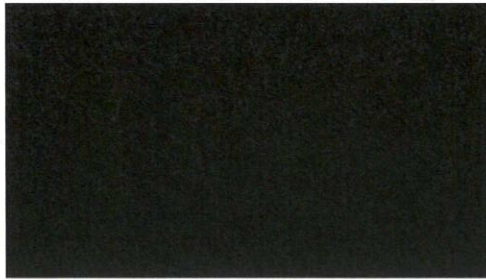




Ministry  
of Defence



FOI2020/04356

E-mail: [Navyse-foimailbox@mod.gov.uk](mailto:Navyse-foimailbox@mod.gov.uk)



1 June 2020

Dear ,

Release of Information

Further to our correspondence of 6 May 2020, I am now in a position to provide you with a substantive response to your request for the following information:

'I'm seeking information on flight Reference cards of the Sea Harrier FRS.1. If it was to further narrow information within im specifically looking for Ski Ramp carrier take off and landing procedures/nozzle configuration for ski ramp departure.'

Your enquiry has been considered to be a request for information in accordance with the Freedom of Information Act 2000 (the Act).

As explained in our interim response, a search was completed within the Ministry of Defence (MOD) and it was confirmed that the Department held some information in scope of your request. It was further explained however that this information may fall within the scope of the qualified exemption under Section 26 (Defence) of the Act. On further consideration of the information, it has been determined that Section 26 (Defence) does not apply on this occasion and no longer applies to your request.

In response to your request, a copy of the Aircraft Manual of Flight Systems for the Sea Harrier FRS Mk 1 is enclosed with this letter.

Under section 16 (Advice and Assistance) of the Act, additional information of interest may also be held by the following repository of historic Naval information:

Fleet Air Arm Museum

Website: <http://www.fleetairarm.com/>

Post: Fleet Air Arm Museum, RNAS Yeovilton, Ilchester, Somerset, BA22 8HT UK

If you have any queries regarding the content of this letter, please contact this office in the first instance.

If you wish to complain about the handling of your request, or the content of this response, you can request an independent internal review by contacting the Information Rights Compliance team, Ground Floor, MOD Main Building, Whitehall, SW1A 2HB (email [CIO-FOI-IR@mod.uk](mailto:CIO-FOI-IR@mod.uk)). Please note that any request for an internal review should be made within 40 working days of the date of this response.

If you remain dissatisfied following an internal review, you may raise your complaint directly to the Information Commissioner under the provisions of Section 50 of the Freedom of Information Act. Please note that the Information Commissioner will not normally investigate your case until the MOD internal review process has been completed. The Information Commissioner can be contacted at: Information Commissioner's Office, Wycliffe House, Water Lane, Wilmslow, Cheshire SK9 5AF. Further details of the role and powers of the Information Commissioner can be found on the Commissioner's website at <https://ico.org.uk/>.

Yours sincerely

Navy Command Secretariat - FOI Section

June 1986

~~UK RESTRICTED~~

AP 101B-4801-15A

# SEA HARRIER FRS Mk 1

## AIRCREW MANUAL — FLIGHT SYSTEMS

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BY COMMAND OF THE DEFENCE COUNCIL

Prepared by Royal Air Force Handling Squadron

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**PART 2**

**CHAPTER 4 - SKI-JUMP AND SHIPBORNE OPERATION LIMITATIONS  
(Extensively Revised by AL3)**

**Contents**

	Para
General ... ..	1
Operation from Land Based Ski-Jumps ... ..	2
Operation from HMS Invincible Class Ships ... ..	5
Operation from Flat Deck Aircraft Carriers ... ..	12
Operation from RFA Argus ... ..	20
Emergency Escape ... ..	24
<b>Illustrations</b>	<b>Fig</b>
Deck Spots on HMS Invincible Class Ships ... ..	1
Angled Deck Limitations for STO ... ..	2
Deck Spots on RFA Argus ... ..	3

**General**

1. The aircraft is cleared to operate from the 12° Yeovilton ski-jump profiles, and from the Bedford ski-jump set to the 7° Invincible profile or the 12° circular arc profile. At sea, operations are permitted from HMS Ark Royal and HMS Invincible (12° ski-jump) (HMS Illustrious is being rebuilt to this standard), from flat deck aircraft carriers and from the RFA Argus, within the limitations specified below. ◆

**Operation from Land Based Ski-Jumps**

2. *Authorised Configurations.* Operations are limited to the load configurations detailed in Table 1 (see CA Release, Section E).

3. *Aircraft State.* The 3-axis autostabiliser should be serviceable and engaged, except where prohibited by Chapter 3, para 13. With the 3-axis autostabiliser switched off, ski-jump launches are cleared subject to the following additional limitations:

- a. Night launches are prohibited.
- b. Maximum headwind is to be 20 knots.
- c. Maximum crosswind is to be 5 knots.
- d. Tailplane trim is to be set ¼° more positive than that detailed in Table 1.

