without radar able to provide a combined Aerodrome and Approach Control service at certain times of the day. Open 6½ days a week between 0600 hrs and 2200 hrs for 6 days and 0800 hrs to 1600 hrs on the half day.

N =4 (i.e. 1 early duties
1 late duties
1 duty to split positions (max 10 hrs)
1 relief duties)

D = 338

R = 120 (as example 1 above)

Therefore $C = \frac{4 \times 338}{365 - 120}$ = (5.5) 6 controllers

Certain assumptions have been made in the calculation of 'N' in the examples above. There are many ways of deploying staff and managers may use other criteria in arriving at 'N'. Whatever method is used, the critical factor will be the regulation of hours scheme.

1.4 In neither scheme has any allowance been made for sickness or other duties. If a controller at the unit in the first example became ill and was absent for any length of time this could result in controllers breaching the hours limitations. As this might require some restriction to the operation of the unit it might be prudent to make such allowance.

1.5 There is scope in the second example for sickness, training etc. If an allowance of 10 days per controller is assumed, 'R' is increased to 130 and 'C' becomes 5.75. The rounded up figure is still 6 controllers.

2 Watch Rosters

2.1 Providers shall meet the rostering limitations specified in the Scheme for the Regulation of Air Traffic Controllers' Hours set out in Section 2.

2.2 Providers shall notify the CAA of formal rostering arrangements of a repetitive nature only once. However, details of the roster actually worked showing variations due to unforeseen circumstances may be required at the discretion of the CAA, ATSSD, particularly where there is a slight shortfall of staff and overtime is likely.

2.3 Providers who are unable to set a regular pattern of attendance for Air Traffic Control Officers shall supply to the CAA a copy of the prepared roster at least 30 days before it is due to come into force together with details of each month’s, or each four week period’s, roster actually worked.

2.4 Rosters supplied to the CAA shall indicate where they meet the various rostering limitations specified in the Scheme for the Regulation of Air Traffic Controllers’ Hours set out in Section 2.

3 Ancillary Tasks

3.1 An ancillary task is any task in an operational control room which is not directly associated with the provision of an Air Traffic Control Service.

NOTE: A person must have an Air Traffic Controller's licence to provide an Air Traffic Control Service.

3.2 Providers shall not normally require controllers to carry out ancillary tasks while they are providing operational Air Traffic Control services.

3.3 Exceptionally, where such ancillary duties are unavoidable, the CAA must be satisfied that controllers will not be distracted from their primary function or placed under undue pressure. These duties and the person responsible for discharging them must be clearly identified in the unit’s MATS Part 2.

4 Operational Support Staff

4.1 Controllers may delegate some of their responsibilities to adequately trained support staff (such as Flight Clerks, Air Traffic Control Assistants and Air Traffic Service Assistants) provided they do not include duties for which an Air Traffic Control licence is required. These responsibilities fall into two categories:

a) Air Traffic Control related duties are those closely associated with the safety of aircraft (e.g. Telephone messages concerning flight data and clearances). These duties and the person responsible for discharging them must be clearly identified in the unit’s MATS Part 2.

b) Other duties of an administrative nature.

4.2 Adequate support staff shall be provided. The number and disposition of support staff will depend on the complexity of the unit. The Provider shall arrange appropriate training and shall be responsible for the continued competency of such staff. The CAA may require to be given details of the training support staff has received.

5 Management Functions & Responsibilities

The provider shall identify the key personnel responsible for the safe operation of the Air Traffic Control unit. Their positions, responsibilities, functions, accountabilities and authority must be clearly defined in writing and an organisational chart indicating the specific responsibilities must be provided. Changes in these personnel must be notified to the CAA.

6 Air Traffic Control Licences

All licensed Air Traffic Controllers must comply with the requirements laid down in CAP 744, UK Manual of Personnel Licensing - Air Traffic Controllers.

Section 2 Scheme for Regulation of the Hours of Civil ATCOs in the UK

1 Purpose

The purpose of this Scheme of Regulation of the hours of civil Air Traffic Controllers is to ensure, so far as reasonably possible, that controller fatigue does not endanger aircraft and thereby to assist controllers to provide a service safely and effectively.

