COMMAND AND STAFF TRAINING INSTITUTE

BANGLADESH AIR FORCE

Individual Staff Studies Programme (ISSP)

PROFESSIONAL-1 : FLYING AND AIRMANSHIP FOR NAVIGATORS

Phase-8 : Part-I

<u>PROFESSIONAL-2 : FLYING AND AIRMANSHIP FOR NAVIGATORS</u>
<u>PHASE -16 : PART-II</u>

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APPROVED

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Notes :

1. **Total Pd in Part - I : 48**
2. **40 mts comprises one pd.**

INTRODUCTION TO THE PHASE

Scope of the Phase

1. This phase deals with professional study materials s on the subject of Flying and Airmanship for Navigators, which has been divided into two parts Part-I&II. The materials contained in this volume constitute Part-II of the Phase. The individual topic has been presented to help the student officer for gaining theoretical background leading to its practical utilization.

Guidance on Methods of Study

2. In addition to this phase note you should study different manuals and publications per training to this subject to improve your knowledge. Following the study guide line given in the conduct of the phase will help to study the subject smoothly.

2. That first flight lasted for 12 seconds and covered a distance over the ground of only

GROUP-A: NAVIGATION
TOPIC-1 : NAVIGATION PLANNING

Introduction

1. The navigation planning requirements for any flight will depend largely on the nature of the task, the area of operation and any procedures or orders relevant to a particular aircraft type or role. Many tasks will be of a 'standard' nature, e.g. regular air transport routes and in such cases, maximum use can be made of Standard Operating Procedures (SOPs), computerized planning facilities and statistical meteorological data. Alternatively the mission may be of an operational or emergency nature and the normal flight planning procedures may have to be amended or circumvented in the interests of expediency; much reliance will be placed on the use of SOPs and on the experience of the crew. It would be inappropriate to attempt to cover all of the specialist procedures in use; rather this chapter will review the basic navigation planning requirements for a straightforward flight at medium or high level.

2. This chapter will highlight only the principle ingredients of navigation planning by describing the pre-planning considerations.

Pre-planning Considerations

3. Before any actual planning can take place a number of factors must be considered which will help to determine the route and techniques to be used. Among these factors are:

a. The task.

b. The fuel requirements or limitations.

c. Aircraft performance.

d. The geography of the area to be over flown.

e. The meteorological forecast of the route or area.

f. The availability of navigation aids.

g. Air traffic restrictions, danger areas and prohibited airspace.

h. Any special procedures that must be obeyed.

j. Availability of diversion airfields.

4. **The Task**. The task may be straight forward; or complex. There may be intermediate stops, specific times to make good at reporting points, air-to-air refueling my be accomplished.

5. **Fuel**. The detail of fuel planning will be covered in Chap 2.

6. **Aircraft Performance**. Aircraft's performance limitations with respect to the cruising level, the runway lengths, AUWs etc is to be considered.

7. **Geography**. There are no particular geographical factors pertaining to the flight should be noted. For the routes over mountainous terrain, particular care must be taken when calculating safety altitude and when monitoring the descent.

8. **Meteorology**. The following meteorological data will be assumed:

   a. Cloud.

   b. Wind.

   c. Temperature.

   d. Weather.

9. **Navigation Aids**. It will be assumed that the aircraft is fitted with serviceable TACAN, VOR, ADF and a Doppler/GPI system. All of the appropriate ground beacons are also serviceable.

10. **Restricted Airspace**. In the en route chart there are a number of Danger, Restricted, Prohibited Areas and Airways for which clearance or control will be necessary.

11. **Special Procedures**. At major civilian airfields, the procedures are complex and will often influence the selection of the route e.g. specific reporting points may need to be flown to SIDs, STARs; and the Planning Document may need to consult.

12. **Diversion Airfields**. When considering diversion airfields it is important to consider their suitability with regards to runway length, navigation and landing aids, weather (including any cross-wind limitations) and necessary services, eg availability of appropriate fuels and oils. The fuel planning implications of diversion will be reviewed in Chap 2.

13. **Safety Altitude**. The safety altitude for each leg or section must be determined from a topographical chart using whatever criteria are laid down by the Command, Group, or other operating authority. In this example the basic criteria of 1,000 ft (2,000 ft in the case of obstacles over 3000 ft) above the highest obstacle within 30 nm of planned track, rounded up to the nearest 100 ft, has been used.

Route Determination and Chart Preparation

13. For the example exercise the En Route Low Altitude and Area Navigation (RNAV) charts are appropriate. It would be prudent to carry High Altitude charts in case it is necessary for weather or air traffic reasons to fly in the upper airspace or cross R-NAV(H) routes. Also a topographical chart should be carried, and in any case will need to be consulted in order to ascertain safety altitudes.

14. **Route**. For convenience, the runway heading at St Mawgan will be maintained until the edge of the MATZ before turning onto the desired track. The principle constraint on the choice of the route is the need to avoid the numerous Danger Areas in the Bristol Channel and Cardigan Bay. With this in mind, turning points have been selected at 5130N, 0400W and at 5250N, 0400W, before making for the Valley overhead (Fig 1). If required the turning points may be lettered or numbered to aid identification.

15. **Chart Preparation**. Having drawn the route on the chart, other points of interest can be added or highlighted, eg isogonals, ASR boundaries, suitable navigation beacons, Danger Area boundaries. NOTAMs should be checked to ensure that no activity is likely to affect the flight and if necessary the route may have to be amended. It may be convenient to draw range arcs, centred on Valley, to make navigation in the terminal phase easier. Once the top of descent point has been determined, further range arcs back along track from this point, and from intermediate turning points, may be constructed if desired. Care must be taken to ensure that working areas of the chart do not become over-cluttered.

Completing the Navigation Flight Plan

16. Fig 3 shows a typical flight plan form - different operators will use variations of this form to cater for their particular requirements. The top part of the form is self-explanatory and needs no further comment here. The bottom section acts as a reminder of various fuel requirements. This section will be concerned with the main body of the form and its completion.

17. The first stage is to enter the names or positions of the way points in the column marked "Route To'. The first point will be "Top of Climb', and the penultimate point 'Top of Descent', although these points have not yet been determined. Tracks and distances are measured and entered in the appropriate columns. The first and last leg distance will be subsequently divided once the climb and descent planning has been completed. In this example the initial part of the climb from take-off to five miles has been ignored for the purpose of calculating headings although it will of course be included in the total distance and in the time and fuel calculations.

18. **Climb Planning**. Fig 4 shows the appropriate page from the Operating Data Manual (ODM) for the climb portion of the flight. Care must be taken to ensure that the page is correct with respect to the climb profile (if the aircraft can undertake a variety of climb profiles), and to the temperature profile (ISA +4 in this case). The layout of the ODM will vary between aircraft but the example is fairly typical. The first task is to decide the level to which it is intended to climb. The flight orders have specified Flight Levels around FL200 and as the flight is below FL245, quadrantal cruising levels should be adopted; FL210 is selected. By finding this level in the left-hand column and reading across to the appropriate take-off weight (21,000 lb in this example) it will be seen that the mean TAS for the climb is 267 kt and the time for the climb is 11 minutes. This data can be inserted in the appropriate columns in the first line of the flight plan. In practice the fuel used in the climb can also be extracted at this stage and recorded in the flight plan but fuel planning will be covered in Chap 2.

19. The next stage is to determine the wind velocity for the climb and then to use the DR Computer to calculate the heading, groundspeed and distance to the top of climb and enter the results on the form. It will be assumed that the aircraft climbs at a steady rate, and the meteorological forecast shows that the wind varies uniformly with the height and therefore the mid-height wind can be used; in this case the 10,000 ft wind, 330°/35 kt, will be satisfactory. The top of climb position can now be plotted on the chart.

20. **Descent Planning**. The descent is planned in a similar manner to the climb using the appropriate page from the ODM (Fig 5) and the correct descent profile; Normal Descent in this example. Mean TAS, fuel used, and time taken are extracted from the table allowing the heading, groundspeed and distance to be calculated, again using mid-height wind (330°/35 kt at 10,000 ft). The top of descent can now be plotted on the chart. In this example the calculated TOD point is within a mile of the last planned turning point and therefore it is reasonable to make them coincident.

21. **Cruise Planning**. Having determined the top of climb and descent positions the leg distances for the cruise portion can be measured and inserted in the flight plan. The cruise section of the ODM can now be consulted, once again ensuring that the correct cruise type or speed and the correct temperature profile is selected (Fig 6). In this case the data given is TAS and fuel flow rate. The TAS may alternatively be calculated on the DR Computer using the forecast meteorological information. The DR Computer can now be used to determine headings, groundspeeds and times for each of the cruise legs and the data entered on the form. Elapsed times and ETAs can be entered in the appropriate columns of the flight plan.

22. **Safety Altitude**. The safety altitude for each leg or section must be determined from a topographical chart using whatever criteria are laid down by the Command, Group, or other operating authority. In this example the basic criteria of 1,000 ft (2,000 ft in the case of obstacles over 3000 ft) above the highest obstacle within 30 nm of planned track, rounded up to the nearest 100 ft, has been used.

23. **F2919/CA48**. If necessary an F2919/CA48 - Flight Plan can now be completed and submitted. The occasions when this form should be completed, and instructions for its completion, are contained in the Planning Document and in FLIPs.

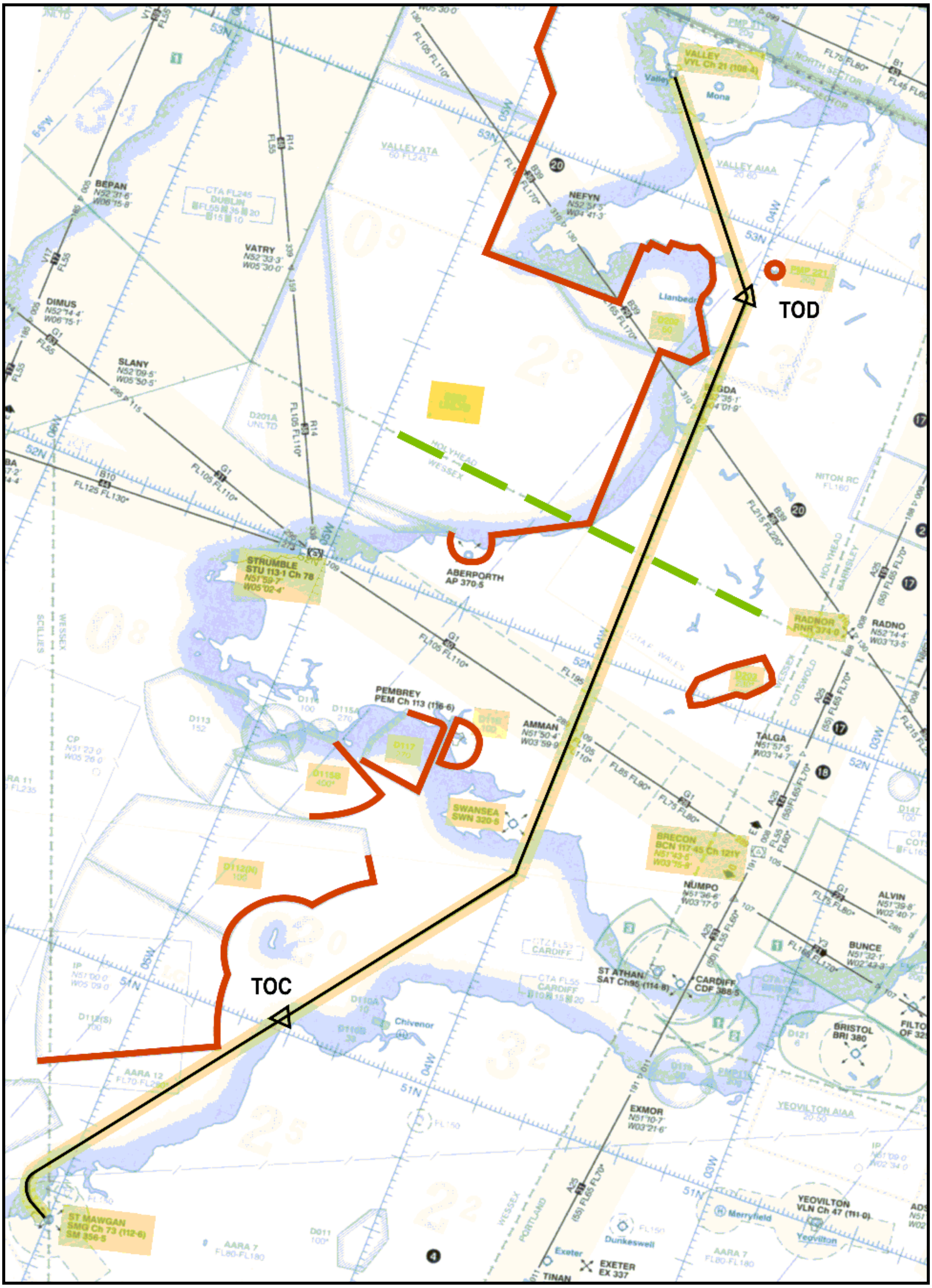


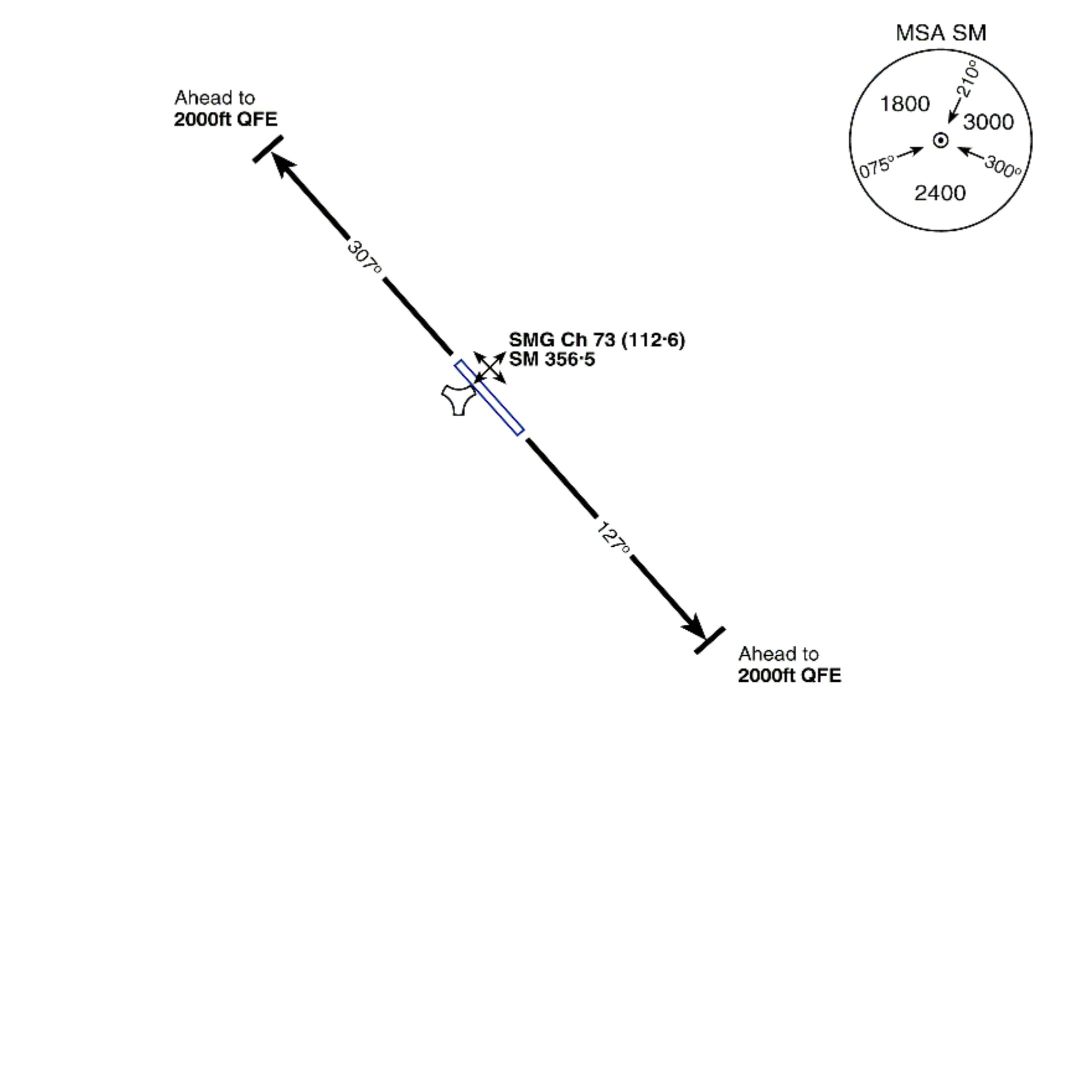
Fig-1 : En-route Chart for Route St Mawgan Valley (not correct scale)

RAF PROCEDURE (APATC-1) Changes: Specification **EGDG** ENGLAND

SIDs **ST MAWGAN**

TOWER	APPROACH	DIRECTOR	LONDON MIL
241·825 123·4 122·1	357·2(MATZ) 126·5	360·55 125·55 344·0	275·475

EMERGENCY SAFE ALTITUDE 100nm **3700ft**	TA 3000ft	Var 6° W



GENERAL

1 No practice diversions including practice PANs after 2300hrs local.
2. Assume normal climb rates after **2000ft QFE.**
3. **CAUTION** Risk of bird strikes.

MINIMUM CLIMB RATES - APATC-1

RWY	Up To	Knots	60	120	180	240	300	360
13	2000ft	Vvfpm	262	524	786	1048	1310	1572
31	Up To	Vvfpm	156	312	468	624	780	936

RWY	**ROUTEING (Including Mnm Noise Routes)**
31/13	Climb on Rwy Hdg **2000ft QFE** then as cleared.

(Replaces S1001A dated 29 JUL 97) Published by No1 AIDU (RAF)

S001A 25 NOV 97 N50 26·43 W004 59·72 (Datum WGS 84) **EGDG** ENGLAND

SIDs **Elev 390ft** **ST MAWGAN**

Fig-2 : St Mawgan Standard Instrument Departure

A/C	C/S	DATE	PILOT	NAV	SCREEN

DIVERSION	1	TR ( )	DIST NM	FL

TR	W/V	HDG	VAR	HDG (M)	DR	WP	ROUTE TO	SALT	RAS MACH	FL ALT	OAT	TAS	G/S	LEG DIST	LEG TIME	ET	ETA	START WT	FUEL FLOW	FUEL USED	FUEL 8000	FUEL MIN
035	330/35	028	6W	034	7S		TOC	3000		210		267	250	46	11	11						
														80								
035	340/45	028	6W	034	7S		5130N 0400W	4000	210	210	-23	290	262	34	8	19						
359	340/45	356	6W	002	3S		5250N 0400W/TOD	5600	210	210	-23	290	249	80	19	38						
319	330/35	320	6W	326	1P		VALLEY	5600		1000		282	250	32	8	46						

MIN THRESHOLD	800
INST APP AT DIVERSION	400
OVERSHOOT AND CLIMB AT DESTN	100
TRANSIT FUEL (W/C + ICING)	
FUEL ON THE GROUND	

FUEL FOR APPROACHES	
VISUAL APPROACH	100
INSTRUMENT APPROACH	200
FULL INSTRUMENT PATTERN AND APPROACH	400

Notes : 1. Max crosswind component - 25 kt 2. Max surface W/V limit - 40 kt

RW.....................ROLL.....................
MIN FUEL.....................COMBAT.....................
RW.....................ROLL.....................
MIN FUEL.....................COMBAT.....................