4. *Operations.*

- a. Minimum deck run from ski-jump exit is 200 feet.
- b. *Water.* A minimum of 20 gallons of water, for use in an emergency, is to

be carried on all launches, except where carriage or use is prohibited (CA Release, Section C).

c. *Launch Planning.* Launches are to be planned using the ODM, Section 11.

d. *Maximum Wind Components.* The following maximum wind components (knots) are not to be exceeded:

Head	Tail	Cross
30	20	15

Note: In Configuration No 23, with AAR probe, the maximum crosswind component is 10 knots.

e. *Maximum Take-Off Asymmetry.* The maximum allowable asymmetric out-of-balance moment for ski-jump tak-off is 2600 lb ft.

f. *Endspeed Limitations.* The maximum groundspeed at ski-jump exit (endspeed) appropriate to the landing gear load limit is given as follows:

- (1) The 12° Yeovilton profiles - CA Release, Section G, Table 8.
- (2) 7° and 12° Bedford profiles - CA Release, Section G, Tables 9 and 10.

Note: The endspeed limitations are shown in the ODM, Section 1.

g. *Lowest Launch Speed and Trim Setting.* The Lowest Launch Speeds and tailplane trim settings appropriate to a fuel load of 4000 lbs or more are shown in Table 1. If less than 4000 lbs is carried, ½° should be subtracted from the trim setting given.

h. *Power Setting.* Short Lift Wet, Short Lift Dry or 97% N<sub>p</sub> may be used for launch. The SLW rating is to be used only in ambient temperatures exceeding +15°C, and a wet no-go VTO is to be executed before launch.

i. *Launch Technique.* See Part 3, Chapter 4.

#### **Operation from HMS Invincible Class Ships**

5. *Mode of Operation.* Operations are restricted to the following and are to be conducted in accordance with techniques specified in the shipborne operations handling section, Part 3, Chapter 4:

- a. Ski-jump take-off (STO).
- b. Vertical take-off (VTO).
- c. Vertical landing (VL).

6. *Authorised Configurations.* Shipborne operations are limited to the load configurations detailed in Table 2, (see CA Release, Section E).

Table 1 - Operation From Land Based Ski-Jumps

CA Release Load Configuration	Lowest Launch Speed (knots)				Tailplane Trim (°) (See Para 3d)
	7° Ski-Jumps		12° Ski-Jumps		
	Short Lift Dry or 97% Ratings	Short Lift Wet Rating	Short Lift Dry or 97% Ratings	Short Lift Wet Rating	
Basic	DLS	DLS+10	DLS-5	DLS+5	+4½
1	DLS	DLS+10	DLS-5	DLS+5	+4½
2	DLS+5	DLS+15	DLS-5	DLS+5	+4½
2A	DLS+5	DLS+15	DLS-5	DLS+5	+4½
5	DLS+5	DLS+15	DLS-5	DLS+5	+5
6	DLS+5	DLS+15	DLS-5	DLS+5	+5
23	DLS+5	DLS+15	DLS-5	DLS+5	+5
26	DLS+5	DLS+15	DLS-5	DLS+5	+4½
26A	DLS+5	DLS+15	DLS-5	DLS+5	+4½
26B	DLS+5	DLS+15	DLS-5	DLS+5	+4½
27	DLS+5	DLS+15	DLS-5	DLS+5	+4½
27A	DLS+5	DLS+15	DLS-5	DLS+5	+4½
33	DLS+5	DLS+15	DLS-5	DLS+5	+5
33B	DLS+5	DLS+15	DLS-5	DLS+5	+5
34	DLS+5	DLS+15	DLS-5	DLS+5	+5½
34B	DLS+5	DLS+15	DLS-5	DLS+5	+5½
40	DLS+5	DLS+15	DLS-5	DLS+5	+5½
40B	DLS+5	DLS+15	DLS-5	DLS+5	+5½

7. Aircraft State. The HUD and autostabiliser requirements for ship ski-jump operation are:

a. The HUD should be serviceable before take-off.

**WARNING:** Night decelerating transitions using head-down instruments rather than the HUD incur significantly higher risk. They should only be made if the HUD is unserviceable, should be regarded as an emergency and should not be practised. In the event of HUD failure, the standby sight should be used as a guide to keep the ship's lights at 105 milliradians depression.