2 Definitions

2.1 Period of Duty

The period between the actual commencement of and the actual end of a shift during which an air traffic controller whose licence contains a rating valid at the unit exercises, or could be called upon to exercise, the privileges of the licence at that unit, and includes prescribed breaks, time spent on other duties such as training, airfield inspection, meteorological observations, collection of landing fees, administration and any extension of duty.

2.2 Operational Duty

The period during which an air traffic controller is actually exercising the privileges of the controller's licence at an operational position.

2.3 Night Duty

A period of duty of not less than four hours between 2200 hours and 0700 hours next following.

2.4 Standby Duty

A period during which, by prior arrangement, a controller is required to be available to report at his place of work with the intention of providing an Air Traffic Control Service. Standby duty is calculated at half period of duty time.

3 Limitations

3.1 Maximum period of duty

No period of duty shall exceed 10 hours. Within 720 consecutive hours (30 days) the aggregate of periods of duty and standby duties shall not exceed 300 hours provided that periods of duty do not exceed 200 hours.

3.2 Intervals Between Periods of Duty

There shall be an interval of not less than 12 hours between the conclusion of one period of duty and the commencement of the next period of duty. Within 720 consecutive hours (30 days) there shall be not fewer than three intervals of a minimum of 60 hours each between the conclusion of one period of duty and the commencement of the next period of duty.

3.3 **Limit On and Interval following Consecutive Periods of Duty**

Upon the conclusion of six consecutive periods of duty within 144 consecutive hours (6 days), or upon consecutive periods of duty within 144 consecutive hours (6 days) reaching a total of 50 hours, whichever is the earlier, there shall be an interval of a minimum of 60 hours before the commencement of the next period of duty.

3.4 **Limits on Night Duties**

Not more than two night duties may be worked in immediate succession.

3.5 **Interval After Night Duties**

Upon the conclusion of two night duties in immediate succession, there shall be an interval of a minimum of 54 hours before the commencement of the next period of duty.

3.6 **Reduction of Intervals for Handover**

In this scheme, where an interval of a minimum of 60 hours (paragraph 3.3) or 54 hours (paragraph 3.5) between periods of duty is stipulated, that interval may be reduced by up to 30 minutes solely for the purpose of orderly shift handover.

3.7 **Breaks in Operational Duty**

No operational duty shall exceed a period of two hours without there being taken during, or at the end of, that period a break or breaks totalling not less than 30 minutes. Although this period may be modified to reflect intensity of workload under the Modification of Limitations provisions below, modification of a period of duty beyond four hours is prohibited. A controller is considered to be providing an Air Traffic Control Service when he is supervising a trainee Air Traffic Controller who is working at an operational position.

3.8 **Holidays**

During any calendar or leave year not fewer than 10 days of total holiday entitlement shall be taken in periods of not less than five consecutive days.

4 Modification of Limitations

4.1 **By the CAA**

The CAA may in its discretion modify any Limitation through and by authorised members of its Air Traffic Services Standards Department ('ATS Standards'). Modifications may be made as a requirement of the CAA or in exceptional or extraordinary circumstances on the application of a Provider of Air Traffic Control Services. Application may be communicated in any manner to ATS Standards and shall be confirmed in writing within the following 24 hours.

Modification may be made or granted upon such terms and for such duration as ATS Standards shall specify. It may be communicated in any manner and shall be confirmed in writing with reasons within the following 48 hours.

In exercising its discretion to make or grant a modification, the CAA shall have regard to:

a) The amount, type and complexity of recent and anticipated traffic handled by the unit and position concerned.

b) The published operational hours of the unit.

c) The pattern of shifts in operation at the time of any shift involved.

d) The qualifications and availability of support and supervisory staff.

e) Exceptional temporary staffing problems.

f) The equipment in use at the unit.

g) Exceptional temporary equipment problems.

h) The type of operating position at the unit.

i) Factors which may compensate for or benefits which may arise from any modification.

j) Such other matters as the CAA considers to be relevant.

4.2 **By the Provider of Air Traffic Control Services**

In exceptional circumstances the Provider of Air Traffic Control Services at a unit may in its discretion modify any Limitation through persons exercising its authority. Such modifications may only be made to overcome short-term, temporary and unforeseen difficulties at the unit and, having regard to the Scheme of Regulation, may only be made if the safety and effectiveness of Air Traffic Control will be maintained. The CAA will require to review the circumstances of each such modification and for this purpose a report and full details of the modification shall be notified in writing, using the form shown in Annex A, to ATS Standards Department within 24 hours of the modification taking effect.