Fig-3 : Flight Plan Form

NORMAL CLIMB

(ISA + 3° C to ISA + 7° C)

PRESS HEIGHT ft × 1000	ISA TEMP °C	MEAN TAS kt	TAKE-OFF WEIGHT (lb × 1000) 21		20		19		18		17		16		15		14		ISA TEMP °C	PRESS HEIGHT ft × 1000
			FUEL lb	TIME min	FUEL lb	TIME min	FUEL lb	TIME min	FUEL lb	TIME min	FUEL lb	TIME min	FUEL lb	TIME min	FUEL lb	TIME min	FUEL lb	TIME min		
42	−57	318							1745	36	1525	30	1375	26	1245	23	1130	20	−57	42
41	−57	314							1585	30	1420	26	1295	23	1180	21	1080	19	−57	41
25	−35	281	1060	13	1005	13	945	12	890	11	835	10	785	10	740	9	690	9	−35	25
24	−33	278	1020	13	955	12	905	11	850	10	805	10	755	9	710	9	665	8	−33	24
23	−31	274	980	12	920	11	870	10	820	10	775	9	725	9	685	8	640	8	−31	23
22	−29	271	940	11	880	11	835	10	785	9	745	9	695	8	660	8	615	7	−29	22
21	−27	267	900	11	845	10	800	9	755	9	715	8	670	8	635	7	595	7	−27	21
20	−25	264	860	10	805	9	770	9	720	8	685	8	645	7	610	7	570	7	−25	20
19	−23	260	820	9	775	9	740	8	695	8	660	7	620	7	590	7	550	6	−23	19
18	−21	257	785	9	740	8	705	8	670	8	630	7	595	7	565	6	530	6	−21	18
17	−19	254	745	8	705	8	675	7	640	7	605	7	575	6	540	6	510	6	−19	17
16	−17	251	710	8	670	7	640	7	610	7	580	6	545	6	520	6	485	5	−17	16
15	−15	247	670	7	635	7	610	7	575	6	550	6	520	6	495	5	465	5	−15	15
14	−13	244	635	7	605	7	580	6	550	6	525	6	495	5	470	5	445	5	−13	14
13	−11	240	600	6	570	6	550	6	520	6	500	5	470	5	450	5	425	5	−11	13
12	−9	237	565	6	540	6	520	5	490	5	470	5	450	5	425	4	405	4	−9	12
11	−7	233	530	6	510	5	490	5	465	5	445	5	425	4	405	4	385	4	−7	11
10	−5	229	495	5	480	5	460	5	440	5	420	4	400	4	380	4	365	4	−5	10
9	−3	224	465	5	445	5	430	4	410	4	395	4	380	4	360	4	345	4	−3	9
8	−1	219	430	4	415	4	400	4	380	4	370	4	355	4	335	3	325	3	−1	8
7	+1	213	400	4	385	4	370	4	355	4	345	3	330	3	315	3	300	3	+1	7
6	+3	207	365	4	350	4	340	3	330	3	320	3	305	3	295	3	285	3	+3	6
5	+5	200	335	3	325	3	310	3	305	3	295	3	285	3	275	3	265	3	+5	5
4	+7	187	290	3	280	3	270	3	265	3	255	3	250	2	245	2	235	2	+7	4
3	+9	175	245	2	240	2	235	2	230	2	220	2	215	2	210	2	205	2	+9	3
2	+11	163	200	2	195	2	195	2	190	2	190	2	185	2	185	2	180	2	+11	2
1	+13	151	150	2	150	2	150	2	150	2	150	2	150	2	150	2	150	2	+13	1

Time to height at intermediate rating (min.)	*Increase in time to height at max. cont. power (min.)*	*Increase in fuel to height at max. cont. power (lb.)*
4	1	35
6	2	60
8	3	95
10	4	135
12	5	180
14	6	230
16	7	295

Fig-4 : ODM Climb Table

	Normal Descent (0.67 M_{IND} /240kt, I A S) (85% N_{MAX} to 30000 FT. Then Flight Idling)		
Pressure Height ft × 1000	Fuel lb	Time Min	Mean T A S kt
42	390	20	341
41	375	19	338
40	360	18	335
39	340	18	331
38	325	17	328
37	310	16	325
36	290	15	322
35	270	15	319
34	250	14	315
33	235	13	312
32	215	13	309
31	200	12	306
30	185	11	303
29	180	11	300
28	175	10	297
27	170	10	295
26	165	10	293
25	160	9	290
24	155	9	288
23	150	9	286
22	145	8	284
21	140	8	282
20	135	8	280
19	130	7	278
18	125	7	276
17	120	6	274
16	110	6	272
15	105	6	270
14	100	5	268
13	95	5	266
12	90	5	264
11	80	4	262
10	75	4	260
9	70	3	258
8	65	3	256
7	55	3	254
6	50	2	252
5	40	2	250
4	30	1	248
3	20	1	246
2	10	0	244
1	0	0	242

	Fast Descent (0.72 M_{IND} /285 kt, I A S) (Air Brakes Open, Flight Idling Throughout)		
Pressure Height ft × 1000	Fuel lb	Time min	Mean T A S kt
42	80	5	377
41	80	5	375
40	75	5	375
39	75	5	371
38	75	5	369
37	70	4	367
36	70	4	365
35	70	4	363
34	65	4	360
33	65	4	358
32	65	4	356
31	60	4	354
30	60	4	351
29	60	4	349
28	60	4	347
27	55	3	345
26	55	3	342
25	55	3	340
24	50	3	338
23	50	3	335
22	50	3	333
21	45	3	331
20	45	3	329
19	45	3	326
18	40	3	324
17	40	2	322
16	40	2	320
15	35	2	317
14	35	2	315
13	35	2	313
12	30	2	311
11	30	2	309
10	25	2	306
9	25	1	304
8	20	1	302
7	20	1	300
6	15	1	298
5	15	1	296
4	10	1	294
3	5	0	291
2	5	0	289
1	0	0	287

FOR DESCENT BETWEEN TWO INTERMEDIATE HEIGHTS THE MEAN TAS IS OBTAINED BY ADDING THE MEAN TAS AT EACH HEIGHT AND SUBTRACTING THE FOLLOWING:

NORMAL DESCENT 240 KNOTS

FAST DESCENT 290 KNOTS

Fig-5 : ODM Descent Table

Long Range Cruise

(ISA +3 °C to ISA +7 °C)

Press Height ft/1000	ISA Temp °C	Speed (below line) knots TAS	Fuel Flow (above line) lb/hr	Speed (knots TAS) above line / Fuel Flow (lb/hr). Below line / Weight (lb/1000): 19	18	17	16	15	14	13	Fuel Flow (above line) lb/hr	Speed (below line) knots TAS	ISA Temp °C	Press Height ft/1000
42	-57		1675				360	1655	1590	1540		375	-57	42
41	-57		1760			357	1735	1670	1615	1565		375	-57	41
40	-57		1845		356	375	1750	1695	1645	1595		375	-57	40
39	-57		1935	356	375	1830	1775	1720	1670	1625		375	-57	39
38	-57	375		1975	1910	1850	1800	1750	1700	1660		375	-57	38
37	-57	367		1940	1885	1830	1780	1730	1795	1645		367	-57	37
36	-57	359		1915	1860	1810	1760	1710	1670	1635		359	-57	36
35	-55	352		1910	1855	1805	1760	1715	1675	1640		352	-55	35
34	-53	346		1900	1850	1805	1760	1720	1680	1640		346	-53	34
33	-51	340		1900	1850	1805	1760	1720	1680	1645		340	-51	33
32	-49	334		1900	1855	1810	1765	1720	1680	1645		334	-49	32
31	-47	328		1905	1855	1810	1765	1725	1690	1655		328	-47	31
30	-45	323		1910	1860	1815	1770	1730	1695	1660		323	-45	30
29	-43	317		1910	1865	1820	1780	1740	1700	1665		317	-43	29
28	-41	312		1915	1870	1825	1785	1745	1705	1670		312	-41	28
27	-39	307		1920	1875	1830	1785	1745	1710	1675		307	-39	27
26	-37	301		1925	1880	1835	1790	1750	1715	1680		301	-37	26
25	-35	296		1930	1880	1835	1795	1755	1720	1685		296	-35	25
24	-33	306		2040	1995	1955	1915	1880	1845	1815		306	-33	24
23	-31	301		2040	2000	1960	1920	1885	1850	1820		301	-31	23
22	-29	296		2045	2005	1965	1925	1890	1860	1830		296	-29	22
21	-27	291		2055	2015	1975	1935	1900	1865	1835		291	-27	21
20	-25	287		2070	2030	1990	1950	1915	1885	1855		287	-25	20
19	-23	282		2075	2035	1995	1960	1925	1895	1865		282	-23	19
18	-21	277		2085	2045	2010	1975	1940	1910	1885		277	-21	18
17	-19	273		2095	2060	2025	1990	1960	1930	1905		273	-19	17
16	-17	268		2115	2075	2040	2010	1980	1950	1925		268	-17	16
15	-15	265		2140	2105	2070	2040	2010	1985	1960		265	-15	15
14	-13	261		2165	2130	2100	2070	2040	2010	1985		261	-13	14
13	-11	256		2195	2160	2125	2095	2065	2040	2015		256	-11	13
12	-9	252		2225	2190	2155	2125	2095	2070	2045		252	-9	12
11	-7	248		2255	2220	2190	2160	2130	2105	2085		248	-7	11
10	-5	245		2295	2260	2230	2205	2180	2155	2135		245	-5	10
9	-3	241		2330	2300	2275	2250	2225	2200	2180		241	-3	9
8	-1	238		2375	2345	2320	2295	2270	2250	2230		238	-1	8
7	+1	234		2425	2395	2370	2345	2325	2300	2280		234	+1	7
6	+3	230		2475	2445	2420	2395	2375	2350	2330		230	+3	6
5	+5	227		2535	2505	2480	2455	2430	2405	2380		227	+5	5
4	+7	224		2590	2560	2535	2505	2475	2450	2425		224	+7	4
3	+9	221		2645	2610	2580	2550	2525	2495	2470		221	+9	3
2	+11	217		2695	2660	2630	2600	2570	2545	2520		217	+11	2
1	+13	214		2750	2715	2680	2650	2620	2590	2565		214	+13	1

Recommended Speeds	
Altitude (ft/1000)	Speed
1 - 24	205 kt IAS
25 - 38	195 kt IAS
39 - 42	.64 M_{IND}

NOTE: For operation above line throttles are set to give Maximum Continuous Power.
For operation below line engines are throttled back to give Recommended Speed.
For fuel flows above line reduce fuel flow by 10 lb / hr / 1000 lb for weights greater than 15000 lb, and increase fuel by 10 lb / hr / 1000 lb for weights less than 15000 lb.

Fig-6 ODM Long Range Cruise Table

TOPIC–2
FUEL PLANNING

Introduction

1. Fuel planning is an integral part of flight planning, and accurate calculation of the fuel requirement for a particular flight is important for safety, economical operation, and the maximum utilization of payload.

2. The methods of calculating the fuel plan, and of monitoring the fuel consumption in flight, will vary between aircraft type and role, and on the requirements of the flight. The principles outlined in this chapter are applicable mostly to larger aircraft.

Fuel Planning Data

3. Fuel consumption is a function of altitude, air temperature, speed, all up weight and engine RPM. Data on fuel consumption, expressed in either lbs or kgs per minute or hour, is presented in the Operating Data Manual (ODM) for the aircraft type, usually in tabular form with entering arguments of altitude and all up weight.

4. The ODM will normally present a rapid planning section where the fuel requirement for a given sector distance is tabulated against a variety of head or tail wind components.

The Fuel Plan

5. Preparing the basic fuel plan is straight forward using the data from the appropriate tables of the ODM. It consists of a climb, a cruise and a descent portion. The cruise portion is divided by a number of way-points. The length of each section for fuel planning considerations will depend on the aircraft type.

6. **Climb**. The fuel for the climb section is extracted from the climb table of the ODM ensuring that the correct climb and temperature profile is selected. In practice this will be done at the same time that the mean TAS and time to climb are found for navigation planning. The top of climb position is plotted allowing the first cruise leg to be defined. The fuel used is entered in the column of the flight plan and by subtraction the fuel remaining and AUW at the top of climb are calculated and entered.

7. **Descent.** The descent fuel is similarly found using the ODM descent tables. The top of descent point can be plotted thus allowing the last cruising leg to be defined. It should be noted that the descent table will normally assume a descent to 1000 ft. If it is planned to stop the descent at an intermediate level then an adjustment must be made. For example if it is intended to descend from FL 310 to FL 40 then the figures for fuel and time for a descent from FL 40 are subtracted from those for a descent from FL 310. The fuel used in the descent can be entered in the flight plan.

8. **Cruise**. The start weight at the beginning of the first leg is used as an entering argument with altitude to determine the fuel flow rate. This can be entered in the flight plan and subtracted from the fuel remaining to give the new fuel remaining, and from the previous AUW to give the AUW for the next leg. The process is repeated for the remaining cruise legs.

Minimum Fuel Requirements

9. The planning procedure discussed above has determined the amount of fuel needed to carry out the flight, but has taken no account of the quantity of fuel with which it is necessary to arrive at the destination.

10 The ODM based calculation gives the amount of fuel remaining when the aircraft arrives overhead the destination at 1000 ft. There will be a minimum landing fuel to cater for gauging errors, which will vary with aircraft type, and additional fuel will be required to carry out an approach (either visual or instrument). Furthermore, it will normally be necessary to carry fuel to allow for an overshoot and climb at the destination, and a transit to, and approach at, a diversion airfield. It may be necessary to make an additional allowance for other factors with some aircraft, eg the possibility of icing conditions.

11. For most aircraft there will be 'standard' amounts for these various fuel requirements (perhaps printed on the flight plan form for convenience) and usually a locally produced diversion table giving the fuel required for the normal diversion airfields. In 'non-standard' cases the diversion fuel will need to be calculated.

In-flight Fuel Monitoring

12. Whereas the fuel plan gives an indication of the expected fuel consumption leg by leg, it can be difficult to make an assessment of the situation when the fuel consumption varies from that expected. To overcome this shortcoming the fuel graph has been developed on which fuel is plotted on the vertical axis against either time or distance on the horizontal axis. The former is known as the fuel/time Howgozit and the latter as the fuel/distance Howgozit. Each type is suited to certain roles; in general the maritime and AAR roles use fuel/time graphs while transport operations tend to use the fuel/distance graph. The fuel/distance Howgozit has the advantage of being ideally suited to the solution of critical point and other tactical problems.

Fuel/Distance Howgozit

13. **Construction.** In fuel/distance Howgozit chart the vertical axis represents fuel remaining while the horizontal axis represents the distance to go to the destination. The departure airfield is represented by the intersection of the total route distance and the take-

off fuel. The destination is similarly represented by the intersection of the flight plan fuel remaining overhead the destination and zero distance to go.

14. **Minimum Fuel Line**. The graph plotted represents the expected fuel consumption for the flight and in particular terminates at the expected fuel remaining overhead the destination. A minimum fuel line may be constructed through the minimum fuel point and parallel to the planned fuel line. As a flight safety item this is normally plotted in red. Any in-flight fuel check that falls below this line means that the destination cannot be reached with the stipulated reserves and some action must be taken to remedy the situation.

15. **In-flight Fuel Checks**. One advantage of graphical monitoring of fuel consumption is that fuel checks can be carried out at any convenient time and are not restricted to pre-planned times or positions. The frequency of fuel checks will normally be stipulated by the operating authority but in general a check will be made at TOC, just prior to TOD and at approximately 30 minute intervals during the cruise.

16. **Fuel Consumption Trend**. After a number of fuel checks it will be possible to join them to establish an impression of the actual rather than the predicted consumption. This trend line may be extrapolated to estimate the effect on the expected destination fuel. Clearly such estimates must be treated with caution and the longer the period over which the trend can be established the more reliable it is likely to be. It is important to give some consideration as to the reason for a trend varying from the prediction.

Fuel/Time Howgozit

17. **Construction**. The fuel/time Howgozit is constructed in a similar manner to the fuel/distance variety except that the horizontal axis represents flight plan elapsed time from take-off.

18. **In-flight Fuel Checks**. Once airborne, the elapsed times on the horizontal axis can be replaced with real times if required. Fuel checks are plotted on the graph as values of fuel remaining against time or elapsed time from take-off.

Fuel Saving

19. If during the flight a fuel check falls below the minimum fuel line, or if a reliable trend shows that the fuel will be below minimum at the destination, then some fuel saving action must be initiated.

20. The action to be taken will depend on a number of factors such as the aircraft type and performance, the nature of the task, and airspace restrictions. Although no precise guidance can be given the following options might be considered:

a. **<u>Shorten the Route or Time on Task</u>**. This is normally the most effective method but in the case of a route is dependent upon the route geometry. It should be relatively simple in a route with large turns, but will be impossible in a straight route.

b. **<u>Alter the Flight Profile</u>**. There are various techniques which may be considered such as remaining at height for longer and executing a rapid rather than normal rate descent, flying at a different speed (endurance cruise), changing the planned approach, eg straight-in visual rather than full instrument recovery, changing the cruise flight level. In the latter case both the effect of a different fuel flow rate and of a different wind structure must be considered.

c. **<u>Renegotiate the Minimum Overhead Fuel</u>**. It may be possible to change the planned diversion airfield to one that is closer or has better weather thus allowing a visual rather than instrument approach and a consequently lower fuel requirement.

TOPIC- 3
LOW LEVEL NAVIGATION PLANNING

Introduction

1. Planning for a low level flight can take a variety of forms. For example it may take 10 minutes and involve using a chinagraph pencil on a plastic covered map whilst sitting in the cockpit of a Harrier, or it may take an hour or two carefully planning a coordinated multi-aircraft interdiction mission in a well-equipped Flight

Planning Section.

2. It is beyond the scope of this manual to cover the particular techniques required for these special cases. However, there are some elementary methods and considerations which form the basis of all low level planning and this chapter will be concerned with these.

3. It will be assumed that the AFCENT 1:500,000 LFC or the 1:250,000 TAC will be used for routine navigation, and the OS 1:50,000 maps for target planning. The discussion will be on the basis of planning for a single aircraft executing a low level navigation sortie, with a simulated level attack on a target. Nevertheless some of the factors to be considered when planning for a formation of aircraft will be mentioned.

4. The aim of low flying is to arrive safely and ideally undetected, at an objective; typically at a target. In practice the target planning will be done before the route planning. However, as low level navigation may be undertaken on occasions without a target element, the route planning will be considered first.

ROUTE SELECTION AND PLANNING

Initial Considerations

5. **Route.** The low level route should normally be the shortest, safest, practical route to the target and back to base or destination. In particular the time spent in "enemy" territory should be kept to the absolute minimum. Long straight legs are easier to fly, particularly if in formation. The following points should be considered when planning the route:

a. **Airspace Reservations**. Controlled and restricted airspace must be avoided. Route restrictions may be imposed by the UKMLFHB, eg avoiding hospitals, following flow arrows etc. The avoidance of certain areas does, of course, have its parallel in a tactical situation where enemy defenses or friendly weapons free zones (WFZs) must be considered.

b. **Visibility.** The area downwind of a large industrial complex is often associated with poor visibility, especially into sun, and therefore should be avoided. Visual perspective and range to the horizon reduce as height reduces.

c. **High Ground**. Wherever possible, the highest ground should be avoided, both for tactical and meteorological reasons. An aircraft flying over high ground is often easy to detect, and high ground is more likely to be enshrouded in low cloud; turbulence is often encountered to the lee of high ground.

d. **Birds**. Flying adjacent to coastlines and estuaries should be kept to a minimum as these tend to have higher than average bird concentrations.

e. **Nuisance**. To reduce undue noise nuisance, towns and villages should be given as wide a berth as is practical; if this is not practical then the transit height must be increased. It should be noted that when flying in formation other aircraft may be displaced laterally and so adequate horizontal clearance must be planned.

f. **Natural Features**. Use should be be made whenever possible of natural line features which lie more or less along track and funnel features which can be followed to the destination, turning point or check feature. Landmarks with vertical extent which rise above the surrounding terrain should be chosen as turning points or check features.

6. **Speed**. Low level fixed wing navigation exercises are normally planned and flown on the basis of maintaining a constant groundspeed. For convenience this groundspeed is usually a multiple of 60 kt so that it equates to an integral number of nm per minute. On the other hand, rotary wing aircraft often fly close to Vmax, and a constant airspeed is flown during a navigation sortie. For most practical purposes it can be assumed that IAS = TAS at low level and thus the only necessary adjustment for speed will be to account for the wind effect. Clearly, if operations are to take place over regions considerably above sea level, the IAS/TAS relationship may need to be considered.

7. **Height.**

a. **Fixed Wing**. In the majority of cases low flying will be carried out between 250 and 500 feet minimum separation distance (MSD). Excursions outside of this bracket, between 100 and 2000 feet MSD, will normally need little change to planning methods, although there may be some need to adjust the low flying techniques.

b. **Helicopters.** Low flying frequently takes place at 50 feet above ground level (AGL) with an associated minimum separation criteria (MSC), even down to hover taxy height in some cases.

8. **Heading**. The low level plan is usually made on a 'still air' basis, and so directions are annotated in terms of track, either true or magnetic, rather than heading. Adjustments are made on the day by rule of thumb methods to account for drift.

9. **Maps**. It is important that maps are updated using the latest CALF, CHAD, CHUM, and NOTAMs. It should be remembered that NOTAMs may be issued after planning is complete and so must be consulted immediately prior to flight so that any necessary amendments to the plan can be made.

Map Preparation

10. **Track**. The track should be drawn on the map in such a way that it is easily seen even in turbulent conditions, ie in a deep colour and boldly, but so that it does not obscure significant detail. Gaps can be left in the track line so that fix points along track are obvious. The track line should be marked at intervals representing the distance flown in one minute (or two minutes if preferred and appropriate), and with times at turning points and at other significant features if required. The track direction should be marked near the start of each leg. Straight line tracks are not mandatory. Although the straight line represents the shortest distance between two points, it is not necessarily the most appropriate route; for example it will often be preferable to follow a valley rather than fly the direct line over hills. In this situation mean tracks for sections of the valley can be measured as guides to direction.

11. **Other Information**. Safety altitude(s) for the route or area of operation should be marked clearly on the map. Other data which may need to be marked or highlighted include altimeter setting regions, radio frequencies and controlled airspace heights.

Fuel Planning

12. The exact fuel planning procedure will depend to a certain extent upon the aircraft type, the nature of the exercise, and local requirements. In general the map should be marked at intervals of between 5 and 10 minutes, and at the point furthest from base, with figures showing the anticipated fuel remaining, and the amount of fuel required to complete the route as planned.

TOPIC–4
TIMING TECHNIQUES

Introduction

1. Many air operations require that aircraft reach a given point at a precise time. As it is usually easier to lose time than to gain it, such operations are often planned with a margin of time in hand. Whether or not this is done, some adjustment to the speed or to the distance flown will invariably be necessary to achieve the planned arrival time.

TIMING BY SPEED ADJUSTMENT

General

2. The obvious way to alter an aircraft's time of arrival at its target is to increase or decrease the airspeed, thus changing the groundspeed. If the aircraft is equipped with a Doppler or inertial navigation system it is more convenient to base adjustment directly on groundspeed.

3. Only a small increase above the standard operating speed of an aircraft at a given height is normally possible without an appreciable penalty in fuel consumption. Small speed changes result in only small increases or decreases in flight time. For example, at a groundspeed of 200 knots an adjustment in groundspeed of 10 knots will gain or lose only three minutes in an hour, the same adjustment at 400 knots gives a difference of only one and a half minutes per hour. If, therefore, accurate timing at the target is to be achieved by speed adjustments, action must be initiated as early as possible. The ideal is to be on time at the beginning of a flight, and stay on time by adjusting the speed at each fix.