Note: Ski-jump launches may be executed using head-down instruments, but this should be practised by day before it is attempted at night.

b. The 3-axis autostabiliser should be serviceable and engaged except where prohibited by Chapter 3, para 14. Approaches and decelerating transitions with autostabilisers unserviceable, or not engaged in IMC or at night, result in an increase in pilot workload and therefore higher risk. Approaches with autostabilisers unserviceable should be regarded as an emergency and should be practised by day only.

c. With the 3-axis autostabiliser switched off, ski-jump launches are cleared subject to the following additional limitations:

Table 2 - Operation from Ski-Jump Equipped Ships

Authorised Configurations	Lowest Launch Speed (See Note 3)		Tailplane Trim (See Note 1)
	Short Lift Dry or 97% Rating	Short Lift Wet Rating	
Basic	DLS-10	Not Cleared	+4½
1	DLS-10	Not Cleared	+4½
2A	DLS-10	DLS-5	+4½
5	DLS-10	DLS-5	+5
6	DLS-10	Not Cleared	+5
8	DLS-10	DLS-5	+5
8A	DLS-10	DLS-5	+5
11*	DLS-10	DLS-5	+4½
11B*	DLS-10	DLS-5	+4
12*	DLS-10	DLS-5	+5
13*	DLS-10	DLS-5	+5½
14*	DLS-10	DLS-5	+5½
14A*	DLS-10	DLS-5	+4
23	DLS-10	DLS-5	+5
26	DLS-10	Not Cleared	+4½
26A	DLS-10	Not Cleared	+4½
26AB	DLS-10	Not Cleared	+4½
27	DLS-10	DLS-5	+4½
27A	DLS-10	DLS-5	+4½
◆ 29	DLS-10	Not Cleared	+5½ ◆
30	DLS-10	Not Cleared	+5
31	DLS-10	Not Cleared	+5½
31A	DLS-10	Not Cleared	+5
◆ 32	DLS-10	Not Cleared	+5 ◆
33	DLS-10	DLS-5	+5
33B	DLS-10	Not Cleared	+5
34	DLS-10	DLS-5	+5½
34B	DLS-10	Not Cleared	+5½
40	DLS-10	DLS-5	+5½
40B	DLS-10	Not Cleared	+5½
41	DLS-10	DLS-5	+5

\*If no centre line store is fitted add +½° to trim.

Note 1: The above trim settings are appropriate to a fuel load of 4000 lb or more. If less than 4000 lb is carried half a degree should be subtracted from the above settings.

Note 2: If the ship pitching motion is significant (more than ± ½°) the lowest launch speed should be raised by 5 knots.



- (1) Night launches are prohibited.
- (2) Maximum headwind is to be 30 knots.
- (3) Maximum crosswind is to be 5 knots.
- (4) Tailplane trim is to be  $\frac{1}{2}^\circ$  more positive than that detailed in Table 2 above.

8. *Ski-Jump Operation.* other basic requirements for ski-jump operation are:

- a. Minimum deck run from ski-jump exit is 200 feet.
- b. *Water.* A minimum of 20 gallons, for use in emergency, is to be carried on all launches, except where carriage or use is prohibited (CA Release, Section G3).
- c. *Launch Planning.* Launches are to be planned using the ODM, Section 11.
- d. *Maximum Wind Components.* The maximum wind components (knots), observed by reference to the Flyco anemometer set to the NORMAL setting, are as follows and are not to be exceeded:

Head	Tail	Cross
50	5	15

Note 1: In Configuration No 2 (with AAR probe), the maximum crosswind component is 10 knots.

Note 2: In HMS Ark Royal and HMS Invincible ( $12^\circ$  ski-jumps) particular care must be taken that the 15 knot crosswind limit is not exceeded when the wind direction is close to RED 90 or GREEN 90.

- e. *Maximum Take-Off Asymmetry.* The maximum allowable out-of-balance moment for ski-jump take-off is 2600 lb ft.
- ◆ f. *Endspeed Limitations.* The maximum groundspeed at ski-jump exit (endspeed) appropriate to the landing gear load limit for operation from HMS Ark Royal and HMS Invincible is given in three Tables in the CA Release, at Section G, and in graphical form in the ODM, Section 11. The CA Release Tables provide endspeeds for varying wind over the deck conditions, aircraft AUV, and ship pitching amplitude for the following situations:

- (1) All configurations, with standard main oleo pressure.
- (2) All configurations except those with only centreline stores, with 125% standard main oleo pressure.
- (3) All configurations except those with only centreline stores and/or gun pods, with 125% standard main oleo pressure. ◆

g. *Lowest Launch Speed and Trim Setting.* The lowest launch speed and tailplane trim settings appropriate to a fuel load of 4000 lbs or more are shown in Table 2. If less than 4000 lbs is carried  $\frac{1}{2}^\circ$  should be subtracted from the trim setting given.

h. *Power Setting.* Short lift wet rating is cleared for use in ambient temperatures exceeding +15°C and in configurations in which operation of the clear aircraft bar will result in the jettison of at least 1000 lb of stores. A wet no-go VTO should be executed before launch. Short lift dry and 97% N<sub>p</sub> are cleared for use without restriction.

i. *Launch Technique.* See Part 3, Chapter 4.