5 Review of Modifications

A Provider of Air Traffic Control Services who objects to the refusal, or to the terms of modification of a Limitation, by the ATS Standards Department may, according to Regulation 6 of the Civil Aviation Authority Regulation 1983, request that the issue be decided by the CAA.

6 Notification of Roster Details

At the request of ATS Standards, the Provider of Air Traffic Control Services at a unit shall supply to the CAA:

a) Not less than 30 days before it is due to come into force, a copy of any proposed working roster and, without request as early as possible, details of any proposed change.

b) Not more than 30 days after receiving a request, details of a roster as actually worked including records of the periods of duty worked.

Annex A Operational Duty in Excess of SRATCOH

<table>
<tr><td colspan="5">OPERATIONAL DUTY IN EXCESS OF SRATCOH</td></tr>
<tr><td colspan="5">Please complete all relevant boxes</td></tr>
<tr><td>ATSU:</td><td colspan="4"></td></tr>
<tr><td>ATCO NAME:
Please Print</td><td colspan="2"></td><td colspan="2">WATCH:</td></tr>
<tr><td>Start Time of Shift:</td><td>Actual Finish Time of Shift:</td><td colspan="2">Start Time of Operational Duty:</td><td>Time Operational Duty Ceased:</td></tr>
<tr><td>SRATCOH Breach Reference Number(s) as per CAP 670:</td><td></td><td colspan="2"></td><td></td></tr>
<tr><td colspan="2">On duty as:</td><td colspan="3">Operational Position</td></tr>
<tr><td colspan="5">NARRATIVE – Give additional relevant information</td></tr>
<tr><td colspan="2">Reporter signature:</td><td colspan="3">Date:</td></tr>
</table>

ATC SUPERVISOR REPORT

NARRATIVE – Give reasons for variation		
Name:	**Signed:**	**Date:**
LOCAL MANAGEMENT ACTION		
Name:	**Signed:**	**Date:**

Annex B Revised Scheme for Regulation of the Hours of Civil ATCOs in the UK (effective from November 2005)

IMPORTANT NOTICE

The revised Scheme for the Regulation of Air Traffic Controllers Hours set out below will be implemented with effect from November 2005. It has been included as an Annex to CAP 670 Part D now so as to allow a period of 18 months in which ATS Providers will be able to adjust staffing levels if the revised scheme makes this necessary. ATS providers are encouraged to submit their proposals for any amendments to watch rosters necessitated by the new scheme to their Regional Manager of ATS, or in the case of Area Control Centres, to the Head of En-route and College Regulation, before the new scheme takes effect.

Until the revised SRATCOH is implemented, the current Scheme for Regulation of the Hours of Civil ATCOs in the UK at Section 2 of Part D shall apply.

1 Purpose

The purpose of this Scheme for Regulation of the Hours of Civil Air Traffic Controllers is to ensure, so far as reasonably possible, that controller fatigue does not endanger aircraft and thereby to assist controllers to provide a service safely and effectively. In all cases the management of controller rostering should be sympathetic to this purpose and where there is any doubt as to the application of these regulations guidance should be sought from the appropriate Regional Manager of ATS Safety Regulation in the case of Airports or the Head of En-route and College Regulation in the case of Area Control Centres.

2 Definitions and Associated Limitations

2.1 Period of Duty

The period between the actual commencement of and the actual end of a shift during which an air traffic controller whose licence contains a rating valid at the unit exercises, or could be called upon to exercise, the privileges of the licence at that unit, and includes prescribed breaks, time spent on other duties such as training, airfield inspection, meteorological observations, collection of landing fees, administration and any extension of duty.

2.1.1 Maximum Period of Duty

Except where other limits are defined within these regulations no period of duty shall exceed 10 hours. Within 720 consecutive hours (30 days) the aggregate of periods of duty and on call duties shall not exceed 300 hours provided that periods of duty do not exceed 200 hours.

2.1.2 Intervals Between Periods of Duty

There shall be an interval of not less than 12 hours between the conclusion of one period of duty and the commencement of the next period of duty. This interval may only be reduced (and only by a maximum of 1 hour) with the approval of the controller concerned and in any individual case such a reduction will be permitted no more than once in a period of 720 consecutive hours (30 days).