4. Two factors usually tell against attainment of the ideal. If operating in an area not served by a reliable wind forecasting service, a situation more common operationally than in training, to stay on time during the early part of the flight might lead to impracticable speed changes being required when near the target, to compensate for major changes from the forecast head or tail wind component. Furthermore, frequent speed changes when operating high performance aircraft are expensive in fuel. It is therefore good practice to make only one or two adjustments to speed in the early stages of the flight, and changes at turning points are usually adequate. The aim is to stay nearly on time but with a progressively decreasing amount of time in hand, arriving on time at a suitable way point near enough to the target to allow any reasonable wind changes to be taken care of by speed adjustment. From that way point to the target timing is checked and speed adjusted at each fix.

Calculation of Speed Adjustments

5. The required groundspeed changes can be calculated as follows:

a. On the Dead Reckoning computer, by calculating the groundspeed required between a fix and the next turning point from time and distance to go.

b. By the use of tables, prepared for the usual operating speeds, giving the amount of time gained or lost if various speed changes are applied for a given period.

c. By using annotations made on the flight plan of the airspeed adjustments required to gain or lose one minute, computed for each leg.

d. By estimation in flight using mental DR (MDR).

6. An MDR change of G/S can be converted to an MDR change in CAS by multiplying it by the approximate ratio of CAS to TAS. Thus, if the required G/S is an increase of 44 kt with a current CAS of 209 kt and a TAS of 282 kt, then the CAS should be increased by 44 x 0.75, ie 33 kt.

Change of Mach Number

7. When an aircraft is being flown by reference to a Mach meter rather than an airspeed indicator, an adjustment to indicated Mach number to gain or lose time can be calculated as follows:

a. Computer Method:

(1) Determine the present groundspeed.
(2) Determine the groundspeed required to make good the required ETA.
(3) Calculate on the computer a new Mach number to fly, using the following formula:

$$\frac{\text{Current Mach No}}{\text{Current G/S}} = \frac{\text{New Mach No}}{\text{Required G/S}}$$

This method is adequate under most circumstances, but becomes increasingly inaccurate with head or tail wind components in excess of 50 kt.

b. **Use of Timing Graph**. The change in Mach number required can be determined directly from a graph (such as that illustrated at Fig 1) as follows:

(1) Calculate the ETA using the current groundspeed and the distance to go.

(2) From this ETA and the required ETA determine the amount early or late.

(3) Enter the graph with distance to go and current groundspeed, extract the Mach number change required to gain or lose one minute, and by proportion determine the Mach change needed.

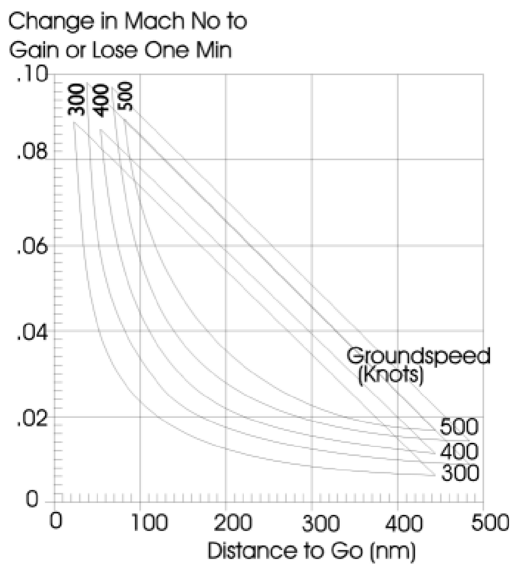


Fig-1 : Change of Mach Number to Gain or Lose Time

TIMING BY ADJUSTMENT OF DISTANCE TO BE FLOWN

General

8. It may sometimes be desirable to adjust timing by altering the distance to go rather than by changing airspeed. The various methods of doing this, some of them requiring pre-planning and some not, are described in the following paragraphs.

Losing Time by 60° Dog-leg

9. Heading is altered 60° in either direction for the length of time that is to be lost, then altered 120° in the opposite direction for the same length of time to regain track. Heading to the next turning point or target is then resumed. The aircraft will thus have flown two sides of an equilateral triangle, and the time lost will be equal to the time taken to fly one side.

10. Small inaccuracies in tracking and time lost will be introduced by the wind effect during the procedure, but they will usually by negligible if the amount of time to be lost is small. If the same constant rate of turn is maintained throughout the three turns, and if legs are timed accurately from leveling out after a turn to the start of the next turn (see Fig 2), the effect on time lost of the time taken to turn can be ignored.

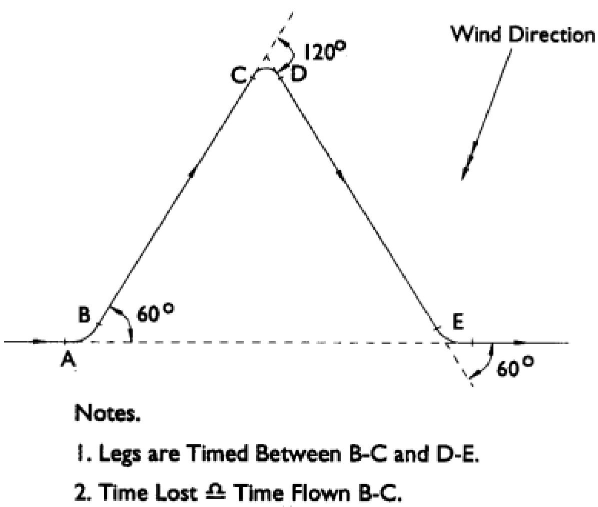


Fig 2 60° degree Dog-leg Procedure

11. The 60° dog-leg procedure as described above can normally be used for small time losses, but if more than two minutes is to be lost, or if the wind is strong, it will be necessary to adjust the time on the second leg to ensure that the final turn will bring the aircraft back on track. If this is not done, the resulting track error will leave a further timing problem, particularly if near the next turning point. Where such an adjustment will be necessary, it is usual to make the first turn towards the "into wind" direction. This will ensure that track can be rejoined with time in hand, and that it will not be necessary to extend the second leg to regain track, thus putting the aircraft in the more difficult position of having to make up time.

Losing Time by 30° Dog-leg

12. A similar procedure, altering heading first 30° in one direction then 60° in the othe before resuming heading, may be used for small adjustments in ETA (see Fig 3).

13. For each minute to be lost each leg is flown for four minutes. This procedure is useful for small time losses (up to two mins) when it is desired to stay near track and avoid big alterations of heading.

14. It should be noted that, where timing is not a consideration, adoption of a formal dog-leg procedure to avoid obstacles or weather will enable the track to be regained and ETA amended with minimum calculation.

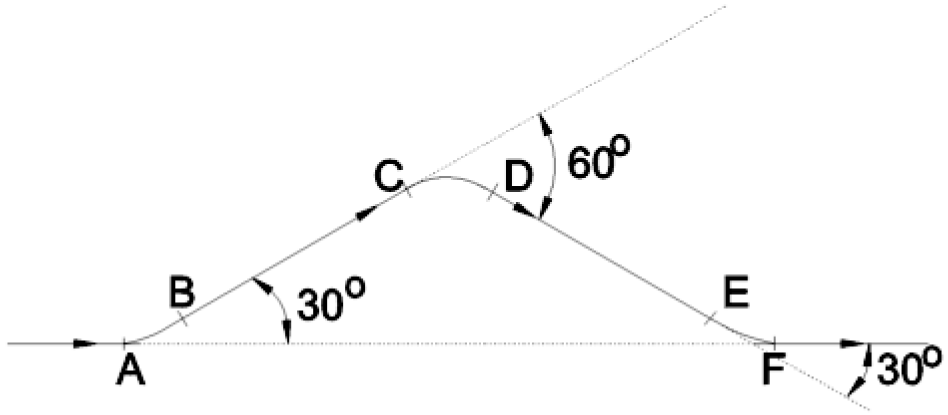


Fig 3 30 degree Dog-leg Procedure

Losing Time by Rate 1 Turns (90° Method)

15. The procedure illustrated at Fig 4 could occasionally be useful in high performance aircraft. The time lost by using the procedure is arrived at as follows:

Distance A-B-C = πd (where "d" is the diameter of turn)
Time A-B-C = 2 mins (360^{o} at Rate 1)
Direct Distance A-D = 2d

Time A-D = $2d \times \frac{2}{\pi d}$ mins
= 1min15 sec (approx)
$\because$ Time lost = 45 sec

16. To lose more than min, subtract from the time to be lost and straighten up between each reverse for half the resultant time.

Summary of Dog-leg and 90° Methods

17. The above methods suffer from the disadvantages that:

a. They are imprecise in track-regaining.

b. They are inaccurate in time losing.

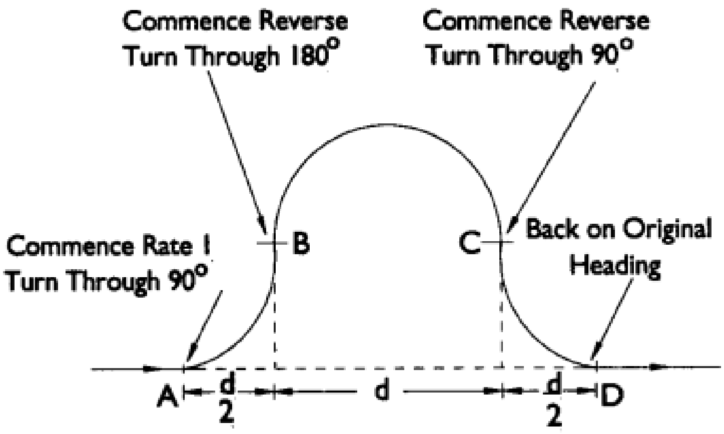


Fig 4 Losing Time by 90 degree Method

18. It is usually necessary for them to be followed by heading corrections, and if precision is required, by speed adjustments. They do however serve to lose a lot of time in a short distance along track, but at the expense of considerable deviation from the planned track - not always tactically acceptable.

<u>Cutting the Corner</u>

19. If there is a suitably large track alteration along the route, timing may be adjusted by extending or cutting the corner at that turning point. Two simple examples of this procedure is shown in Fig 5.

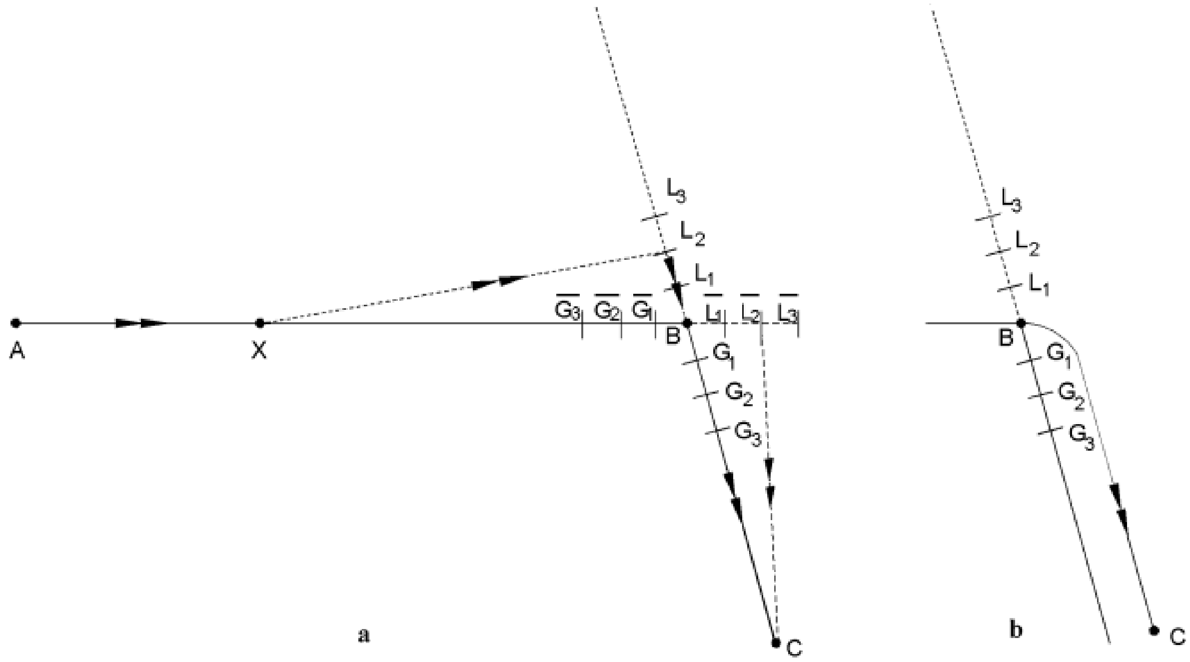


Fig 5 : Timing by Adjustment of Track at a Turning Point

20. Given a route A-B-C (Fig 5a), timing is adjusted by adopting a new turning point in place of position B. As shown in Fig 5a, distances representing 1, 2 and 3 minutes of groundspeed are marked along the track B C and its reciprocal, and marked G1, G2 and G3 (gaining time) and L1, L2 and L3 (losing time). If at position X the aircraft was two minutes ahead of time, heading would be altered to fly the track X-L2-C. Alternatively, the track AB may be extended beyond B and the 1,2 and 3 minute marks placed on this extension for losing time (, and) and on the reciprocal for gaining time (, , and). If running late, time may be gained by turning early to C from either , or . If early, overflying B and turning towards C from , or will provide the appropriate number of minutes delay. However, since the track has changed so too will the groundspeed. Thus a revision of timing on the new leg will be necessary. Where turning circles have to be followed for, and using the first method as an example, it is convenient to mark the timing points along a line parallel to the track from B to C, passing through the originally planned start turn point at B, as shown in Fig 5b. ETA start turn is then easily calculated.

21. These methods demand distances X-B and B-C and the angle at B to be such that triangles XBL3 and XBG3 (and BC and BC) may be considered isosceles, so that, for example, XB is approximately equal to XL2.

Pre-computed Timing Leg

22. A more precise method of adjusting timing by revising the distance to be flown is to use pre-computed timing legs at any convenient turning point. Use is again made of the principle of isosceles triangles.

GENERAL CONSIDERATIONS

Accuracy

25. Accurate flying and navigation are essential to successful timing. Turns should be executed at the planned rate, and the aircraft flown at the correct airspeed and altitude. Track keeping is important; attempts to make up or lose time by speed adjustment will be negated if the aircraft is allowed to stray far from the planned track.

Early Remedial Action

26. The task of arriving at a target or destination on time will be simplified if any tendency to gain or lose time is quickly recognized, and if remedial action is taken before too big an error has accumulated. When the aircraft is early, case must be taken to ensure, before shedding all the time in hand, that the planned route for the remainder of the flight to the target, coupled with practicable speed adjustements, gives sufficient flexibility to make up any foreseeable subsequent loss of time.

TOPIC-5
MAP READING AND NAVIGATION TECHNIQUES

Introduction

1. Modern aircraft systems are quite capable of performing the routine navigation tasks necessary in a low level mission. However, like all computer systems, they are unable to think, or automatically to instigate changes to a plan when conditions vary from those expected. Moreover although reliability is generally high, such systems do occasionally fail or become degraded. Particularly in the final stages of an attack, it may become necessary to refine the system's navigation solution by direct visual reference to the outside world. Furthermore, there are still many aircraft, especially in the training role, without sophisticated systems. There is therefore a continuing need to develop the skills of low level navigation using the basic aids of map, compass, stop watch, eye, and brain.

2. The aim of low level navigation is to get the aircraft to an objective safely and, ideally, undetected. There is therefore a need to blend accurate navigation, both in space and time, with skilful flying, sound airmanship, and tactical awareness. This chapter will be concerned primarily with the navigation techniques although reference will be made to the other factors.

Map Reading

3. The art of map reading consists of visualizing the physical features represented on the map by symbols, and thus forming a complete mental picture of the ground by relating the features one to another. It is also necessary to perform this analysis in reverse, ie seeing an arrangement of features on the ground and being able to recognise the relevant portion of the map. Expertise at low level map reading demands much practice but there are a number of factors which can make the task easier. The most important of these are thorough flight planning and pre-flight route study. When in flight, maintaining track and time should be a prime aim; errors should be recognised and acted upon early, but concentration on navigation to the detriment of other tasks must be resisted. It is equally important to keep a good look-out to reduce collision risks, to detect any enemy activity, to be aware of any potential weather problems, and to manage the aircraft systems. To this end, significant features should be selected at the planning stage at perhaps 3 to 5 minute intervals, and the in-flight technique should be to identify these features as early as possible and fly with reference to them. The check feature need not be exactly on track; a good feature close to track will usually be better than a poor feature on track, and it is a relatively simple matter to fly the appropriate distance away from the feature.

4. **Selection of Features**. The ideal check feature will be big (or part of a big feature), unique, have some vertical extent, and will contrast in colour or texture with its surroundings. Only rarely will a feature possess all of these attributes and some compromise will be necessary. The value of any type of feature to navigation will depend on circumstances - minor roads may be poor features in built-up areas but may become very significant in an otherwise barren landscape. Careful map study is necessary to ensure that the feature will be seen. For example, when crossing a valley at 90° any feature in the valley, on or close to the near side, may not be seen until it has been passed. Many features will show seasonal variation - thus snow cover may hide smaller roads, but conversely cleared roads may become more apparent due to their increased contrast with the surroundings. Some of the more commonly used map reading features are discussed

below, however only rarely any one feature is used in isolation; it is the relationship of one feature to another that provides confident identification:

a. **Coastlines.** Coastlines are generally excellent fixing features, unfortunately many routes do not allow much time within sight of one. Coastlines are rarely entirely uniform for any great distance, there is usually some associated feature such as a river estuary, headland, or beach to enable position to be fixed with reasonable accuracy.

b. **Water Features**. Large rivers, estuaries, canals and lakes normally show up well, even taking into account seasonal variations such as floods and droughts. However water features tend to occupy the lowest ground in the area and so they may be hidden from view by the surrounding terrain. This is particularly true of lakes in mountainous regions; it is quite possible to fly within a mile or two of a mountain lake and not see it. Smaller rivers are often tree-lined which may be a help or a hindrance. The trees help to locate the river but tend to hide the detail so that particular features of the river may not be seen.

c. **Mountains and Hills**. From a low level viewpoint mountains and hills take on considerable significance, however the interpretation of topography from the map is more difficult than the interpretation of water and man-made features. Isolated hills provide the best features; terrain which undulates fairly uniformly is perhaps the most difficult to use unless there are additional features such as significant woods or transmission masts. Wherever there are mountains and hills there will be valleys and these can be extremely valuable features. They can usually be identified with confidence from their orientation and from the presence of roads, railways and settlements, and they provide a line feature for navigation and a route away from the highest ground.

d. **Towns and Villages**. Because the over-flight of towns and villages should be avoided they cannot be used for accurate pinpointing on their own. However they are useful as general indicators of position and in directing the eyes to suitable features nearby. The identification of a town or village must normally be done by relating it to other features in the vicinity, eg roads, railways, rivers and hills.

e. **Railways**. In areas of dense population and industry the identification of railway lines can sometimes prove troublesome but in more rural areas they provide an excellent line feature and, if there is some unique aspect to the line such as a junction, station, or conspicuous bridge, a pinpoint can be obtained.

f. **Roads**. The usefulness of roads as check features is extremely variable. Motorways are particularly distinctive but a single track narrow road may be just as significant in open country, especially over mountainous terrain. In between these extremes the usefulness will depend on the surrounding landscape, but in general the larger the road the more use it is likely to be.

g. **Woods**. Like roads, woods can vary between excellent and useless. Although woods may appear to have a particularly distinctive and identifiable shape on a map, this shape will normally not be apparent from a low level viewpoint. The exception is when the wood is on a facing slope eg on the far side of a valley. In this situation woods can prove extremely valuable check features. Although there can be some change to wood shapes due to felling and afforestation, the impact of this activity is normally fairly obvious. Nevertheless some care is needed.

h. **Miscellaneous Features**. Many other features can prove to be satisfactory navigation checks. Power transmission lines can act as line features, and as pinpoints where they cross each other or other line features. Power stations, airfields, transmission masts, lighthouses, monuments, and follies are all worthy of consideration.

5. **Relative Value of Features**. Three types of map detail are always plotted in their correct geographic positions. These are:

a. Coastlines.

b. River centerlines.

c. Tops of Hills (Spot height/Trig points).

To avoid being superimposed, all other features are likely to have adjusted positions. In making the adjustments, the cartographer takes care to display the detail correctly relative to adjacent features. Thus, for example, a mast will always be depicted on the correct side of the motorway even though accurate plotting would show it in the fast lane. In this case, it is the standard motorway feature which takes up more space on the map than its actual width demands. Such minor errors in position are unlikely to pose navigational difficulties in practice.

Timing

6. The intelligent use of the stop watch is perhaps the most valuable aid to low level navigation. Provided that the correct heading and speed are flown, the stop watch will provide a relatively accurate means of reckoning position, and the refinement of this position by reference to map and ground will be considerably eased. The watch can thus be used to resolve any ambiguity of features.

7. There are three methods of timing in common use:

a. **Continuous Timing**. This is the simplest timing method in which the watch and the route timing marks are started at the navigation start point (or take off) and are run continuously to the navigation stop point (or landing). Where targets are included in the route, it will usually be preferable to re-start the stop watch at each IP so that the IP to target run can be navigated as a separate entity and with no accrued errors. The technique is to keep as close as possible to the elapsed time on the map, principally by MDR speed adjustment. If the route has to be cut short the watch may be stopped and re-started once the time line has been regained. If the aircraft is forced off the planned track, the technique of leg timing is used.

b. **Hack Timing**. This method is a variation of continuous timing and can be used when it is necessary to achieve a 'real' (rather than elapsed) time on target (TOT). At the planning stage the total elapsed time from take off to TOT is measured and the take off time determined. The watch is started (hacked) at this calculated take off time regardless of the actual aircraft position at the time. The aircraft is then flown to make good the timing marks on the map. Large errors should be corrected early by cutting short the route, and smaller residual errors can be corrected by MDR speed adjustment. All errors should be removed before reaching the IP and, as with continuous timing, it is usually preferable to re-start the stop watch at the IP.

c. **Leg Timing**. Leg timing is the technique which is primarily used when the aircraft is forced off the planned track. The stop watch is started when the aircraft leaves track and again whenever a significant feature is found. Thus the technique provides a means of reckoning aircraft position relative to a series of known 'most recent' fixes. The technique may also be used for routine navigation as it is in rotary wing operations by timing each leg (or series of short legs) individually. In order to achieve a TOT the system must be augmented with real times at each turning point.