2.1.3 Limit on and Interval following Consecutive Periods of Duty

2.1.3.1 Upon the conclusion of six consecutive periods of duty within 144 consecutive hours (6 days), or upon consecutive periods of duty within 144 consecutive hours (6 days) reaching a total of 50 hours, whichever is the earlier, there shall be an interval of a minimum of 60 hours before the commencement of the next period of duty. This interval may be reduced in accordance with paragraph 2.1.3.2.

2.1.3.2 Within 720 consecutive hours (30 days) there shall be not fewer than three intervals between the conclusion of one period of duty and the commencement of the next period of duty. These intervals shall total not less than 180 hours with the minimum interval being not less than 54 hours.

2.2 Operational Duty

The period during which an air traffic controller is actually exercising the privileges of the controller's licence at an operational position.

2.2.1 Breaks in Operational Duty

2.2.1.1 No operational duty shall exceed a period of two hours without there being taken during, or at the end of, that period a break or breaks totalling not less than 30 minutes.

2.2.1.2 At units where workload for any part of the day is judged to be low and the activity is spasmodic rather than continuous, periods of operational duty, at these times, may be extended to a maximum of four hours, provided that the following break is taken pro-rata (e.g. 45 minutes after 3 hours or 60 minutes after 4 hours). (see Note below)

NOTE: Judgements on unit workload are to be made by unit managers in consultation with the appropriate Regional Manager of ATS Safety Regulation in the case of Airports or the Head of En-route and College Regulation in the case of Area Control Centres.

2.3 Night Duty

A period of duty wholly or partly within the period of 0130 and 0529 hours.

2.3.1 Limits on Night Duties

Not more than two night duties may be worked in immediate succession. In all cases the maximum night duty period shall not exceed 9.5 hours and the night duty must conclude no later than 0730 hours.

2.3.2 Interval After Night Duties

Upon the conclusion of two night duties in immediate succession, there shall be an interval of a minimum of 54 hours before the commencement of the next period of duty.

2.4 On Call Duty

A period during which, by prior arrangement, a controller is required to be available to report at his place of work with the intention of providing an Air Traffic Control Service.

2.4.1 Limits for On Call Duties

2.4.1.1 The maximum On Call period of duty, where the controller does not attend the place of work, shall be 20 hours. For the purpose of this particular limitation, all On Call Duty time spent in attendance at the place of work shall count double. For example, if a controller attends the place of work ten hours after commencing an On Call Duty the 20-hour maximum On Call period of duty will be reached when the controller completes five hours at the place of work. [10 hours + (5 hours x 2 = 10 hours) = 20 hours.]

2.4.1.2 Not more than two On Call duties shall be worked in a period of 144 hours (6 days).

2.4.1.3 Prior to commencing an On Call duty controllers are to be rested in accordance with the scheme's regulations and, if called in, will be subject to the minimum interval between duty periods as per paragraph 2.1.2. An On Call duty controller who is not called in during an overnight On Call duty shall not be utilised before midday next following.

2.4.1.4 Normally only one attendance at the place of work per On Call duty shall be permitted. Units needing to operate in exceptional circumstances outside these limitations may seek modification by the CAA in accordance with paragraph 4.1.

2.5 Early Start

An early start is a period of duty which commences between 0530 and 0629 hours.

2.5.1 Limits on Early Starts

2.5.1.1 Not more than 2 early starts shall be worked in a period of 144 hours. Consecutive early start duties shall not be permitted where both duties commence before 0600 hours. An early start, commencing before 0600 hours shall count as two morning duties when considering the limitations on consecutive morning duties in paragraph 2.6.1.

2.5.1.2 The early start maximum duty period shall be 8 hours.

2.5.1.3 At units where the two hour maximum duty period is reduced to 1.5 hours by enhanced relief, all operational duty periods for a controller on an early start commencing before 0600 shall be limited to 1.5 hours (on any operational position whether designated for enhanced relief, or not) and for a controller on an early start commencing at or after 0600 (on any operational position whether designated for enhanced relief, or not) the first operational duty period shall be limited to 1.5 hours.

2.6 Morning Duty

A morning duty is a period of duty, which commences between 0630 and 0759 hours.