8. Each of these methods has its advantages, disadvantages, and adherents. Any continuous timing technique works well, particularly if it is necessary to achieve a TOT, unless diversions from track are occasioned, when the timing is likely to be thrown awry and the watch will not be readily available for ad hoc off track navigation. Leg timing is very flexible and lends itself to stopping and starting in flight as any significant features are noted. It can thus provide very accurate navigation between fix or turning points as accrued errors are not carried forward, and it lends itself to off track navigation. However, if it is required to make a TOT, an additional clock, and real time marks at each turning point, will be needed. A decision on the timing method to be employed will be made on the basis of the flight objectives, the probability of staying on track, and on personal preference.

Estimation of Drift and Required TAS or Groundspeed

9. In order to have the best chance of staying on track and on time due account must be taken of the effect of wind velocity. If the aircraft is equipped with doppler or inertial systems a continuous display of track and groundspeed is available and corrections can easily be made. Without these aids more elementary methods must be employed and the use of mental DR techniques is usually called for.

10. Without better information, the forecast wind velocity for the route or area of operation must initially be relied upon; refinement of this may be possible by observing smoke plumes. Given the wind speed and direction it is possible to use rule of thumb methods in order to resolve the velocity into approximate head or tail and cross wind components. Low level flight is only exceptionally undertaken in wind speeds greater than 40 knots and the approximate methods are therefore normally adequate.

11. **Drift**. To estimate the drift on a given heading it is first necessary to determine the maximum drift that could be experienced, ie if the wind was at 90° to the heading. This is easily calculated by dividing the wind speed by the TAS expressed in nm/min. For example given a wind speed of 30 kt and a TAS of 300 kt, the maximum drift would be = 6°. The actual drift experienced can now be calculated by considering the angle between the wind direction and the track (the wind angle) and using a 'clock analogy'. The wind angle is considered to be minutes of time, and the proportion of an hour that this number of minutes represents, is the proportion of the maximum drift that will affect the aircraft. For example a wind angle of 15° equates to ¼ of an hour and so ¼ of the maximum drift will be experienced. For wing angles of 60° or more it is assumed that the aircraft will experience the maximum drift. An example of the complete calculation is given below:
W/V: 270/30 TAS: 300 kt (5 nm/min) Track: 240°T

Max Drift = $\frac{30}{5} = 6^o$

Wind Angle = 270 - 240 = 30° which, in minutes, is ½ of an hour.

Drift is therefore 6° x ½ = 3°

Clearly care must be taken to apply the drift in the correct sense.

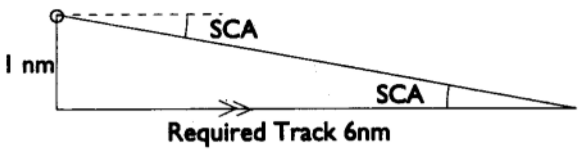
12. **Required TAS**. The calculation of the required TAS to maintain the desired groundspeed is made in a similar manner to drift. In this case the maximum effect occurs when the wind is directly on the nose or tail, falling to zero when the wind is at 90° to track. Thus the clock analogy of (90 – wind angle) is used to estimate the proportion of the wind speed to be added to or subtracted from the desired groundspeed to give the required TAS. Using the previous example, (90 – wind angle) is 60° which corresponds to a full hour, and so all of the wind speed is assumed. As it is a head wind component, a TAS of 330 kt will be needed to maintain the desired groundspeed of 300 kt.

13. **Groundspeed.** In the case of rotary-wing aircraft flying at a constant IAS/TAS, the clock analogy method can be used to derive a correction to apply to TAS to give groundspeed.

Regaining Track

14. Inaccuracies in planning, in wind estimation and in maintaining heading will cause the aircraft to deviate from track. It is usually desirable to regain track as soon as possible as this makes map reading easier and avoids infringing avoidance areas. This can be achieved by identifying an on-track feature and altering heading to fly over it, by following a funnel feature or, if track cannot be visually identified, but the present position relative to track can be pin-pointed, by using the Standard Closing Angle (SCA) technique.

15. **Standard Closing Angle Technique**. The SCA technique (Pt 4, Sect 3 Chap 2) is an application of the 1-in-60 rule and is designed to eliminate 1 nm of track error in 1 minute. Fig 1 shows a situation in which an aircraft with a groundspeed of 360 kt is 1 nm off track. In 1 minute the aircraft would travel 6 nm, and by the 1 in-60 rule:



$$SCA = \frac{\text{Distance off}}{\text{Distance along}} \times 60 = \frac{1}{6} \times 60 = 10\,^{\circ}$$

Fig 1 : Standard Closing Angle

$$SCA = \frac{\text{Distance Off}}{\text{Distance Along}} \times 60$$

$$= \frac{1}{6} \times 60 = 10^o$$

The aircraft should therefore be turned right by 10° for one minute to regain track. In more general terms the SCA is found by dividing 60 by the groundspeed in nm/min, and track is regained by altering heading through the SCA and maintaining this heading for a number of minutes equal to the off-track error in nm. Variations can be made when necessary by doubling the angle and halving the time or vice versa. However, using large angular corrections can lead to errors due to the breakdown of the 1-in-60 rule and also to timing errors; 30° is generally considered to be the maximum heading alteration that should be employed.

Regaining Time

16. As well as maintaining track, it is usually necessary to maintain the planned timing, and the same errors that lead to the aircraft deviating from track can lead to deviations in time. The techniques of dog-legs, cutting corners and pre-computed timing legs outlined in Section 2, Chapter 5 can be applied to the low level environment. Providing that the speed range of the aircraft permits it, and the fuel penalty is acceptable, relatively small timing errors can be corrected by speed changes. Two methods of calculating the necessary adjustment are:

a. Adjust speed by a number of knots equal to the number of seconds late or early and maintain this speed for a number of minutes equal to the groundspeed in nm/min. eg 420 kt groundspeed, 20 seconds late: fly at 440 kt for 7 minutes.

b. Adjust speed by an amount equal to 5 times the groundspeed in nm/min and maintain this speed for a number of minutes equal to one fifth of the number of seconds early or late. eg 420 kt groundspeed, 20 seconds late: fly at 455 kt for 4 minutes.

In either case the speed adjustment can be halved and maintained for twice the time (or vice versa) if necessary. Should a turning point or fix occur during the correction it is usually preferable to re-assess the timing at this point.

17. Helicopters cruise close to their maximum permitted speeds and although it is easy to lose time, gaining time along the route by increasing speed can be difficult. If one or more legs of the route are planned at a speed lower than the normal cruise speed, then time can be gained by flying the 'slow' legs at normal cruise speed. The amount of time to be gained by this method can be calculated by subtracting the leg time flown at normal cruise speed from the leg time at the slower speed.

Weather Avoidance

18. Should bad weather be encountered during low level flight there are four options available; lateral avoidance, vertical avoidance, turn back, and emergency low level abort. The extent and nature of the weather together with the nature of the terrain and the objectives of the flight will determine which course of action is appropriate. An early appreciation of impending poor weather will reduce the chances that the last option has to be resorted to, and provide more thinking time to implement one of the other options.

19. **Lateral Avoidance.** Lateral avoidance is by far the preferred method as low level flight is maintained and the flight objectives stand a greater chance of being achieved. It may be possible to follow a valley or line feature that avoids the weather and returns the

aircraft on or close to track. Equally it may be possible to fly from one significant landmark to another around the weather and back to track. If these options are not practical then a procedural technique can be used - the dog leg.

20. **The Dog Leg**. The dog leg provides a simple procedural technique for avoiding a patch of poor weather on track whilst ensuring that the aircraft will return back onto, or close to, track. Fig 2 illustrates the principle. The aircraft is turned at A by an amount sufficient to avoid the weather, the time is noted, and this heading is maintained until the weather is cleared (B). The time from the initial turn to this point is noted and the aircraft is turned back towards track through twice the original heading change. This heading is maintained for the time noted above when a turn back on to the original track is made (C). Although track will be regained, time will be lost due to the greater distance flown. For a 30° dog leg the time lost will be ¼ of the time taken to fly the leg AB; for a 45° dog leg it will be about ½ the time, and for a 60° dog leg it will be approximately equal to the time. A variation on the simple dog leg technique is to turn back to a track parallel to the planned track before turning to regain track (Fig 3).

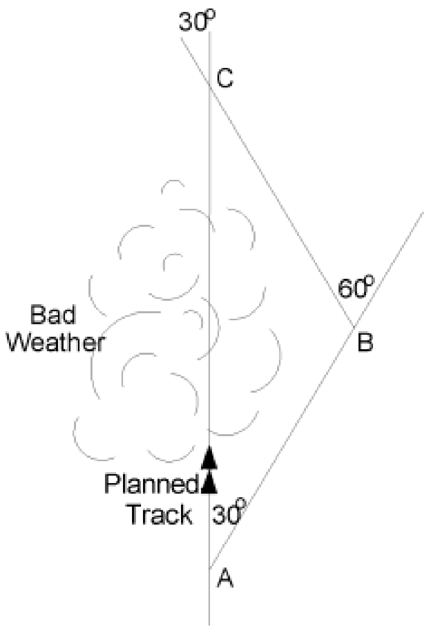


Fig 2 Simple Dog Leg

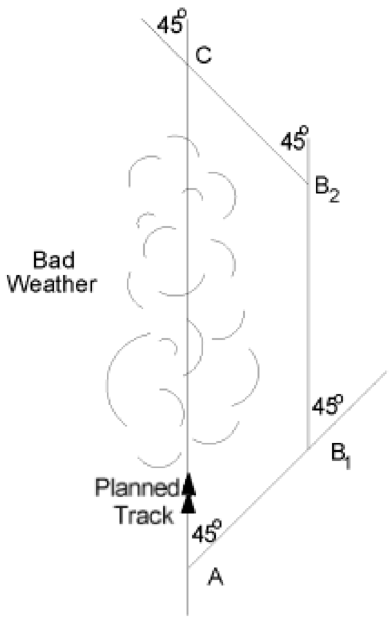


Fig 3 Dog Leg with Parallel Section

21. **Vertical Avoidance**. If the lateral extent of the weather cannot be determined, or if lateral avoidance is precluded by restricted airspace, it may be necessary to climb on track to maintain VMC or to level at safety altitude. By adjusting the IAS the planned groundspeed can be maintained; reducing IAS by the desired TAS in nm/mins for every 1000 ft climbed above sea-level is sufficiently accurate to about 10,000 ft. If accurate speeds and headings are flown, and turns are made on time, it should be possible to identify a ground feature once clear of the weather so that a return to low level can be made. If it is necessary to fly above cloud for a lengthy period then DR accuracy will be degraded and it may be necessary to resort to radio aids, radar assistance or to discontinue

the sortie. Particular attention should be paid to the base altitude or level of any controlled airspace that crosses the route. The vertical avoidance option is not always available to helicopters due to aircraft operating limitations such as icing.

22. **Turn Back**. If the lateral and vertical extent of the bad weather is such that neither of the above techniques is practical, or if climbing on track would mean penetrating controlled airspace, then the most practical option is to retrace the track already flown as this is known to be clear of bad weather. It is important that the decision to turn back is made early enough so that the turn can be completed in VMC. It may be possible once in clear weather to re-plan in the air to reach a target or destination, but often the sortie will have to be abandoned. In helicopters it is first possible to reduce height and speed to maintain visual contact with the ground before considering a turn back.

23. **Emergency Low Level Abort**. Should unacceptable weather be flown into, an emergency low level abort must be carried out. The flying technique will vary with aircraft type but in essence it is necessary to achieve the maximum angle of climb in order to avoid any high ground or obstructions. If the aircraft is likely to penetrate controlled airspace on climb out then it is necessary to squawk emergency and call for assistance on 243 MHz as soon as is practicable. The low level abort should be a rare occurrence; good look-out and sound airmanship should allow one of the other options to be executed in good time. The helicopter technique is to perform a quick stop manoeuvre to bring the aircraft to the hover. If the bad weather precludes a turn back then the helicopter can be landed to await a weather improvement.

Lost Procedure

24. Thorough planning, careful route study and accurate planning should drastically reduce the possibility of becoming lost. Among the most common causes of uncertainty are missing a turning point and flying on regardless, or having to re-route to avoid bad weather. Checking for gross errors in heading and timing may resolve the problem, but should uncertainty persist it is important to recognise it as early as possible and take positive remedial action.

25. In peacetime the first action will be to climb to improve the view, and then to fix position by the best available means - visually, radio aids, or with radar assistance. Should this not be possible then use of the emergency organization will be necessary. An assessment of fuel state and safety altitude must be made.

26. If it is necessary to remain at low level or if radio contact cannot be established then other courses of action will be needed. It should be possible to deduce an approximate position based on the time and position of the last known fix and the speed and heading flown subsequently. Clearly the accuracy of the compass system and of the speed flown should be considered, as should the wind velocity in relation to that expected. Checks of these factors may well reveal the cause of the uncertainty and may give more clues as to position. The general topography may provide additional information, ie is the terrain flat, hilly, or mountainous; is the region rural or urban? Having established a DR position, a circle of uncertainty can be drawn around it of radius equal to 10% of the air distance flown since the last fix. The technique now should be to maintain visual contact with the ground and to set heading towards a line feature (eg coastline, railway, motorway) outside of the circle of uncertainty, whilst map reading from ground to map. On reaching the line feature it can be followed until a further feature allows a pin-point to be established.

TOPIC- 6
MENTAL DEDUCED RECKONING

Introduction

1. The lack of space in a single or two-seat cockpit normally precludes the use of the traditional plotting and calculating equipment: DR Computer, protractor and dividers. Even where they can be carried, the sortie profile may make their use impractical and it will frequently be necessary to react quickly to changing circumstances. Further limitations may be imposed in some aircraft by a lack of navigation aids. There is therefore a requirement to be able to solve mentally the problems of distance, direction, speed and time. An appreciation of the techniques of Mental Deduced Reckoning (MDR) can also be useful in checking the results of the more traditional methods, thus avoiding gross errors. The techniques outlined below will give solutions that are sufficiently accurate for most purposes; in the majority of cases experience and practice will improve the quality of the result.

Estimation of Map Distances

2. With practice in using particular maps and their scale, it should be possible to make reasonable estimates of distance by eye. This skill can be aided by calibrating parts of the hand, eg the length of a thumb or a span, and pre-flight map preparation should include distance-to-go markers or time marks to turning points. Finally it may help to have a calibrated (secured) pencil, or indeed any convenient straight edge which can be used to measure the length required against the latitude scale.

Estimation of Map Directions

3. Most people can bisect or even tri-sect an angle by eye quite accurately. Thus a 90° angle can be progressively broken down by bisection to 45°, 22° and 11° or by tri-section to 30° and 10°. Combinations of these techniques can produce a wide range of angles.

4. Use of the 1:60 rule can give results which are accurate to within 1° up to about 30° and only about 2° in error at 40°.

5. A required direction can often be estimated by comparison with other known directions on the map such as drawn and measured tracks, or overprinted VOR radials.

Estimation of TAS

6. Because of the rather complex effects of deviations from the standard atmosphere and of compressibility, there is no simple formula for the determination of TAS from either CAS or Mach number. Nevertheless there are a few methods which can produce acceptable results within their limitations.

a. **Tabular Solution**. Table 1 shows the factor by which the CAS should be increased to approximate TAS at various heights:

CAS to TAS Correction Factors

Height (feet)	Starting Value	Starting Value Sq'd	Fraction of CAS to Add to Starting CAS
40,000	10	100	1 x CAS
35,000	9	81	$\frac{4}{5}$x CAS
30,000	8	64	$\frac{2}{3}$x CAS
25,000	7	49	½ x CAS
20,000	6	36	⅓ x CAS
15,000	5	25	¼ x CAS
10,000	4	16	$\frac{1}{6}$x CAS
5,000	3	9	$\frac{1}{10}$x CAS

Note that the square of each 'starting value' gives the approximate fraction of the CAS by which it should be increased. If the starting value of 10 for 40,000 ft is memorized, it is necessary only to reduce it by 1 for every 5,000 ft below.

b. Up to about 25,000 feet the TAS can be estimated by multiplying the CAS in nm/min by the altitude in thousands of feet and adding this figure to the CAS.

eg CAS = 210 kt Altitude = 20,000 feet

210 kt = 3.5 nm/min

Therefore TAS = 210 + (3.5 ´ 20)

= 280 kt

c. At about 25,000 feet, the Mach number x 10 is approximately equal to the TAS in nm/min, eg M 0.6 equates to 6 nm/min, which is 360 kt. A correction can be applied to this by adding or subtracting 1 kt for each 1000 ft below or above 25,000 ft respectively if the Mach number is 0.6 or less, or 2 kt per 1000 ft for Mach numbers in excess of 0.6.

Estimation of Drift and Groundspeed

7. **Drift**. To estimate the drift on a given heading it is first necessary to determine the maximum drift that could be experienced, ie if the wind was at 90° to the heading. This is easily calculated by dividing the wind speed by the TAS expressed in nm/min. For example given a wind speed of 50 kt and a TAS of 300 kt, the maximum drift would be 50/5 = 10°. The actual drift experienced can now be calculated by considering the angle (the wind angle) between the wind direction and the heading and using a 'clock analogy' to the sine function. The angle is considered to be minutes of time, and the proportion of an hour that this number of minutes represents, is the proportion of the maximum drift that will be affect the aircraft. For example a wind angle of 15° equates to 1/4 of an hour and so 1/4 of the

maximum drift will be experienced. For wind angles of 60° or more it is assumed that the aircraft will experience the maximum drift. An example of the complete calculation is given below:

W/V: 270/60 TAS: 300 kt (5 nm/min) Track: 230

Max Drift = $\frac{60}{5}$ = 12°

Wind Angle = 270 - 230 = 40° which, in minutes, is 2/3 of an hour.

Drift is therefore 12° X $\frac{2}{3}$ = 8°

Clearly care must be taken to apply the drift in the correct sense.

8. **Groundspeed.** The calculation of groundspeed is made in an analogous manner to drift. In this case the maximum effect occurs when the wind is directly on the nose or tail falling to zero when the wind is at 90° to heading, ie a cosine function. However the same clock analogy can be used but entering with 90° wind angle. This then generates the proportion of the wind speed to be added or subtracted from TAS to give groundspeed. Using the previous example with a wind angle of 40°, for groundspeed determination 90° wind angle gives 50°. So the proportion of wind speed to be used is 5/6, ie 5/6 x 60 = 50 kt. In this example it is a head wind component and the groundspeed will be 250 kt.

Regaining Track

9. **Standard Closing Angle Technique**. The SCA technique is an application of the 1-in-60 rule and is designed to eliminate 1 nm of track error in 1 minute. Fig 1 shows an aircraft, whose groundspeed is 360 kt, 1 nm off track. In 1 minute the aircraft would travel 6 nm and by the 1-in-60 rule:

$$SCA = \frac{\text{Distance off}}{\text{Distance along}} \times 60 = \frac{1}{6} \times 60 = 10\,^{\circ}$$

Fig 1 : Standard Closing Angle

For different groundspeeds the SCA is found by dividing 60 by the groundspeed in nm/min. The SCA can be used to regain track by altering heading through the SCA and maintaining this heading for a number of minutes equal to the off track error in nm. Variations can be considered when necessary, eg by doubling the angle and halving the time, or vice versa. However using large angular corrections can lead to errors due to the breakdown of the 1-in-60 rule, to timing errors, and to the fact that the changing effect of the wind on the new heading is ignored; 30° is generally considered to be the maximum heading alteration that should be employed.

Regaining Time

10. As well as maintaining track, it is often necessary to maintain the planned timing. Providing that the speed range of the aircraft permits it, and the fuel penalty is acceptable, relatively small timing errors can be corrected by speed changes. Two methods of calculating the necessary adjustment are:

a. Adjust speed by a number of knots equal to the number of seconds late or early and maintain this speed for a number of minutes equal to the groundspeed in nm/min, eg 420 kt groundspeed, 20 seconds late: fly at 440 kt for 7 minutes.

b. Adjust speed by an amount equal to 5 times the groundspeed in nm/min and maintain this speed for a number of minutes equal to one fifth of the number of seconds early or late, eg 420 kt groundspeed, 20 seconds late: fly at 455 kt for 4 minutes.

In either case the speed adjustment can be halved and maintained for twice the time (or vice versa) if necessary. Should a turning point occur during the correction it is usually preferable to re-assess the timing at this point.

11. Time can be lost by using standard dog-legs. A 60° dog-leg will lose the time equal to the time of each leg, while for a 30°dog-leg, each leg needs to be flown for a time equal to four times the time that needs to be lost.

GROUP- B : AIRMANSHIP

TOPIC-1 : ATS AND ICAO RULES OF THE AIR (ANNEX 2)

Definitions

1. **Acrobatic Flight.** Maneuvers intentionally performed by an aircraft involving an abrupt change in its attitude, or variation in speed.

2. **Advisory Airspace.** A generic term meaning variously, advisory area(s) or advisory route (s).

3. **Advisory Area.** A designated area within a flight information region where air traffic advisory service is available.

4. **Advisory Route.** A route within a flight information region along which air traffic advisory service is available.

5. **Aerodrome.** A defined area on land or water (including any buildings, installations and equipment) intended to be used either wholly or in part for the arrival, departure and movement of aircraft.

6. **Aerodrome Control Service.** Air traffic service for aerodrome traffic.

7. **Aerodrome Control Service.** A unit established to provide air traffic control service to aerodrome traffic.

8. **Aerodrome Traffic.** All traffic on the manoeuvring area of an aerodrome and all aircraft flying in the vicinity of an aerodrome.

> ***Note :*** *An aircraft is in the vicinity of an aerodrome when it is, entering or leaving an aerodrome traffic circuit.*

9. **Aerodrome Traffic Zone**. An airspace of defined dimension established around an aerodrome for the protection of aerodrome traffic.

10. **Aeronautical Information Publication.** A publication issued by or with the authority of a state and containing aeronautical information of a lasting character essential to air navigation.

11. **Aeronautical Station.** A land station in the aeronautical mobile service carrying on a service with aircraft stations. In certain instances, an aeronautical station may be placed on board a ship.

12. **Aeroplane.** A power-driven heavier-than-aircraft, deriving its lift in flight chiefly from aerodynamic reactions on surfaces which remain fixed under given conditions of flight.

13. **Aircraft.** Any machine that can derive support in the atmosphere from the reactions of the air.

14. **Air Defence Identification Zone (ADIZ).** The area of air space over land or water, extending upward from the surface, within which the ready identification, the location, and the control of aircraft are required in the interest of national security.

15. **Air Traffic.** All aircraft in flight or operating on the manoeuvring area of an aerodrome.

16. **Air Traffic Advisory Service.** A service provided within advisory airspace to ensure separation, in so far as possible, between aircraft, which are operating on IFR Flight plans.

17. **Air Traffic Control Clearance.** Authorization for an aircraft to proceed under conditions specified by an air traffic control unit.

18. **Air Traffic Control Service.** A service provided for the purpose of:

a. Preventing collisions:

(1) Between aircraft, and

(2) On the manoeuvring area between aircraft and obstructions, and

b. Expediting and maintaining an orderly flow of air traffic.

19. **Air Traffic Control Unit.** A generic term meaning variously area control center, approach control office or aerodrome control tower.

20. **Air Traffic Service.** A generic meaning variously flight information service, alerting service, air traffic advisory service, air traffic control service, area control service, approach control service or aerodrome control service.

21. **Air Traffic Service Unit.** A generic term meaning variously, flight information center or air traffic control unit.

22. **Airway.** A control area or portion there of established in the form of a corridor equipped with navigational aids.

23. **Alerting Service.** A service provided to notify appropriate organizations regarding aircraft need of search and rescue aid and assist such organizations as required.

24. **Alternate Aerodrome.** An aerodrome specified in the flight plan to which a flight may proceed when it becomes inadvisable to land at the aerodrome of intended landing.

Note : An alternate aerodrome may be the aerodrome of departure.

25. **Altitude.** The vertical distance of a level, a point or an object considered as a point measured from measured from mean sea level.

26. **Approach Control Office.** A unit established to provide air traffic control service to controlled flights arriving at, or departing from, one or more aerodromes.

27. **Approach Control Service.** Air Traffic Control service for arriving or departing controlled flights.

28. **Area Control Center**. A unit established to provide air traffic control service to controlled flights in control areas under its jurisdiction.

29. **Area Control Service.** Air traffic control service for controlled flights in control area.

30. **ATS Route.** A specified route designed for channeling the flow of traffic as necessary for the provision of air traffic services.

> ***Note*** *: The term ATS route is used to mean variously, airway, advisory route, controlled or uncontrolled route, arrival or departure route,, etc.*

31. **Ceiling.** The height above the ground or water of the base of the lowest layer of cloud below 6,000 metres (20000 feet) covering more than half the sky.

32. **Clearance Limit.** The point to which an aircraft is granted an air traffic control clearance.

33. **Control Area.** A controlled airspace extending upwards from a specified height above the surface of the earth without an upper limit unless one is specified.

34. **Controlled Aerodrome.** An aerodrome at which air traffic control service is provided to aerodrome traffic.

> ***Note :*** *The term controlled aerodrome indicates that air traffic control service is provided to aerodrome traffic but does not necessary imply that a control zone exists, since a control zone is required at aerodromes where air traffic control service will be provided to IFR flights, but not at aerodromes where it will be provided only to VFR flights.*

35. **Controlled Airspace.** An airspace of defined dimensions within which air traffic control service is provided to controlled flights.

36. **Controlled Flight.** Any flight which is provided with air traffic control service.

37. **Control zone.** A controlled airspace extending upwards from the surface of the earth to specified upper limit.

38. **Cruising level**. A level maintained during a significant portion of a flight

Note : The word level, except in the expression flight level designates the vertical position, regardless of the reference data or the units of vertical distance used. In air-ground communications a level will be expressed in terms of altitude, height or a flight level depending upon the reference datum and the altimeter setting in use in a particular area.

39. **<u>Current flight</u>**. The flight plan, including changes, if any brought about subsequent clearances.

40. **<u>Danger Area.</u>** An airspace of defined dimensions within which activities dangerous to the flight of aircraft may exist at specified times.

41. **<u>Expected Approach Time.</u>** The time at which it is expected that an arriving aircraft will be cleared to commence approach for a landing.

42. **<u>Final Approach.</u>** That part of an instrument approach procedure from the time the aircraft has :

a. Completed the last procedure turn, where one is specified or

b. crossed a specified fix or

c. intercepted the last track specified for the procedure, until it has crossed a point in the vicinity of an aerodrome from which :

(1) a landing can be made or

(2) a missed approach procedure is initiated.

43. **<u>Flight Crew Member.</u>** A crew member charged with duties essential to the operation of an aircraft during flight time.

44. **<u>Flight Information C4entre.</u>** A unit established to provide flight information service and alerting service.

45. **<u>Flight Information Region.</u>** An airspace of defined dimensions within which flight information service and alerting services are provided.

46. **<u>Flight Information Service.</u>** A service provided for the purpose of giving advice and information useful for the safe and efficient conduct of flights.

47. **<u>Flight Levels.</u>** Surfaces of constant atmospheric pressure which are related to a specific pressure datum, 1013.2 mb (29.92 inches), and are separated by specific pressure intervals.

Note 1 - *A pressure type altimeter setting, will indicate altitude :*

a. when set to a QNH altimeter setting, will indicate altitude.

b. when set FE altimeter setting, will indicate height above the AFE reference datum;

c. when set to a pressure of 1013.2 mb (29.92 inches), may be used to indicate flight levels.

Note 2 - *The terms height and altitude used in Note 1 above, indicate altimetric rather than geometric heights and altitudes.*

48. **Flight Plan.** Specified information provided to air traffic services, units, relative to an intended flight or portion of a flight of an aircraft.

49. **Flight Visibility.** The visibility forward from the cockpit of an aircraft in flight.

50. **Ground Visibility.** The visibility at an aerodrome, as reported by an accredited observer.

51. **Heading.** The direction in which the longitudinal axis of an aircraft is pointed, usually expressed in degrees from North (true, magnetic, compass or grid).

52. **Height.**

a. The vertical distance of a level a point, or an object considered as a point, measured from specified datum.

Note : *The datum may be specified either in the text or in an explanatory note in the publication concerned.*

b. The vertical dimension of an object.

Note : *The term height may be used in a figurative sense for a dimension other than vertical, eg the height of a letter or a figure painted on runway.*

53. **IFR.** The symbol used to designate the instrument flight rules.

54. **IFR Flight.** A flight conducted in accordance with the instrument flight rules.

55. **IMC.** The symbol used to designate instrument meteorological conditions.

56. **Instrument Approach Procedure.** A series of predetermined manoeuvres for the orderly transfer of an aircraft under instrument flight condition from the beginning of the initial approach to a landing, or to a point from which a landing may be made visually.

Note : *The term instrument flight conditions is used in this definition in preference to other terms such as instrument meteorological conditions, because the latter term refers to meteorological conditions necessitating under instrument flight rules, but does not necessarily imply flight by reference to instruments, which is the intent of the present wording.*

57. **Instrument Meteorological Conditions.** Meteorological conditions expressed in terms of visibility, distance from cloud, and ceiling, less than the minima specified for visual meteorological conditions.

58. **Landing Area.** The part of the movement area intended for the landing or take-off run of aircraft.

59. **Manoeuvring Area.** That part of an aerodrome to be used for the take-off and for the movement of aircraft associated with take-off and landing.

60. **No Light Area.** Area in which aircraft may engage in night flying without displaying navigation lights or conforming to the semicircular rules. Details are to be notified to the ATCC at least two hours before the exercise begins, giving:

a. The area concerned.

b. Estimated times of entry and departure.

c. Track and altitude to be maintained.

61. **Pilot-in-command.** The pilot responsible for the operation and safety of the aircraft during flight time.

62. **Prohibited Area.** An airspace of defined dimensions, above the land areas or territorial waters of a State, within which the flight of aircraft is prohibited.

63. **Reporting Point.** A specified geographical location in relation to which the ;position of an aircraft can be reported.

64. **Restricted Area.** An airspace of defined dimensions, above the land areaas or territorial waters of aa State, within which the flight of aircraft is restricted in accordance with certain specified conditions.

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

66. **Signal Area.** An area on an aerodrome used for the display of ground signals.

67. **Taxiway.** A defined path, on a land aerodrome, selected or prepared for the use of taxing aircraft.

68. **Terminal Control Area.** A control area normally established at the confluence of ATS routes in the vicinity of one or more major aerodromes.

69. **Track.** The projection on the earth's surface of the path of an aircraft, the direction of which path at any point is usually expressed in degrees from North (true, magnetic or grid).

70. **Transition Altitude.** The altitude in the vicinity of an aerodrome at or below which the vertical position of an aircraft is controlled by reference to altitude.

71. **VFR.** The symbol used to designate the visual flight rules.

72. **Visibility.** The ability, as determined by atmospheric conditions and expressed in units of distance, to see and identify prominent unlighted objects by day and prominent lighted objects by night.

74. **Visual Meteorological Conditions.** Meteorological conditions expressed in terms of visibility, distance from cloud, and ceiling, equal to or better than specified minima.

75. **VMC.** The symbol used to designate visual meteorological conditions.

Designations

76. Flight Information Region.

77. Controlled Airspace.

a. Control Area.

b. Control Zone.

c. Air Way.

78. Advisory Airspace.

a. Advisory Area.

b. Advisory Route.

79. Air Defence Identification Zone (ADIZ).

80. Prohibited Area.

81. Danger Area.

82. Restricted Area.

83. No Liter Area.

Safety Altitude Instructions (BAF)

84. Three factors affect the safety altitude:

a. The navigational error assumed in deciding the highest ground over which there is any possibility of the aircraft being flown.

(1) Due to the wide range of speeds and the varying accuracy of fixing aids in operation it is not possible to lay down an arbitrary figure for this error.

b. The airflow effect over high ground.

(1) An allowance of 10 per cent of the height of the highest ground is to be made.

c. The altimeter setting system in force.

(1) An allowance of 1,500 feet is to be made.

d. An example of the calculation of safety altitude for an aircraft expected to fly over ground 3,000 ft high is as follows:

(1) 3,000 ft plus (b) 300 ft plus (c) 1,500 ft equals 4,800 feet (Safety altitude).

e. Application of the semicircular system of cruising level where applicable will then give the minimum altitude to fly.

Altimeter Setting Procedure (BAF)

85. In general the following altimeter settings are used:

a. At all Aerodromes ………………QNH.

b. En-route ……………………….. ..1013.2 mbs, or 29.29 inches.

c. Control Areas and Zones ….... A value of QNH as specified by the ATCC concerned.

d. Transition level is the level at which the pilot of a descending aircraft changes to QNH from the standard setting (1013.2 mbs). This may be regarded as the lowest flight level at which an aircraft can safely proceed on the 'en-route' altimeter setting.

e. Transition Altitude is the level at and below which QNH setting is mandatory.

f. Transition Later is the airspace between Transition Level and Transition Altitude.

g. Aircraft climbing change from QNH to 'en-route' setting after leaving transition altitude and before reaching transition level.

h. A descending aircraft when above Transition level is to report his altitude as flight level (eg 6,500 ft as flight level 65; 12,000 ft as FL 120).

j. In ascent altitude is to be given in feet up to the Transition altitude and as flight level above it.

86. **Flights within Controlled Airspace.**

a. **Under VFR.** Aircraft are to be flow in VMC and in accordance with the Rules of the Air.

b. **Under IFR.**

(1) **Flight Plan**. File a flight plan as required.

(2) **ATC Clearance**. Before entering a controlled airspace obtain AC clearance to do so and adhere strictly to the terms of that clearance thereafter.

(3) **Communications.** Establish two-way communication with the appropriate ATC unit and maintain a continuous listening watch.

(4) **<u>Position Reporting.</u>** Pass position report over each specified reporting point.

(5) **<u>Emergency.</u>** Inform the controlling unit immediately if any emergency compels deviation from the terms of present clearance.

(6) **<u>Communication Failure.</u>**

(a) In VMC, continue flying in VMC and land at the nearest suitable aerodrome.

(b) **<u>In IMC.</u>**

i. Continue according to current flight plan, maintaining last acknowledged or assigned cruising level (s) for which clearance has been received.
ii. Arrive as closely as possible to ETA.

iii. Commence descent as nearly as possible to the last acknowledged Expected Approach Time or, if not. Expected Approach Time has been acknowledged, as nearly as possible to the flight ETA, and

iv. Land within 30 minutes of ETA or the last acknowledged Expected Approach Time whichever is the later or leave the controlled airspace before this time.

Note : ***<u>Expected Approach Time.</u>*** *Calculated by ATC, this is the time at which it is expected that an arriving aircraft will be cleared to begin an approach for landing.*

87. **<u>Flight Within Advisory Space.</u>**

a. Aircraft requiring air Traffic Advisory Service under IFR within the Advisory Routes and Areas are to :

(1) File a Flight plan.

(2) Comply with reporting procedures.

(3) Maintain communication with the unit providing the service, notifying changes in cruising level, track and ground speed.

88. **<u>Joining Airways.</u>**

a. A request for permission to join an airway is to be made on the appropriate frequency at least 10 minutes by R/T (20 minutes by W/T) before ETA at the point of entry. The selected entry point must be the Designated or on Request Reporting Point must convenient to the route. The entry request is to include the following:

(1) Call sign.

(2) Aircraft type.

(3) Position, cruising level and flight conditions.

(4) ETA at point of entry.

(5) Desired cruising level on airway.

(6) Route and point of first intended.

(7) True airspeed.

89. **Crossing Airways.**

a. Aircraft requiring to cross an airway under IFR are to:

(1) File a flight plan.

(2) Request crossing clearance 10 minutes by R/T (20 minutes by W/T) before ETA at entry point, giving:

(a) Identification.

(b) Aircraft type.

(c) Track (True)

(d) Place and estimated time of crossing.

(e) Desired crossing level.

(f) Ground speed.

(3) Maintain two-way communication with the controlling authority.

(4) Report on entering and leaving the airway.

(5) Selected crossing points should be associated with a radio facility to assist accurate navigation and airways are to be crossed at an angle of 90 degrees to the direction of the airway, or as close to this angle as is practicable.

b. **Entering Control Areas.** Procedure to enter control areas is similar to the procedure for joining airways.

90. **<u>Position Reporting.</u>**

a. Position reports are to be passed to the appropriate ATC Unit as follows:

(1) Within control area/ zone as instructed.

(2) On reaching control area/zone boundary.

(3) In ADR's and airways at each designated reporting point.

(4) Outside controlled and advisory airspaces half hourly irrespective of the weather conditions.

(5) When passing from one FIR to another.

(6) On request reporting points.

b. Position reports should be made as soon as possible after the aircraft has passed the reporting point.

c. When passing from one FIR to another the position reports is to be passed to the ATC Units controlling both regions.

d. **<u>Contents of Position Reports.</u>** Position reports are to contain the following in the order stated:

(1) Aircraft identification.

(2) Position.

(3) Time of Position.

(4) Flight level or altitude.

(5) Flight conditions.

(6) ETA at next reporting point.

91. **<u>Pre-Flight Action.</u>**

a. The captain and crew of the aircraft will:

(1) have the flight authorized.

(2) Obtain a weather forecast from the Meteorological office.

(3) Report to flight planning section where he/they will carry out full flight planning in accordance with Air Headquarters instructions.

(4) Compile a flight plan when required.

(5) Ensure that the air traffic control officer is notified of the flight, and if a flight plan is necessary that a copy is passed to him.

(6) Obtain from the air traffic control officer final air traffic instructions and clearance necessary or applicable to the intended flight, at the same time notifying the control officer of any corrections to the flight plan that may be necessary.

92. **Diplomatic Clearance and Flight by BAF Aircraft Abroad.**

a. Regulations concerning flights by Bangladesh Air Force aircraft to or over commonwealth or foreign countries and details regarding diplomatic clearance are to be obtained from the Deputy Director of Air Transport, Air headquarters, Dhaka.

b. BAF aircraft, so far as possible and consistent with operational necessity, are to be flown in accordance with air traffic regulations issued by the countries over which they are flown.

93. When flying VMC it is the direct responsibility of the person in command of an aircraft to avoid collision with other aircraft, notwithstanding that the flight is being conducted on an air traffic clearance.

94. **Diversions.**

a. There are two grades of diversions, which are :

(1) Grade 1- This diversion is issued by the operating authority either direct or through air traffic control

(2) Grade 2 - This diversion may be issued either by the operating authority or by air traffic control, and is advisory.

Note 1 : Either grade may be issued for administrative reasons.

Note 2 : The final decision on whether or not to divert remains with the captain of the aircraft.

Flight Plans

95. a. A Flight Plan is a specified information provided to air traffic services units, relative to the intended flight of an aircraft.

b. It is the responsibility of the captain of an aircraft to ensure the flight plan is correctly complied and contains all the data relative to the intended flight.

c. No deviation shall be made from a flight plan without informing the appropriate air traffic services unit as soon as practicable.

d. Flight plans are to be submitted to the nearest area control center, aerodrome control tower or air ground communications station either in person, or by telephone or radio as applicable.

e. A flight plan may be filed through intermediate stops.

f. Flight plans are require in the following cases :

(1) For all IFR flights prior to operating in controlled airspaces, advisory airspaces and other areas as may be exempted by Air Traffic Services.

(2) For all international operations.

(3) For all flights prior to departure from all aerodromes in Bangladesh, with the exception of such local flights as may be exempted by Air Traffic Control.

g. **Filing of Flight Plans.** Flight plans are to be filed in advance. The minimum period of advance notification is as follows:

(1) **In-Flight IFR Plan.** A flight plan filed from an aircraft in the air shall be transmitted at least ten minutes' flying time before the intended point of entry into a controlled airspace if transmitted by radio-telephony and twenty minutes if transmitted by radio-telegraphy.

(2) **On0Ground (Bangladesh).** Flight Plans will be accepted only within 45 minutes prior to departure. A flight plan for an IFR flight should be submitted at least 30 minutes prior to departure.

h. **Contents.** A flight plan shall comprise information as required to be filled in on BAF form 2919.

j. **Delay.** In case of a delay of one hour or more in the expected scheduled ground time, a new flight plan should be submitted and the old flight plan to be cancelled.

k. **Changes in Flight Plan.** The appropriate ATC authority is to be notified immediately, in case of any of the changes in the flight plans.

(1) **VFR Flight Plan.**

(a) Cancellation.

(b) More than 30 minutes in ETD (BAF) otherwise aas in sub para j. above.

(c) Route or destination.

(2) **IFR Flight Plan.**

(a) Outside controlled airspace.

i. As in sub-para IK (1) I above.

ii. Height.

(b) In controlled airspace.

i. More than 10 minutes in ETD.

ii. Height route or destinations.

iii. More than 5 minutes in ETA (Bangladesh, more than 3 minutes ETA at destination or over a next reporting pointy.

l. **Cancellation of IFR Flight Plans in-Flight.** Pilots may cancel IFR flight plans at any time by notifying traffic control provided they are operating in VFR weather conditions when they take such action and where conditions indicate that the remainder of flight can be conducted in accordance with visual flight rules.

m. The cancellation of an IFR flight plan is only acceptable when the pilot-in-command uses the expression "Cancel my IFR Flight Plan."

n. The fact that an aircraft reports flying VMC does not of itself constitute cancellation of an IFR flight plan and unless definite cancellation is made in the manner indicated in sub-para k. (2), the flight will continue to be regarded in accordance with the instrument flight rules.

p. If a flight plan has been cancelled and subsequent IFR operation becomes necessary, a new IFR flight plan must be filed and air traffic clearance obtained before encountering instrument meteorological conditions.

Note : *Acceptance of a Flight Plan shall not constitute an ATC clearance or an authorization to depart. No aircraft shall from a controlled aerodrome without prior authorization obtained either by radio or visual signals from the Aerodrome Control Tower. ATC clearance shall be obtained on radiotelephony by IFR flights prior to take-off from aerodromes located in controlled airspaces.*

96. **Filing of Flight Plan (BAF).**

a. Following procedure of filing a flight will apply to BAF aircraft operating within Bangladesh. A flight plan is to be filed with the ATC of departure for all flight as specified below:

(1) **Flights in IMC/IFR.** For all transit flights planned in IMC/IFR, the Flight plan is to be invariably filed in writing irrespective of distance/ flying time involved.

(2) **Local Flight.** For flights in local flying area and over approved firing ranges, the Flight Plan can be filed on R/T. This may be done independently or in supplement to the Flying Programme supplied to ATC earlier.