2.6.1 Limits on Morning Duties

A maximum of 5 consecutive morning duty periods shall be permitted and for the purpose of this calculation early starts shall be counted and early starts before 0600 hours shall count double. The maximum morning duty period shall be 8.5 hours.

3 Additional Limitations

3.1 Reduction of Intervals for Handover

3.1.1 In this scheme where an interval of a minimum of 60 hours or 54 hours between periods of duty is stipulated, that interval may be reduced by up to 30 minutes solely for the purpose of orderly shift Handover.

3.1.2 The time taken for orderly handover/takeover before a shift start, up to a maximum of 15 minutes, shall not be considered to form part of the oncoming controller’s period of duty.

3.2 Holidays

During any calendar or leave year not fewer than 10 days of total holiday entitlement shall be taken in periods of not less than five consecutive days of booked leave (excluding rostered days off).

3.3 Simulators

3.3.1 Operational and Emergency Continuation Training on simulators and other simulator activity, which may affect a controller's licence, shall be counted the same as operational duty when considered for the purposes of the scheme.

3.3.2 Trial and evaluation simulations which take place within periods of duty, or in place of operational duties, may be conducted within the overall limitations of Periods of Duty. However, trial and evaluation simulations which take place within the normal 60 hour or 54 hour intervals between periods of duty shall have an interval of 48 hours between the end of the simulation and the commencement of the next period of duty, or alternatively an interval of 24 hours shall immediately precede and immediately follow such periods of simulator duty.

NOTE: Simulations which are part of Air Traffic Controller rating training at Air Traffic Control Training Colleges are not subject to the requirements of this scheme.

4 Modification of Limitations

4.1 By the CAA

4.1.1 The CAA may in its discretion modify any Limitation through and by authorised members of its Air Traffic Services Standards Department ("ATS Standards"). Modifications may be made as a requirement of the CAA, or in exceptional or extraordinary circumstances, on the application of a Provider of Air Traffic Control Services. Application may be communicated in any manner to ATS Standards and shall be confirmed in writing within the following 24 hours.

4.1.2 Modification may be made or granted upon such terms and for such duration as ATS Standards shall specify. It may be communicated in any manner and shall be confirmed in writing with reasons within the following 48 hours.

4.1.3 In exercising its discretion to make or grant a modification, the CAA shall have regard to:

a) The amount, type and complexity of recent and anticipated traffic handled by the unit and position concerned.

b) The published operational hours of the unit.

c) The pattern of shifts in operation at the time of any shift involved.

d) The qualifications and availability of support and supervisory staff.

e) Exceptional temporary staffing problems.

f) The equipment in use at the unit.

g) Exceptional temporary equipment problems.

h) The type of operating position at the unit.

i) Factors which may compensate for, or benefits which may arise from, any modification.

j) Such other matters as the CAA considers to be relevant.

4.2 By the Provider of Air Traffic Control Services

In exceptional circumstances the Provider of Air Traffic Control Services at a unit may in its discretion modify any Limitation through persons exercising its authority. Such modifications may only be made to overcome short-term, temporary and unforeseen difficulties at the unit and, having regard to the Scheme of Regulation, may only be made if the safety and effectiveness of Air Traffic Control will be maintained. The CAA will require to review the circumstances of each such modification and for this purpose a report and full details of the modification shall be notified in writing, using the form shown in Annex A to Part D, to ATS Standards Department within 24 hours of the modification taking effect.

5 Review of Modifications

A Provider of Air Traffic Control Services who objects to the refusal, or to the terms of modification of a Limitation, by the ATS Standards Department may, according to Regulation 6 of the Civil Aviation Authority Regulation 1983, request that the issue be decided by the CAA.

6 Notification of Roster Details

At the request of ATS Standards, the Provider of Air Traffic Control Services at a unit shall supply to the CAA:

a) not less than 30 days before it is due to come into force, a copy of any proposed working roster and, without request as early as possible, details of any proposed change.

b) not more than 30 days after receiving a request, details of a roster as actually worked including records of the periods of duty worked.

7 Guidance on Minimum Rest Facilities

7.1 At all units the minimum rest facilities should consist of a separate room, which is remote from the operations room and reasonably quiet. There should be sufficient and adequate furniture for the number of staff likely to be on a fatigue break at one time.

7.2 Facilities for obtaining refreshments should be available within a reasonable distance of the unit or appropriate facilities should be provided for the storage and preparation of food and drinks.