(3) **Training Cross Country Flights**. When proceeding on a cross country flight, is a part of an approved flying syllabus of a training unit, it is sufficient to give ATC the serial number of the training cross country on telephone or R/T, provided the cross country syllabus is held by the ATC. For other cross country flights, not involving landing out station, details of each leg are to be given; this could be done by telephone, but not by R/T.

b. When giving approval of a flight on telephone, the ATCO is to pass information about the current NOTAMS. Latest weather report en-route and destination, and any other information considered necessary for the safe operating of the aircraft. Weather briefing is the personal responsibility of the captain of the aircraft, and para b. above does not absolve him of it; if the latest weather is not available with the ATC he is to get it from the Meteorological Section.

ATCO on duty has the right to demand a written Flight Plan whenever in his judgement the nature of flight or traffic requires it; or he considers it necessary to keep a record of the flight clearance. In all such cases he is to make the reason known to the pilot.

Note : *These instructions do not apply to civil and foreign aircraft using BAF airfields; the civil aircraft will file the flight plan according to DGCA/ ICAO requirements, and the foreign aircraft according to ICAO and any special instructions, if issued about their operations, by Air Headquarters.*

97. a. If on an IFR flight, when operating from within a controlled airspace, or when the point of entry into controlled is within 10 minutes' flying time (20 minutes when using W/D from the point of departure, ATC clearance must be obtained prior to departure.

b. **In-Flight Clearance.** If on an IFR flights, ATC clearance must be obtained prior to entering to controlled airspace, or if on a VFR flights, prior to entering into IFR weather conditions within controlled airspace.

c. If at the time of requesting clearance to enter a control area the aircraft is flying outside the flight information region in which the entry point is situated, then sufficient time be allowed for clearance to be obtained from the ATCC conc3erned by the ATCC with which the aircraft is in communication.

d. **Adherence to Air Traffic Control Clearance.** When an Air Traffic Control clearance has been obtained the pilot in command shall not deviate from the previsions there of unless an amended clearance is received. In case emergency authority is used to deviate from provision of an ATC clearance, the pilot-in-command shall notify air traffic control as soon as possible and, if practicable, obtained an amended clearance.

e. Further clearance must be obtained from the controlling authority if the original flight plan is modified in any of the items as stated in para K(2).

f. Pilots must keep in mind the fact that once an IFR flight has entered a control area or control zone, no deviation from the provision of a traffic clearance received shall be made, unless an emergency exists, without first obtaining approval from air traffic control for such change.

g. **Air Traffic Control Instructions.** Air traffic control instructions are the directions issued by an air traffic control unit for an aircraft to proceed or to delay its flight in a specified manner.

h. **IFR Approach Clearances.** An approach clearance issued to an aircraft is approval for one approach only. If landing is not completed after one instrument approach, a pilot shall follow the specified missed approach procedure, unless otherwise instructed by air traffic control, and request further clearance from air traffic control. Air Traffic Control will then determine whether the pilot will be cleared for another immediate attempt or be directed to stand by on a designated holding pattern at an assigned level until other aircraft in line have landed or taken off. This decision will be based upon existing traffic conditions unless an emergency situation exists. A decision to route the aircraft to an alternate aerodrome will be made by the pilot or aircraft operator involved after co-ordination, when practicable, with the air traffic control personnel concerned.

j. A new approach clearance will be required prior to commencing an additional approach. If pilot elects to proceed to the alternate aerodrome as specified in the flight plan, he must so advise air traffic control and obtain a traffic clearance.

Note : *If the pilot decides that he can proceed under VFR weather condition to the aerodrome of destination he may do so by canceling his IFR flight plan and obtaining a clearance from aerodrome control when required.*

TOPIC- 2

ICAO ATS AIRSPACE CLASSIFICATIONS (ANNEX 11)

Reference: Jeppesen Airway Manual (MES – 1)

Section - Air Traffic Control

Classifications of Airspaces

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TOPIC- 3
FLIGHT PROCEDURES (DOC 8168)

Reference: Jeppesen Airway Manual (MES – 1)

Section - Air Traffic Control

Flight Procedures

General Principles	General Information
	Accuracy of Fixes
	Turn Area Construction
Departure Procedures	General Criteria
	Standard Instrument departure
	Omni directional Departure
	Published Information for Departure
Arrival and Approach Procedures	General Criteria
	Arrival Segment
	Initial Approach Segment
	Intermediate Segment
	Final Approach Segment
	Missed Approach Segment
	Visual Manoeuvring (Circling) Area
En-route Criteria	En-route Criteria
Holding Procedures	Holding Criteria
	Obstacle Clearance
RNAV and Satellite Based Procedure	General Information for RNAV System
	Departure Procedures (RNAV)
	Arrival and Non-Precision Approach Procedures (RNAV)
	Arrival and Approach Procedures with Vertical Guidance (RNAV)
	Precision Approach Procedures (RNAV)
	RNAV Holding
	Enroute (RNAV)

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TOPIC- 4
AIRCRAFT OPERATING PROCEDURES

Reference: Jeppesen Airway Manual (MES – 1)

Section - Air Traffic Control

Aircraft Operating Procedures

Altimeter Setting Procedures	Introduction to Aircraft Operating Procedures
	Basic Altimeter Setting Requirements
	Procedures for Operators and Pilots
	Altimeter Corrections
SSR Transponder Operating Procedures	Operations of Transponders
Simultaneous Operations on Parallel or Near-parallel Instrument Runways	Modes of Operations

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TOPIC- 5
AIR TRAFFIC MANAGEMENT (DOC 4444)

Reference: Jeppesen Airway Manual (MES – 1)

Section - Air Traffic Control

Air Traffic Management

Air Traffic Management	General Provision for Air Traffic Services
	Separation Methods and Minima
	Separation in the Vicinity of Aerodromes
	Miscellaneous Procedures

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TOPIC- 6
FLIGHT SAFETY GENERAL

Fire Precaution

1. Every aircraft is to carry where applicable, as part of its equipment fire extinguishers of approved pattern according to the scale in the schedule of equipment. The captain of the aircraft is to ensure that the correct number of extinguishers are carried in the aircraft.

2. Matches other than the “Safety” type are not to be taken into aircraft.

Chocks

3. Chocks are normally to be placed in front of the wheels of an aircraft before the engines are started and when crews are being changed eg in training sorties.

Maps

4. The captain of the aircraft is to ensure that maps covering the whole of the route or area over which the flight is to take place are carried in the aircraft. Maps covering the diversion are also to be carried.

5. There is sometime a possibility of maps being inaccurate. Map users are to report any error on published maps which is likely to endanger the safety of aircraft, as soon as possible to Air Headquarters.

Safety Equipment

6. **Responsibility of the Captain**. The captain of the aircraft is to ensure that his crew is proficient in the use of the safety equipment carried in the aircraft. He is also to ensure that passengers are suitably briefed before flight on the handling of the safety equipment which they may be called upon to use.

7. **Carriage and Wearing of Safety Equipment**. Detailed instructions regarding the carriage aid wearing of safety equipment is to be found in the appropriate manuals, T.O. Dash one for the aircraft type and in Chapter 14. Station Commander may authorise deviation from these principles if the flight conditions likely to be encountered, or the type of aircraft to be used, necessitate such deviation.

8. **Modification of Safety Equipment**. Safety equipment is not to be modified without the prior approval of the Air Headquarters.

9. **Parachutes**. On the following occasions :

a. In training and operational aircraft, parachutes are to be worn by all occupants except as mentioned in sub-para (b) below. However, crew members whose duties prevent them from wearing a parachute are exempted from doing so.

b. In transport and communication aircraft, parachutes are to be carried for the occupants on the following occasion:

(1) President’s flight.

(2) For VIPs VVIPs.

(3) Trial of dropping equipment.

(4) Air-tests after a minor or major accident.

(5) Training aircraft when the caption of the aircraft is uncategorized.

(6) Formation flying.

(7) When Station Commander consider the carriage of parachutes desirable.

c. **Exemption to Carry Parachutes**. For a specific flight, when it is considered impracticable to comply with the above orders, the Station Commander may modify the orders in sub-paras (a) and (b) above.

10. **Life-Saving Jackets**. Life-saving jackets are to be worn by or carried for all occupants of aircraft flying within five miles of the sea.

11. **Survival Packs**. A survival pack which contains a dinghy of an appropriate type is to be carried for all occupants of aircraft, when both a parachute and a life saving jacket are required to be worn.

12. **Multi-Seat Dinghies**. Multi-seat dinghies of sufficient capacity to accommodated all the occupants are to be carried in transport or communication aircraft when flying is intended or likely to be carried out over the sea.

<u>Safety Harness</u>

13. In fighters, bombers and training aircraft, safety harnesses are to be worn at all times. In transport aircraft, safety harness or belts where provided, are to be worn during flight at the discretion of the captain but are always to be worn during take-off and landing.

Passengers and crew members not provided with a safety harness or belt are to station themselves at their crash position during :

a. Take-off and landing.

b. At the captain's discretion.

Oxygen Equipment

14. The captain of an aircraft in which oxygen equipment is fitted is responsible for the efficient use of that equipment by his passengers and crew. Before take-off he is to ensure that the equipment is serviceable and that the passengers and crew fully briefed on the use of the equipment.

15. Jet aircraft should operate only when enough oxygen is carried for the entire duration of the flight. In exceptional circumstances flights without oxygen may be authorised by the Station Commander.

Armament Exercises

16. To avoid aircraft being damaged by ricochets, Station Commanders are to ensure that air to ground ranges in use are cleared of stones, tocks, bullet heads and other hard objects prior to commencement of each day's exercise. This order does not apply to the tactical ranges.

17. All air to air exercises are to be carried out in pre-determined range areas. RSO (Two aircraft) is to ensure that there is no vessel/ship in the vicinity and that he is flying in the correct area. Air to air exercises may be conducted above weather provided radar aids can determine position of firing aircraft and a low-looking radar aid can declare range area clear of vessels.

18. **Armament Switches**. While carrying live armament stores armament switches are to be set at "fire" only when the aircraft is actually in the attack. At all other times, safety switches are to be at "safe".

Security of Aircraft

19. (Before leaving an aircraft at an out-station base or airfield) the captain of an aircraft is to ensure that :

a. The aircraft is properly secured and as far as possible protected from weather.

b. The appropriate lights are switched on if necessary.

c. If at a non- BAF airfield, the aircraft is secured and guarded as far as possible.

Restrictions on Aircrew

20. Aircrew are not permitted to fly or continue flying while fasting when the last meal was taken 5 hours or more before the flight. In addition, flying is not to be undertaken sooner than one hour after taking the fast.

21. No aircrew is to consume any type of alcohol less than 10 hours prior to flying.

Flying Fatigue

22. All aircrew are to be afforded periods of rest sufficient to ensure that their efficiency is not undermined by fatigue. Accordingly the following principles relating to crew duty time, maximum flying hours and crew rest periods have been laid down.

23. Where aircrew are likely to be employed or engaged in flying activity to the maximum, officers responsible for authorizing flights, and captains of aircraft are to ensure that all pilots/aircrew are fit for the assigned missions and what they have had at least 8 hours of rest prior to the commencement of the day's flying.

24. OC Wing/Squadrons and transport aircraft captains are authorised to reduce drew duty time and increase the rest time at any stage they consider that flying safety is being endangered as a result of fatigue. They are also to reduce or restrict the number of hours/sorties required to be done by an aircrew, when it is suspected that inefficiency in flying is attributable to flying fatigue.

Maximum Flying Hours

25. Aircrew are not to exceed the flying hour limitations laid down below, in their specific roles :

a. Transport.

(1) 1000 hours in a year.

(2) 300 hours in 3 consecutive months.

(3) 125 hours in 28 consecutive days.

b. Fighter and fighter Bomber. – 04 hours in a month.

c. Bomber. - 60 hours in a month.

d. Training. - 60 hours in a month.

TOPIC- 7
EMERGENCY PROCEDURES

Reference: Jeppesen Airway Manual (MES – 1)

Section - Emergency

Emergency Procedures

Emergency Procedures	Definitions
	Emergency procedures
	Unlawful Interference
	Communication Failure

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GROUP-C : METEOROLOGY

TOPIC- 1 : ICE ACCRETION ON AIRCRAFT

Super-Cooling

1. At some level in the cloud the temperature will be reduced to freezing point (32^0F or O^0C), and normally when water is cooled to this temperature it turns into super-groups in-cloud, however they remain water even though their temperature be well below freezing point. Such drops are known as Super-cooled drops, and their temperatures may be many degrees below freezing point. Generally speaking, however, portions of cloud below O^0F (32^0F below freezing) consist mainly of ice particles, while between O^0F and 32^0F Super-cooled water drops predominate.

2. Now a drop in the super-cooled state is very unstable. It needs very little inducement to turn to ice. In fact, if it is touched by a particle of ice or is broken up, it will immediately start to freeze. When the super-cooled drop is very cold, a substantial portion will freeze. When the super-cooled drop is very cold, a substantial portion will freeze; but only a small portion of a drop not much below freezing level will turn to ice, the rest remaining as liquid.

Icing on Aircraft

3. Suppose now that an aircraft is flying through a cloud where the temperature is, say 27^0F. The leading edge of the wing strikes a super-cooled drop and breaks it up. Immediately part of the drop freezes on the leading edge of the wing, the remainder of the drop then is flowing back over the surface of the wing.

4. Now because the air temperature is 27^0F, the aircraft wing will be at that temperature, and will then cause the hitherto unfrozen part of super-cooled drop to solidity.

5. As the above process is repeated continuously, the ice formed by freezing on impact builds up into a mushroom-shaped mass all along the leading edge, while the water frozen by contact with cold surface of the wing forms a solid layer of clear ice.

Types of Icing

6. In cloud at very low temperatures the greater portion of each drop freezes on impact at the leading edge. The ice then builds up as a deposit of rime pellets of granular structure, with a good deal of air imprisoned in the deposits. Almost the entire deposit takes the form of the mushroom nose on the leading edge, but it has little cohesion, and is easily broken off. Such a deposit is known as Rime Ice.

7. A more dangerous form of icing is the clearance referred to above, which forms when that portion of a super-cooled drop which does not freeze immediately on impact

freezes later as it pass over the wing surface. Clear ice is very tough and adhesive to the aircraft, and is detached only with great difficulty.

8. This type of icing occurs when the temperature is not far below, freezing level. Generally speaking, clear ice is likely to form when the temperature in the cloud lies between 32^0F & 14^0F, while below 14^0F rime ice is more likely.

9. It should be noted that even when clear ice is being formed, rime ice deposits will also build up on the leading edge, due to instantaneous freezing on impact of portion of the super-cooled drops. The rime, however, will be closely bound together by the clear ice, and in contrast to rime alone, is extremely difficult to break off.

10. Not only the leading edges of the wing are affected all leading edges and protuberances which meet the air flow will accumulate ice, including the propeller blades and pilot static head. It should also be noted that ice crystals and hail do not adhere to the aircraft, and while frozen in themselves, they do not cause icing.

Engine Icing

11. **Piston Engine Icing**. On piston engines icing may occur not only when the external air temperature is below O^0C but even at temperatures as high as 25^0C. It may occur in clear air if the air is sufficiently moist. Engine icing results in loss of engine power due to blocking of air intake and disturbance of fuel metering, while movable parts of the fuel system may freeze up. Two main classes of ice formation may be distinguished, viz, impact ice and induction system (or carburetor) ice, but these do not always appear together.

a. **Impact Ice.** Impact ice is formed in the same way as airframe ice by the freezing of super-cooled drops on impact, & can therefore occur only at temperature below O^0C.

b. **Induction or Carburetor Ice.** In the induction system or Carburetor, ice may form not only because of the cooling due to fuel evaporation, but also owing to adiabatic expansion as air flows through the carburetor choke and post the throttle butterfly. Throttle icing tends to increase as the throttle is closed, but is unlikely with intake air temperature above + 5^0C. The cooling effect due to fuel evaporation may be considerable, and is largely responsible for engine icing at temperatures much above O^0C. The most severe engine icing for a given relative humidity occurs with inlet air temperature around + 13^0C. (Serious icing is unlikely with inlet temperature above 25^0C with relative humidity less than 60 per cent. While fuel evaporation ice is also unlikely below – 10^0C). Flight in rain or clouds within these temperature limits is liable to result in engine icing, and this may also occur in clear air if it is sufficiently moist.

12. **Jet Engine Icing**. Jet engines are chiefly affected by impact icing, at temperature below $O^{0}C$. Ice may form on the front of the engine at the mouth of the air intake, and on the early stages of the compressor; the resulting loss of power may be accompanied by surging and high jet pipe temperature. On a centrifugal type compressor the centrifugal effected and rise of temperature make the formation of ice unlikely. On the axial flow compressor, however, ice may occur on the first few rows of rotors and stators, and may also build up on the swirl vanes ahead of the compressor. If pieces of ice break away considerable damage may be done to the compressor.

13. **Icing of Fuel Tank Vents.** Icing of the vents on fuel tanks may sometimes affect engine operation by interfering with the flow of fuel from the tanks. Fortunately this type of icing appears to be rather rare, and remedies rare, and remedies are available.

14. **Icing Risk.**

a. Icing on propellers, causing dangerous vibration.

b. Ice may build up on leading edges, disturbing the air flow and causing dangerous loss of lift and increase in drag.

c. Sheer weight of ice on upper surfaces may force the aircraft down.

d. Ice may jam the control surface.

e. Interference with radio by ice forming on aerials.

f. Ice may choke the pilot and static heads, causing failure of altimeter, airspeed indicator, and rate of climb indicator.

g. Ice may form in the carburetor, causing loss of power or even complete engine failure.

Hints on Flying in Icing Regions (Thunder Storm)

15. a. To fly below the $O^{0}C$ level, although on piston engines, icing of the engine may still persist.

b. To fly above the $–40^{0}C$ level, or about 20,000 ft above the $O^{0}C$ level, if aircraft ceiling permits. It may not be necessary to go so high; 10,000 ft above the $O^{0}C$ level will often be high enough to stop appreciable icing, particularly in layer clouds.

c. To leave the cloud or precipitation area by change of altitude or heading.

d. **Hail.** A severe storm can produce very large hailstones which could do enormous damage to a light aircraft. Even larger commercial aircraft have been damaged, and hailstones of upto two pounds have been recorded.

e. **Rain.** Rain resulting in reduced visibility below the cloud.

f. **Lighting.** Which is not a surround risk, but which may cause temporary blindness and effect the accuracy of the compass.

g. It follows that thunderstorms in fact, any clouds of great vertical development should be avoided and it is axiomatic to say that the more hours pilots have, the less they feel inclined to fly through them. Isolated thunderstorms can easily be avoided by altering course, but if flying through the storm cannot possible be avoided, the following points should be noted:

(1) Choose the shortest possible path through the storm. That is, fly a fixed course at right angles to the storm's length.

(2) Do not attempt to fly under the storm unless the terrain is flat and a safe altitude can be maintained.

(3) Maintain constant altitude with artificial horizon.

(4) Avoid fiddling with the instruments because all instruments become unreliable.

(5) Avoid flying on the bad icing region from 32^0F to 14^0F ie 0^0C.

(6) Keep your eyes fluid to the instruments, to minimize the effects of lightning blindness; and if flying at night, keep cockpit lights burning as brightly as possible In most cases the private pilot will not come into intimate contact with thunderstorms, for conditions usually are such that clearance for VFR flight will not be given, and the pilot will have to wait for more favourable weather. Nevertheless, fore – warned is forearmed should be the occasion ever arise.

(7) Fly within 5 – 10,000 ft from the top of the cloud if aircraft permits, or fly within lower 8000 ft from the ground.

(8) Avoid Rain-Core belt if flying below the clouds, because of severe down draft.

(9) Avoid flying below the anvil to avoid hailstones.

TOPIC-2
THUNDERSTORM

Definition

1. **Cloud may be Formed by Convection.** By the warming of parcel of air and its consequent rising and cooling to below dew point. According to the Degree of instability, the cloud could be small and shallow or large and of great vertical extent.

2. A characteristic of all cumulus cloud is their uniformly base and heaped up billowy appearance with clear out edges.

Cumulonimbus Cloud

3. It is a development of cumulus, occurring where instability is very marked. In fact cumulonimbus has its beginnings in the same manner as Cumulus but develops to much greater heights with stronger vertical currents.

4. The name “Cumulonimbus” indicates ((i) that it is a member of the cumulus family and (ii) that it is a rain-bearing cloud (from nimbus meaning rain).

5. The lower portion of a typical cumulonimbus (abbreviated Cb) has the appearance of a large cumulus, but the upper part has the appearance of an anvil with its edges inclined to be ragged and “fuzzy” or fibrous.

Thunderstorms

6. A fully developed thunderstorm is a storm in which there is lightning thunder, hail and rain. As they are always associated with the formation of towering cumulonimbus clouds and present serious hazards to aircraft, it is essential for the pilot to know it thoroughly Thunderstorms frequently move across country in more or less continuous but narrow belts, advancing approximately at right angles to their length. At other times a single cumulonimbus cloud may cover many square miles, forming an almost overcast sky obscuring the upper portions of the cloud. Then a number of scattered and clearly defined Cb clouds may be seen in the sky at one time, each one producing a thunderstorm of its own.

7. Not every Cb cloud will produce a thunderstorm; nor will every storm be produced by a Cb. Cb cloud necessarily gives rise to all the phenomena mentioned above.

Composition

8. The cumulonimbus cloud consists of a series of cells in the various stages of development. The width of an individual cell is approximately 1-3 miles horizontally, and the distance between cells is usually 3-6000 feet.

a. **Stage One – 'Building Stage'.** The cell is formed by air being caused to rise by a trigger action or by divergence from other cells giving rise to convergence. Each cell consists of rising air during this stage.

b. **Stage Two – 'The Mature Stage'**. Air in the cell continues rising and the excess water vapour in the air condenses out, forming raindrops in the upper layers of the cell. The rain drops are held in the rising air currents until their weight is too great to be supported. They start to fall taking air with them and this air continues to move downwards because it becomes colder and denser than its surroundings. This gives rise to the downdraft which continues downwards through the cloud and outside the cloud at the base. It is this downdraft which is the 'first gust' and the cause of heavy rain under the cloud.

c. **Stage Three – 'The Dissipation Stage'.** The process outlined in stage two above continues until the downdraft has spread across the whole of the lower levels of the cell, when up current becomes of secondary importance. Eventually the whole cell consists of a gentle downdrafts and dissipation takes place.

9. The structure of cumulonimbus cloud may be seen from a cross section of a typical thunderstorm as shown in the figure below.

10. The warm air rises as a very strong current in a comparatively small forward portion of the cloud. This up-flow is balanced by down currents which are less violent and spread the cloud base over a large area.

Fig-1

Types of Thunderstorm

11. All cumulus and cumulo-nimbus clouds arise in unstable rising air. So far we have only considered the air to start rising through surface heating. Air may be forced to rise

through other causes, however, thunderstorms may be classified according to these causes, as follows:

a. **Heat Thunderstorms.** These are of the type that has no far been considered. They are initiated purely by surface heating in an unstable atmosphere. They are very common in the tropical regions of Australia, although they are by no means unknown in the southern regions. Over land they occur mainly in the late afternoon during the summer months.

b. **Cold Front Thunderstorms.** These are formed when a cold air mass pushes the moist, warm, lighter air, and hence forcing it aloft. In Australia they occur most frequently in winter.

c. **Thunderstorms in Cold Streams.** When a cold stream moves over warmer ground, the lower layers gradually become warmed to such an extent that the Environment lapse Rate becomes greater than the DALR. The mass the when a cold is unstable and thunderstorms easily develop. They are particularly common in southerly or south-westerly streams over the Alps in south-eastern Australia.

d. **Thunderstorms due to Orographic Uplift.** "Orographic Uplift" means the forced lifting of air by its passage across mountainous regions (from the word "Oros" meaning a mountain). If the air is unstable, the initial ascent on crossing a mountain will cause the air to keep on rising, and large Cu or Cb, and perhaps thunderstorms, will develop. This process is closely associated with the cold stream thunderstorms.

e. If the air is stable, it will settle to its original level after crossing the hill, and little or no cloud will be formed.

f. In all cases the conditions necessary for thunderstorms are :

(1) The air must be unstable to or height of at least 10,000 above condensation level.

(2) There must be sufficient water vapour in the atmosphere for condensation level to be at fairly low altitude.

(3) There must be some means of causing the air to rise in the first place.

Turbulence

12. Just as a boat pitches and rolls in the waves, so is an aircraft affected by an vertical motion of the air, An aircraft moving in a rising air current will be carried upwards, while a down current will obviously carry the aircraft down with it. This gives rise to the familiar "bumps", or turbulence, as it is more technically known. When the vertical currents are violent and suddenly encountered, the turbulence is severe, and may throw the aircraft out of control, or even cause structural failure.

13. In large Cu and Cb clouds, and particularly in thunderstorms the currents are very violent and turbulence is at a maximum.

14. A region of particularly severe turbulence is in the region behind the up-rushing sheet of warm air.

Squall Cloud

15. The “nose” of well developed Cb. Cloud of ten takes the form of a roll-type cloud. When clearly defined, it has the appearance of a cylinder stretching the full width of the leading edge of the cloud base. Blue-black, dul and threatening it produces violent squalls, (hence the name :squall cloud”), and is extremely dangerous to all types of aircraft. More often the actual squall cloud is hidden by the main cloud base. The heaviest rain, frequently associated with thunder and lightning, falls a little behind the squall cloud in the down currents.

Lightning

16. More than one theory has been advanced to explain the cause of lightning, but we need not go into details. Briefly, however, it can be said that due to the terrific turbulence within the cloud, the water drops are broken up and violently agitated. In this process different portions of the cloud acquire varying charges of electricity. When a large difference in the electrical charge is built up between two portions of one cloud, or between two clouds, or between a cloud and the ground a flow of electricity will take place, which is manifested as lightning.

17. Lightning is not a serious danger to aircraft, in which all metal parts are linked by metal strips called “bonding”. If the aircraft is struck, the lightning has a free passage and enters and leaves harmlessly. If the bonding is imperfect, however, the results are likely to be disastrous. On fairly serious hazard brought about by lightning is the temporary blindness caused by the brilliance of the flash. Other effects are risk of damage to radio equipment and possibility of compass bring made inaccurate.

Hail

18. Strong up-currents overcome gravity and force a water droplet up into the ice crystal zone. The water droplet freezes into ice and begins to fall. Further up-currents carry it once more into the ice crystal zone and as it collides with other droplets and crystals its size increases. Finally it is too heavy to be further tossed about by the convection current and it falls.

The Dangers in Thunderstorm

19. Extremely violent vertical currents, resulting in difficulty, and perhaps complete loss of control, and the risk of structural failure. Where down currents are encountered, the aircraft may be forced to lose height to a dangerous extent. Icing on different parts of an aircraft have very much adverse effects in its operations.

TOPIC-3
TURBULENCE

Definition

1. The word turbulence normally refers to atmospheric motions smaller than the scale which is designated as the flow.

2. Bumpiness is the term which describes the perceptible aircraft motions which result from atmospheric turbulence.

3. The most important mode of response of the aircraft to atmospheric turbulence is the vertical acceleration of the entire structure. Small scale horizontal accelerations are not readily detected nor are they at all significant.

Mechanical Turbulence

4. The main source of turbulence in the atmosphere is the frictions along the surface of the earth. The roughness of the surface creates eddies or whirls of air which are force up to higher levels. The turbulent flow consists of a succession of gusts and lulls the period of which is irregular and the length of the period is a few seconds. The strength of the gusts is proportionate to the roughness of the ground and the velocity of the wind and increases as the stability of the air decreases. Turbulence caused by friction is called mechanical turbulence.

Influence of Mountain Ranges

5. The most striking feature is the development of eddies on the lee side of the mountain. On the windward side there may or may not be a stationary eddy according to whether the incline is steep or not. These eddies may force a pilot down if he is flying against the wind and not keeping sufficient altitude. A pilot flying with the wind will generally gain altitude. If this mountain is very steep there may be a stationary eddy on the lee side and cause difficulties. The eddies around mountain ranges reach up to some altitude above the range and cause intense mixing of air which may lead to formation of clouds (Stratus).

Thermal Turbulence

6. Irregular distribution of temperature in the atmosphere also produces turbulence. The warmer lumps of air will rise and the colder will sink thus producing irregular flow. This kind of turbulence is called thermal turbulence.

7. The thickness of the turbulent layer along the earth’s surface depends mainly on the stability of the air. In unstable air the convectional currents are super-imposed on the general flow. They cause strong fluctuations in the wind and sometimes become wind squalls. These squalls are generally connected with convective clouds.

8. The intensity of thermal turbulence and the convectional gusts and squalls depends on the nature of earth's surface. The middy temperature on sandy fields is higher than the temperature over grassy lands. The differences in temperature give impulses of considerable intensity to local convectional currents and cause bumpiness.

Inversion

9. Bumpiness is also experienced when an aircraft passes a temperature inversion. Temperature inversions are usually wind discontinuities also and both wind speed and direction are different above and below the inversion. Sometimes ripples develop along the inversion and an aircraft flying close to the inversion may be exposed to a series of bumps in a regular period.

Bumpiness due to Horizontal Variations in Wind

10. Generally bumpiness is caused by upward or downward currents in the air. But sudden horizontal variations in the wind may also cause bumpiness. A sudden lull causes a sudden increase in dynamic lift which is field as an upward or downward bump.

Typical Situations for Turbulence

11. Turbulence will occur within clouds of vertical development, over the hilly and mountainous areas, within the areas of sudden wind shifts such as fronts, cyclonic storms and within areas of wind shears both vertical and horizontal specially in the region of Jet Steam and tropopause.

Clear Air Turbulence

12. Turbulence in the atmosphere produced by mechanical or thermal effects has been discussed already. It has been found that bumpy flying conditions may also occur at high altitudes in clear air well away from surface effects or thunderstorms. This phenomena is termed Clear Air Turbulence (CAT). The higher the speed of the aircraft the more marked is its effect. CAT is generally associated with the following.

a. Mountain wave.

b. Jet Stream.

c. Mechanical effect.

d. Artificially induced turbulence.

e. Other clear air turbulence.

Mountain Wave Turbulence

13. Under certain conditions when air flows against a mountain, stationary waves are set up for several miles (20 to 30 or over more) to the lee of the mountain range which may possess extreme turbulence with very high velocity up drafts and down drafts.

14. The vertical motions associated with those standing waves may at times become very strong and can cause an aircraft to gain or loss height as in the case of the thunderstorm turbulence. Gust velocities of the order of 12m/sec are not uncommon and if an aircraft encounters gusts of this intensity at normal cruising speed it is in danger of severe structural damage.

Jet Stream Turbulence

15. The clear air turbulence generally encountered in the higher levels above 6 kms is in most cases associated with the Jet Streams. The characteristic feature of this turbulence is that it occurs in patches with horizontal dimensions of the order of 50 miles but in extreme case they may exceed 300 miles. The average vertical extent of the patches is about 750 yards but at times it may be as small as 20-30 yards. One significant difference between the high level turbulence and other forms is that it has very rapid bumpiness associated with it. This rapid bumpiness sat high levels is sometimes described as “cobblestone” effect because flying under these conditions is similar to the jolty driving over a cobblestone road.

Areas of Turbulence in Jet Stream

16. Jet stream turbulence is most often encountered in the quadrant below the jet stream axis on the cyclonic side (left side), looking downward. Similarly above the axis on the anti-cyclonic side (right side) is also a preferred region of a secondary maximum. The quadrant below the jet axis of the anti-cyclonic side (right side), is a region of distinct minimum of turbulence. Longitudinally along the jet axis the situation is not so distinct although studies made so far indicate that preferred regions for turbulence may be :

a. Regions of isotach maxima.
b. Regions where jet stream splits.
c. Regions where there is strong curvature of the jet stream.

Other High Level Turbulence

17. Apart from the clear air turbulence associated with jet streams there are certain other synoptic features with which high level turbulence is known to be associated. These are high level Low or Trough and Tropopause. The association of turbulence with these systems is, however, not quite as strong as it is with the jet stream.

Artificially Induced Turbulence

18. In addition to the turbulence resulting from natural cases there is a mechanism for artificially inducing clear air turbulence, which can be serious hazard to small aircraft. It has been found that large aircraft with high wing loading releases vertices from their wing tips which can create severe turbulence over a narrow region behind the aircraft. The turbulence so induced can constitute a serious hazard when a small aircraft attempts to land behind the big aircraft.

Height, Range and Severity

19. Clear air turbulence can be experienced at all levels from ground upto the tropopause, but the majority of the cases occur near the tropopause, particularly in the range 7,000 ft below the tropopause the 3,000 ft above. The turbulent layer is usually only about 500 ft deep so that it can often be avoided by a small change in altitude, but turbulent layers of more than 6,000 ft in thickness have occasionally been reported.

20. The severity of clear air turbulence varies within wide limits, but in severe turbulence aircraft have occasionally suffered slight structural damage. With severe turbulence there is also a marked tendency for aircrew to be lifted from their seats.

Effects of Turbulence in Flight

a. Due to sudden increase or decrease in dynamic lift, high performance aircraft may stall.

b. Stresses and fatigue on the airframe and structural damage may occur.

c. All instruments depending on pressure will give wrong indications.

d. Physical and mental strain on the pilot.

e. Losing of control due to roughness of the flight.

f. Operations such as bombing and air-to-air/air-to-ground firing become more difficult and inaccurate.

TOPIC-4
JET STREAMS

Definition

1. A jet stream is a strong narrow current, concentrated along a quasihorizontal axis in the upper troposphere or in the lower stratosphere, charactarised by strong vertical and lateral wind shears and featuring one or more velocity maximia.

2. A jet stream can be compared to a narrow current moving along the hemisphere in a wave like pattern. It can be imagined as a flat tube roughly horizontal with dimensions described below.

Cause of Jet Stream

3. Concentration of a large fraction of the total kinetic energy of the atmosphere in the jet stream belt.

4. Concentration of the bulk of temperature gradient in a narrow zone of the west wind belt.

General Characteristics

5. The well-defined segments of the jet stream have wind velocities from 50 kts to 300 kts, are normally 1,000 to 3,000 miles long, 100-400 miles wide, and 3000 to 7000 ft thick.

6. The horizontal wind shear on the cold air side (popular air mass side) is 100 Kts in 100 miles; on the warm air side (Tropical air mass side) is only 25 Kts in 100 miles.

7. The vertical wind shear above and below the jet core is approximately 20 Kts 3000 ft.

8. The high winds in a jet stream pulsate eastwards and sometimes encircle the entire hemisphere but more often it is broken up into several discontinuous segments. It usually runs from West to East but can also flow from north to south.

9. Ver large changes in wind speed with changes in height are shown in the figure given below.

Height in 1000 of feet.

60
50
40
30
20
10

50 100 150 200 (Nautical Miles)

Fig Graph of actual wind condition found In one case of a Jet Stream.

10. Usually accompanying a polar out-break, the core of the jet stream is on the average 200 nautical miles behind the surface cold front and between 30000 ft to 40000 ft high. New branches of a jet stream are usually found above an occlusion. If waves aloft in a jet stream become unstable, they tend to occlude and a pocket of cold polar tropospheric air is embedded in warm tropical air.

Location of Jet Stream

11. There are five main areas of occurrence of jet streams in the vicinity of latitude 30^0 in both north and south hemisphere between latitudes 40^0 and 60^0 in both hemispheres and over equatorial regions. In addition, jet streams at very high levels are found over sub-polar region.

Jet Stream on Local Climate

12. The climatologically element which has been most closely associated with the jet stream is precipitation. Precipitation maxima tend to be oriented along or just north of the band of strongest winds sat 300 mb level. Rainfall decreases northward from here but much more rapidly on the south side. Over considerable areas precipitation is in excess of 20 cm or 4 inches per 100 miles.

13. The traveling surface disturbances propagate mainly along the jet stream.

14. The alternating regions of maximum and minimum wind speed which travel along the jet axis are to play on important role in determining regions along the jet where the formation or intensification of extra-tropical cyclones is likely to occur.

Effects of Jet Stream

15. a. **Clear Air Turbulence.** Due to the high speed of winds in a jet stream, friction with the surrounding air develops turbulence in a shallow lever immediately above and below the jet stream. The turbulence in cloudless portion of the sky is called clear Air Turbulence or CAT. It occurs most frequently above 20,000 ft and 40,000 ft CAT areas are shallow when compared to vertical extend of low level convective turbulence, CAT varies between 500 ft to 20,000 ft in thickness, between 10 to 20 miles in width and between 40 to 50 miles in length. Most of the CAT areas are found on the low-pressure side of the jet. Severe CAT is associated with the center of vertical shear isotachs when horizontal shear is also present. CAT is a welcome sign for navigational purposes, especially at night when visual observations are very limited as it gives warning for entering or leaving the Jet Stream. While flying in the

jet stream, it gives an indication that the aircraft is losing the maximum tail vector and flying in an area of wind shear.

b. **Clouds and Jet Stream.** Location and direction of a jet stream is sometimes indicated by the type, structure and formation of clouds. These jet stream clouds look like the sea surface wind lanes crossed with waves or cross-banded altocumulus layers. The cirrus, cirrostratratus and cirrocumulus are frequently associated with strong winds aloft. The value of clouds develop in the vicinity of a jet stream.

c. **High altitude Flying.** A pilot flying at an altitude just below the jet stream axis can make use of the aircraft thermometer. If the temperature is rapidly falling off, then the aircraft is flying in rapidly decreasing tail winds.

Jet Stream Flying

16. If a pilot determines that his aircraft is in an adverse jet stream, he can do one of three things : (1) he can change heading, (2) he can change altitude, or (3) he can land. The pilot will have to consider several things before he can make the correct decision.

a. If the pilot knows his position with regard to the jet core he may climb or descend, if he finds that the wind advantage gained by this change in altitude will offset the decrease in the efficiency of his aircraft at the near altitude.

b. A better general procedure for the pilot who knows his position with regard to the jet core may be to change heading. But when flying under controlled conditions one cannot go wandering all over the sky. Therefore, this procedure may not be acceptable to other.

c. Landing may be the best procedure for a pilot who does know his relative position with regard to the jet stream. The decision, of course, is upto the pilot.

d. If the pilot determines that the jet stream is oriented as a strong cross wind, he should not attempt to remain on course through the jet stream area. By trying to remain on course, the loss of ground speed would be significant and could cause fuel consumption to become critical. The pilot should head through the jet stream area at a right angle. It is generally a good idea to try to remain below the core of the jet when crossing through the jet stream area for weaker winds below the jet core will, in most cases, enable a pilot to save time and fuel even at an altitude of less efficient engine operation.

Jet Stream Over Bangladesh

17. Jet Stream is frequently located in winter as far south as 20^0 N. An average of 100 to 150 knots is often encountered in winter at about 34,000 ft. Jet stream shows a tendency to split when impinging upon a large mountain range. The subtropical branch of the jet stream flows around the southern slopes of the Himalayas while the polar-front jet travels around the northern edges of the plateau of Tibet. Both jet streams merge again in a marked confluence zone over Eastern Asia. The onset of the Indian summer monsoon is associated with the disappearance of the westerly jet stream along the southern slopes of the Himalayas. Upper-level easterlies appear over Bangladesh and Northern India, and the intertropical convergence zone advances far towards the north into the Indian peninsula, carrying heavy monsoon precipitation in its wake.

TOPIC-5
MONSOON

Introduction

1. Monsoon is a seasonal flow of air. Its activity is most prominent in India, Bangladesh, Pakistan and Southeast Asian countries. In other parts, lime west Africa, eastern north Atlantic, Monsoon visits in rare occasions and that is unworthy to be mentioned. Our discussion on monsoon will mostly be confined to Indian monsoons

Definition of Monsoon

2. CS Ramage, professor of meteorology, Hawaii University, defined monsoon as a flow of alternate air associated with alternate pressure systems having a change of wind direction of at least 120^0 between January and July flow. The differential heating land and sea makes the continents warmer in summer and colder in winter. This results a low pressure system over land in summer and high pressure system in winter. This two alternate pressure systems cause wind to flow in alternate direction ie from sea to land in summer and from land to sea in winter. These winds are called Monsoon.

Types of Monsoon

3. Mainly there are two types of monsoons encountered by Indian subcontinents: They are as follows:

a. Winter monsoon or NE Monsoon.

b. Summer monsoon or SW Monsoon.

4. Each monsoon is separated by two transition periods. They are :

a. Spring transition (March-April)

b. Autumn transition (October-November)

5. Another common term we generally use is ‘Break monsoon’. This is not a separate monsoon; rather, it’s a temporary break of rainfall during southwest monsoon season. The details of each monsoon is given in subsequent paragraphs.

NE Monsoon

6. This monsoon starts setting in our area in the month of December and continues till Mid-of February. This is because, in these months, the Sun is in the southern hemisphere and length of days in our area is longer than that of night. As a result the land, (which absorbs and radiates low pressure system shifts from lands to the equatorial seas. This creates high pressure system over the land and air rush into the low pressure system near the equator. To fill up the gap over land, air from “Siberian high” starts flowing in our area as a NE’ly wind. This is, in short, known as NE monsoon. Since this air comes from a colder region (at least 15^0), the flow of NE monsoon brings lot of cold to our area.

SW Monsoon

7. This is well-known to all of us because of its heavy rainfall in our area. It first appears in Andaman seas in the month of May and by mid-June it extends to whole of India and Bangladesh. This monsoon remains active till the end of August and in exceptional cases to mid-of September.

8. In fact, this occurs due to the creation of a low pressure are over the land, as the sun moves to the northern hemisphere. This results in a cyclonic flow of air around the low. Since, northern side is blocked by the Himalayas, the air comes from southern side, as SW flow, carrying lot of moisture from the Bay of Bengal and giving heavy rainfall to India and Bangladesh. This is popularly known as SW monsoon.

Break Monsoon

9. During the monsoon period, successive few days go without rain. The ITCZ shifts north ie to the foot of the Himalayas. In this period Bangladesh, West Bengal and Orissa, Bihar etc have no rain, whereas excessive rainfall occurs in the Cherapunjee area. This rainless days in our area is known as break monsoon.

Spring Transition

10. Withdrawn of NE monsoon and gradual approach of SW monsoon is known as spring transition. March and April, are the vulnerable period for change of surface wind to south to SW'ly direction. In the lower layer (5 to 7000 ft) the southerly wind carries moisture from the Bay and upper North-westerly winds carry cold & dry air. Any instability in the atmosphere causes afternoon thundershowers known as Nor'wester.

Autumn Transition

11. The withdrawal of SW monsoon and gradual approach of NE monsoon is known as autumn transition starting from mid of September and ending mid of November. This is the period when prominent Cyclones or depressions form in the Bay of Bengal.

Monsoon Depressions

12. Monsoon depression forms over the head bay. Before the formation lower tropospheric SW'ly wind increases and weather deteriorates over peninsular India. Recent research by Indian Meteorologists indicates that the formation mechanism of monsoon depression over head Bay is different than that of frontal depression at higher latitudes.

13. Monsoon depression over the north Bay develop under the following conditions:

   a. Existence of a low or a trough of low over the Gangetic Bay or ever head bay.

   b. Movement of a low to the north Bay either from Burma or from south China sea as easterly through.

   c. Existence of a positive vortices at the upper troposphere over north Bay.

14. All of the above conditions need to be fulfilled for the formation of monsoon depression. Generally, monsoon depressions do not turn into Cyclone or hurricane due to the reasons as below:

a. The sensible heat required for a tropical cyclone to be developed can not be supplied by condensation of water.

b. The presence of a strong vertical wind shear over that area at upper level (about 15 mps).

Movement and Transformation

15. Monsoon depression over the Bay of Bengal moves west or north westward like a tropical cyclone. It moves along mean troposphere isotherm and also parallel to winds at 10 to 12 km height. Depending on the intensity, it moves upto Kashmir and then re-curves North or northeastward due to polar westerly. Unlike tropical cyclone, it has less pressure gradient and hence less energetic due less temperature gradient.

16. Monsoon depressions do not die down over the load because they got moisture from marshy or watery land due to heavy shower. When it makes to Rajasthan or adjacent area, it sometimes combine with the existing lows there and become more powerful causing heavy rain/ shower over northern or western part of India. Finally it dies out when the moisture supply is cut-off.

TOPIC-6
NOR-WESTERS

Climatology of Nor-Westers

1. Premonsoon months (March-May in West Bengal and Bangladesh are characterized by the occurrence of violent thunderstorms which are popularly called Nor'westrers. Nor'westers are caused by the undercutting of most Bay air by wedges of cold air extending from the valleys of Assam. The days for the period 1900-1926 comprising some 511 thunderstorms at Calcutta shows that thunderstorms are most frequent between 19 and 21 hours and the quietest time from 0600 and 1300 hours IST. The following points are evident:

a. Thunderstorm occur in the Calcutta division of West Bengal and Dhaka division of Bangladesh generally during afternoon and evening with none occurring late at night and morning.

b. The frequency of occurrence at other hours increases as one proceeds from West Bengal to Chittagong division.

c. Nor'westers in Submontance stations of Northern West Bengal and Bangladesh are maximum during night with a little thunderstorm activity between 16 and 20 hours BST.

d. Number of thundery days is larger in Chittagong division than in other parts and the storms are spread out among all hours of the day but maximum at 21-23 hours BST.

Causes of Nor-Westers

2. It occurs due to latent instability below the 'inversion' with 'environment of latent instability' above it. Trigger action destroys the inversion and instability is released. The trigger action is supplied by one or a combination of the following :

a. Insulation.

b. Inflow of moist winds from the Bay into West Bengal and Bangladesh due to a disturbance or Cyclonic storm.

e. Eastward passage of the cold front of a western disturbance generally in an occluded from.

d. Convergence of air due to Katabatic flow from the Brahmaputra Valley.

e. Outflow of cold air in different direction from a parent thunderstorm.

3. **Types of Nor-Westers**

a. **Types 'A'.** Start in West Bengal and Chota Nagpur in a AW-SE direction. The actual region of start may vary according to the synoptic situation and also the area affected by the disturbance. There have been cases where thunderstorms started in south Bihar and spread out to the Chittagong coast and also when they started in Northwest Orissa and the disturbance spread to Orissa coast. The squalls associated with thunderstorms have NW'ly direction and their average speeds vary from 40-50 mph. Hail sometimes occurs either at the beginning of the disturbance or during its travel. The rainfall associated with these storms averages from a few cents to an inch or so in Calcutta and Dhaka divisions. Over Chittagong division it is more copious and occurs for a longer time. Type A seems to be the most predominant type and accounts for 45 per cent of thunderstorms. Associated with this type are thunderstorms whose activity is localized and which start off in Calcutta reach Dhaka divisions afternoon before the main sequence starting from Chota Nagpur.

b. **Type 'B'**. Starts mostly in the night and early morning and moves down from a N to S direction. This is less frequent than A. Squalls associated with this type come usually from a northerly direction. Hail is rare but copious rainfall occurs in Chittagong division on some occasions.

c. **Type 'C'.** Is rarer than the rest. It starts somewhere near the eastern hills of Assam at 1100 hours and moves west-words reaching Calcutta at about 2100 hours IST. The squalls associated come mainly from NE to E.

d. **Type 'D'.** Is very similar to type B, besides being 'local' thunderstorms, mostly due to afternoon heat or local orography and sometimes due to the influence of thunderstorms which might have affected or continuous in the immediate past. These are small in number and are not violent in character.

4. **Points About Nor' Wester.**

a. Over Calcutta there are four Nor 'Westers in March, eight in April and twelve in May.

b. Nor 'Westers cease in June as soon as Monsoon is established.

c. Frequency over Chittagong division is higher than over Calcutta.

d. Almost 60 percent of thunderstorms over Calcutta occur between 1700 and 2100 hours IST 10 percent occur between midnight and 0900 hours IST.

e. Thunderstorms over West Bengal and Bangladesh come from all points of the compass, but those coming from W-NW are most frequent.

f. Most thunderstorms are associated with squalls; speed 35-50 mph over Calcutta and higher speed over South West Bengal and Chittagong division when speed may reach 100 mph.

g. Visibility reduced to nil due to dust rising vertically high. Visibility is also bad during precipitation.

h. The hight of base of the cloud is 500 feet or less and thickness 20,000 feet or more.

j. Speed of vertical currents in Nor'Westers is very high.

TOPIC-7
FORECASTS, AIRCRAFT OBSERVATIONS AND REPORTS

Reference: Jeppesen Airway Manual (MES – 1)

Section - Meteorology

Forecasts, Aircraft Observations and Reports

Forecasts	Interpretation and Use of Forecasts
	Aerodrome Forecasts
	Landing Forecasts
	Take off Forecasts
Aircraft Observations and Reports	Routine Aircraft Observations
	Special Aircraft Observations
	Reporting of Aircraft Observations in Flight

TOPIC-8
METEOROLOGICAL OBSERVATIONS AND REPORTS

Reference: Jeppesen Airway Manual (MES – 1)

Section - Meteorology

Meteorological Observations and Reports

Meteorological Observations and Reports	Routine and Special Observations
	Contents of Reports
	Observations and Reporting Met Elements

TOPIC-9
SERVICES FOR OPERATING FLIGHT CREWS

Reference: Jeppesen Airway Manual (MES – 1)

Section - Meteorology

Services for Operating Flight Crews

Services for Operating Flight Crews	General Provisions
	Briefing, Consultation and Display
	Flight Documentation
	Information for Aircraft in Flight

GROUP-D : SURVIVAL
TOPIC– 1 : JUNGLE SURVIVAL

Action After Landing

1. After landing carry out the following immediate action :

   a. First aid to injured personnel.

   b. Fix position.

   c. Rendezvous with crew members if scattered.

   d. Establish 2-way radio contact if possible.

   e. Prepare all signaling gear for immediate use.

   f. Check emergency equipment including rations.

   g. Institute immediate rationing.

   h. Elect a leader and apportion duties.

   j. Relax and formulate a plan of action.

2. Decision whether or not to leave the aircraft depend entirely on the factors prevailing at the time. If the aircraft is easily visible from the air, emergency ration adequate, water available, no sign of human habitation, surrounded by dense jungle, and air search is expected, stay with the aircraft, but if the factors available suggest that a trek may be the best plan, organize accordingly once a plan has been formulated, based on main factors and carefully considered, put it into effect at once and stick to it.

Staying with the Aircraft

3. If a decision is made to stay with the aircraft ensure that every possible means of attracting attention is made ready for instant use. Make use of the following :

   a. Parachute canopies spread out over the aircraft, over trees or pegged out in clearings.

   b. Yellow dinghies inflated and prominently displayed.

   c. Bright cowlings or panels spread out near the aircraft.

   d. Clothing spread out on the ground or hung on a line.

   e. If possible keep a fire always alight. At night make flame, during the day make smoke.

   f. Use pyrotechnics sparingly. Use only when aircraft are heard or seen.

   g. Indicate special needs by use of the ground air emergency signaling code.

Leaving the Aircraft

4. If a decision is made to leave the aircraft the following points should be borne in mind.

a. Don’t take along unnecessary equipment.

b. Take such items as parachute canopies, shroud lines, survival kits, first aid kits, axes, knives, food and water.

c. Do not discard clothing. It is cold at night in the jungle.

d. When finally leaving the aircraft, lay out the appropriate ground emergency signal.

5. **Signaling**

a. **Use of Signal Mirror**. Hold mirror a few inches from face and sight at airplane through hole. Spot of light through hole will fall on face, hand or shirt. Adjust angle or mirror until reflection of light spot in rear of mirror disappears through hole while you are sighting airplane through hole. Do not continue to flash mirror in direction of plane after receipt of signal has acknowledged.

b. Aircraft Radio/Emergency Radio.

c. Smoke by Day. Add engine oil, rags soaked in oil or pieces of rubber to make black smoke, Burn green leaves, or moss to make white smoke.

d. Flame by night. Set up four fires if possible.

e. Signals with flash light, emergency radio light or landing light.

f. Spread out parachute Mae West and engine cowlings.

g. Fluorescent dye.

h. Disrupt the natural look of the ground.

Water

6. Survival is more dependent on a supply of drinking water than any other commodity. Normally in the jungle the supply of water can be purified by any of the following means.

a. Use the halazone tablets in the survival kit.

b. Two or three drops of iodine to one quart of water. All to stand for 30 minutes.

c. A few grains of permanganate of potash to a quart of water. Allow to stand for 3 minutes.

d. Boil for at least three minutes.

7. Sources of water which should be purified before drinking.

a. **<u>Water Holes</u>**. Water-found here will probably be muddy, and with pieces of rotten vegetation in it, so filter it first, then allow to stand for a few hours, filter again, then purify by one of the methods suggested.

b. **<u>Digging</u>**. Treat water as for a above. If on the seashore, dig a small hole a few yards above high tide, and as soon as you find water collecting, stop digging. Water collected in this way should be fairly free from salt, the fresh water floating on the top of salt water, hence don't go too deep. The water obtained in this way may taste slightly brackish, but will be safe to drink. If very strong, filter it a few times, or try again further up the foreshore.

c. **<u>Stagnant Water</u>**. This is not necessarily infected, but in order to make sure, filter it, then purify. Stagnant water may be found in small pools, amongst rocks, dead tree stems, etc.

d. **<u>Large Rivers</u>**. This water will be muddy and probably infected, so treat as for water holes.

8. **<u>Sources of Water in Tropical Forests</u>**. Fresh water, not need of purification :

a. **<u>Rain</u>**. Build a rain trap from large leaves, with framework made up from bamboo or branches.

b. **<u>Jungle Wides (and Rattans)</u>**. Select the lower loop of any vine, and cut out a length of four or five feet, from which drinkable water may be drained.

c. **<u>Streams</u>**. All fast flowing streams, having a mixed sandy and stone bed, provided this water will also be pure, and ready for drinking.

d. **<u>Plants</u>**. During the monsoons, or rainy season, water can be collected from natural receptacles found on various plants. This will be fresh rain water, and fit for human consumption.

e. **<u>Bamboo</u>**. In the base of large female bamboo stems will be found drinking water. It is not possible to guarantee finding water from this source on every occasions.

f. **<u>Coconuts</u>**. In the green unripe coconut will be found a very good substitute for water, i.e., "coconut milk". One nut way contain as much as two pints of this delicious cold fluid. Do not drink the milk form the ripe or fallen coconuts.

9. If only a small quantity of water is required to boil some fruits or vegetables, etc., take one section of bamboo, cut a hole in the top, and suspend over the fire by means of two horizontal sticks or two pieces of jungle vine or rattan.

10. If bamboo is not available make a vessel from fibrous barks or leaves. A container thus made will not burn below the waterline, moisten the area above the waterline to reduce the risk of the container catching fire.

Food

11. Many species of fruit and vegetables can be utilized to augment the dry rations contained in the food packs. Most of these are described in detail in the relevant. Survival publication Main points to bear in mind are :

a. Avoid any fruit or vegetable which gives a milky sap. Common edible food/plants are tern, sweet, potatoes yours bread fruit, cassia maniox, peanuts and pineapple Berries, Bananas, Mango, sugar Cane etc.

b. Eat sparingly at first to note effects.

c. It is normally safe to eat anything that a monkey will eat.

d. All birds and reptiles are good to eat.

e. Fish can be obtained from streams, rivers and lakes. Rest time to fish are just dawn and just before dusk.

Animal Hazards

12. The jungle abounds in all forms of animal life most of which, however, will avoid the scent and sound of man. The main protections are given below:

a. **Mosquitoes**. Avoid swampy area-keep body covered-Camp to Lea ward of a smoky fire-Use anti-malaria tables in survival kit.

b. Wasps, Bees, Hornets and Ants Nest usually in tress-Avoid disturbing.

c. **Leeches**. Avoid swampy ground – de – leech periodically. Do not pull off burn with cigarette end or hot ember.

d. **Snakes**. Most snakes will glide away on being disturbed Exercise caution following animal tracks – Do not corner or antagonize a snake – If bitten, cut with a knife or razor blade to the depth of the bite in the direction of the blood vessels and tendons and squeeze or suck the poison out.

Camping

13. Choose camping sights in conformity with the following requirements :

a. Proximity to food and water.

b. On solid ground free from mud.

c. With natural protection from weather and animal life.

d. Any from decaying vegetation.

d. Not directly under coconut palms or dead trees.

Natives

14. Treat natives as friendly. Deal with the chief of headman. Request – do not demand – Give small trinkets as gifts – Lave native women alone.

Travel

15. Before you start to travel, make careful plans bearing in mind the following considerations :

a. Travel only during the day.

b. Pick the easiest path possible.

c. Travel along animal tracks or elephant trails if possible.

d. If a stream is found, follow it. It will most probably lead to human habitation.

Bamboo

16. Bamboo is the jungles most important single aid to the survivor. It can be used in the following ways:

a. To obtain water.

b. To transport water.

c. As a cooking utensil.

d. As a framework for tent.

e. As a fighting rod.

f. As a raft.

g. As fuel for the fire.

h. Young bamboo bots are excellent food after the small black hair attached to the edges of the leaves have been removed.

TOPIC– 2
SEA SURVIVAL

IMMEDIATE ACTIONS AFTER DITCHING

Release and Board the Dinghy

1. Inflate the dinghies and get aboard. Don't jump in or you may damage the dinghy. Don't board an inverted dinghy, for if the air beneath is expelled a suction is created and dinghy may be difficult to set right. Make sure that all the survival equipment goes aboard especially parachute pack. With a little ingenuity it can be made to serve a multitude of purposes, especially as extra clothing.

Roll Call

2. The captain of each dinghy calls the roll, endeavours to find any missing crew passengers and then cuts the painter.

Paddle Clear and Salvage Equipment

3. Padlle clear off the aircraft. Beware of any jagged metal. Beware of the aircraft as it sinks, especially the tail plane Salvage all floating equipment and lash all equipment securely to the dinghy. One of the occupants should then securely attach himself to the dinghy with a length of line a safety precaution against losing the dinghy through its over-turning and drifting away.

Stream sea Drogues and Servicing Dinghy

4. Rendezvous with the other dinghy if more than one has been launched and secure the dingies together. About twenty-five feet of life between dinghies has been found to be the best length to avoid snatching. Stream the sea drogues to minimize dinghy drift. If necessary, top-up the buoyancy chambers using the topping-up bellows. Bale out with the bear and Viscose sponge.

Administer First Aid

5. First aid should be administered without delay to the injured and to those suffering from shock. Injured personnel usually require extra water, food and clothing-a point to be borne in mind when rationing. Wet clothes should be removed and dried, if there is any spare clothing.

Plan of Action in Dinghy

6. When the immediate actions after ditching have been completed the captain should then discuss a plan of action with the crew. If the captain is missing or badly injured, it will be necessary to appoint another captain before trying to formulated a plan of action.

7. **Factors Affecting the Plan of Action**

a. The state of W/T contact and the amount of information signaled before ditching.

b. The likelihood of air search and its probable efficiency in the prevailing weather.

c. The position of ditching in relation to the nearest land, surface craft, main shipping lanes and air routes.

d. Knowledge of and the advantage to be gained from, wing, current and tides. This will be important in the tropics where air search may be limited, and it may ultimately be decided to make a landfall.

e. Rations available, particularly water.

8. The decision must then be made whether to remain in the vicinity of the ditching, or to set course for an area where help is more likely. It is preferable to remain in the vicinity of the ditching for at least 72 hours; but should circumstances favour a departure of the cress initial fitness and energy. The plan of action should be adhered to, despite any temptation to change it later.

Dinghy log

9. All signaling gear should be checked and prepared for instant use, according to the instructions supplied with each item.

Allocation of Duties

11. Duties should be allotted by the captain to all occupants of the dinghy.

12. Duties should include signaler, navigator, aircraft spotter, and fieldsman, and in a large crew duties can be allocated by means of a watch system. A record of duties carried out should be entered in the log. The duty of distributing the rations is the responsibility of the captain, the issues being recorded in the log to avoid arguments.

Drinking Water

13. Drinking water is your most essential need. A man in good health can live form 20 to 30 days without food, without water he can live only for about 10 days and even less in the tropics. A man needs a minimum of a point (20 ounces) a day to keep fit, but he can survive on two to eight ounces a day. Therefore, the rationing of water must be instituted without delay and not relaxed until final rescue.

Water Rationing

14. While no hard and fast rules can be laid down for the rationing of water, the following method is recommended:

a. 1st Day, no water issued, except for the injured. The body acts as a reservoir and you can live off the water it has stored.

b. 2nd, 3rd and 4th Day. 14 ounces per head daily, if available.

c. 5th Day Onwards. Two to eight ounces per head daily, depending on the climate and the water available. Rain water and water obtained from any additional sources, must also be rationed except when it is raining.

Water Rules

15. To preserve the water in the body is almost as important as having water to drink. Here are a few very important rules for guidance :

a. Keep your shirt on to prevent the loss of body moisture through unnecessary perspiration and exposure.

b. Sleep and rest are most important during a shortage of water. In the tropics, keep your exercise to a minimum.

c. Prevent sea-sickness if possible Valuable water can be lost through being sick.

d. Do not drink sea water or attempt to make your fresh water last longer by adding sea water to it.

e. Do not drink urine.

f. Do not drink alcohol.

g. Keep smoking to a minimum.

h. To alley thirst, and keep the mouth moist by increasing saliva it may be found beneficial to suck a piece of cloth or a button.

j. Do not eat unless you have adequate water for digestion. Water and food in survival are closely related.

Food

16. This sufficient to follow three simply rules:

a. The quantity of the food and water rations must be varied in direct proportion to each other. If you have plenty of water you can increase the food ration, but as the water ration decreases the food ration must also be decreased.

b. Protein food, such as any raw fish, bird, or seaweed, will require more water than your emergency flying rations.

c. Live off natural foods if your ration of water will permit and save your emergency flying rations for the read emergency when your water supply is getting low.

Protection of Health

17. The ailments likely to effect survivors of sea are chiefly caused by exposure to weather and sea-water, and by shortage of fresh water.

a. **Sea Sickness**. Refrain from eating and drinking for some time, lie still and maintain bodily warmth.

b. **Immersion Foot**. Exposure of legs and feet to cold water for some time results in damage to be tissue. The affected part becomes red and painful and difficult to move. This is followed by swelling, the appearance of blisters and dark patches, and breaks in the skin. Prevention lies in keeping the feet as warm and dry as possible and in ensuring that the floor of the dinghy is dry.

c. **Salt Water Sores**. These are boils or 'burns' caused by exposure to salt water. Prevention is by keeping the body as dry as possible.

d. **Sore Eyes**. Sore eyes result from excessive exposure to glare from the sky and water, and should be treated with boric ointment and bandage lightly.

e. **Pared Lips and Cracked Skin**. These discomforts may be remedies by the application of any greasy ointment such as boric or Vaseline.

f. **Constipation or Difficult Urination**. These complaints should not give cause for alarm, as they are to be expected with shortage of food and fresh water.

g. **Frost Bite**. The symptoms of frost bite consist of small patches of white cream coloured skin, st5iff and firm to the touch. A prickling sensation may be felt. If the condition is allowed to become serious, tissues and bone may be come frozen and blood cells clot. When the affected part is warmed, there will be a swelling and redness of the skin with accompanying pain depending on the degree of frost bite usually is experienced in extreme cold exposed finger nose, cars being most susceptible. Protection obtained by keeping as warm and dry as possible, moving limbs, and exercising face muscles. Affected parts must not be rubbed to or massaged, but, armed gently with breath warm hands, or other warm parts of the body.

Dangerous Fish

18. Dangerous fish, such as the shark, barracuda, or swordfish, are most common in tropical waters. Without provocation they will not normally attack you or the dinghy. A few simple hints should help safeguard you from attack or injury.

Hints on Dealing with Dangerous Fish

19. Keep clothing on and keep a good look out.

20. Do not fish if sharks, barracuda or swordfish are in the vicinity.

21. Do not trail hands or feet over the side of the dinghy.

22. Do not throw waste food or scraps over board during the day time.

23. If dangerous fish are about, remain quiet, and the likelihood of attack will be negligible.

24. Survivors in the water without a dinghy should form a circle facing outwards and beat the water with strong regular strokes if sharks are about.

Making A Landfall – Land Indication

25. The presence of land may be detected sometimes long before it can be seen. Following are the few indications :

a. Cumulus clouds in an otherwise clear sky likely to have been formed overland.

b. Very few sea birds sleep on the water, and very rarely do they fly more than 100 miles from land. The recognition of those birds and their direction of flight will often indicate the direction and distance of land. They fly away from land before noon and return in the late afternoon and evening. Storms sometimes blow land birds far out to sea, so alone bird is not reliable indication.

c. Lagoon glare nigh a green nigh tint in the sky or on the underside of a cloud by the reflection of sunlight form the shallow water over, coral reefs.

d. Drifting wood or vegetation is often a sign of the proximity of land.