9. *Vertical Operations.* Vertical operations are to be conducted using those configurations specified in the CA Release, and within the following limitations:

a. Vertical operations are to be normally conducted into wind.

b. Vertical operations are not to be conducted at weights above those given by the VSTOL computer for the prevailing ambient conditions. Additionally, VTO are to be restricted to those weights specified for 'GOOD GO' with no allowance added for wind. When ship pitch motion is greater than ± ½°, the VL and VTO weights given by the computer must be reduced by 500 lb.

**WARNING:** Recovery and vertical landing with any asymmetric combination of 1000 lb bombs is not possible. See Chapter 2, para 45.

c. Wind over deck limits for day and night vertical operations to and from nominated spots are given in Table 3 below.

Table 3 - Vertical Operations from HMS Invincible Class Ships

◆ Operation	Orientation	Deck Spots (see Note 2)	Max Wind Speed (Knots)	RED	GREEN
DAY VTO	Facing Forward	1, 6, 8, 10	40	0° to 10°	0° to 5°
	Facing Aft	1, 6, 8, 10	20	160° to 180°	Not cleared
	Cross Deck	1 6, 8, 10	15 15	Not cleared Not cleared	5° to 90° 90° to 180°
NIGHT VTO	Facing Forward	6, 8, 10	20	0° to 10°	Not cleared
DAY VL	Facing Forward	1	45	0° to 10°	0° to 5°
		2, 3, 4	45	0° to 15°	Not cleared
		6, 8, 10	45	0° to 15°	0° to 5°
	Facing Aft	1, 6, 8, 10	20	160° to 180°	Not cleared
		2, 3, 4	20	170° to 180°	Not Cleared
		2, 3, 4	30	170° to 180°	170° to 180°
Cross-Deck	1	25	Not cleared	5° to 90°	
	6, 8, 10	30	15° to 60°	Not cleared	
	6, 8, 10	20	60° to 180°	90° to 180°	
NIGHT VL	Facing Forward	6, 8, 10	40	0° to 10°	0° to 5°

Note 1: The 10 deck spots provided on HMS Ark Royal and HMS Invincible to which Table 3 refers are identified in Fig 1.

Note 2: Vertical operations cannot be conducted at No 10 spot on HMS Ark Royal because of deck geometry.

- ◆ 10. *Approach Limitations.* MADGE and CCA approaches are cleared down to 200 ft cloudbase and 0.5 NM visibility by day in IMC and by night provided that the HUDWAC and NAVHARS systems are fully functional with no failure warnings. In any HOME or reversionary display mode, or when NAVHARS /HUDWAC are present, the corresponding limits for reversionary MADGE approaches are 300 ft and 1.0 NM.

- a. The serviceability of the HUD to be checked against the head-down instruments immediately before commencement of the approach.

**WARNING:** Night decelerating transitions using head down instruments rather than the HUD incur significantly higher risk. They should only be made if the HUD is unserviceable, should be regarded as an emergency, and should not be practised.

- b. A LSO, equipped with a stabilised sight, is to monitor the night and foul weather approaches and provide a continuous commentary if required.

- c. It is assumed that CCAs are regularly practised and that for all fuel critical night and foul weather approaches the ship is prepared to provide CCA guidance in the event of aircraft navigation system failure.

- d. It is assumed that approaches and decelerations using head-down instruments have been practised by day only in the aircraft, or in the simulator. The T Mk 4N is not considered suitable for this purpose because the layout of the head-down instruments is different.

Note 1: For IMC operation, see Chapter 2, para 34.

Note 2: For satisfactory ship radar tracking during CCA, the aircraft I-band transponder should be serviceable and operating.

Note 3: Approach limitations assume that pilots have been briefed on HUD unreliability and the insidious nature of some critical flight information failures and that ship's lighting/approach aids (HAPI/CLUBS/DAPS) are being used.

Note 4: In the event of a HUD failure, the standby sight should be used during the decelerating transition, aiming to keep the ship's lights at 105 milliradians depression.

11. *Ship Motion.* The amplitude limits for ship motion when operating from HMS Invincible class ships are:

- a. Pitch: plus or minus 2°.

- b. Roll: plus or minus 2°.

#### **Operation from Flat Deck Aircraft Carriers**

12. The aircraft is cleared to operate from flat deck aircraft carriers by day only.



a. *Angled Deck.* The geometry of the deck is to be within the limits shown in Fig 2.

b. *Minimum Deck Run.* Minimum deck run is to be 300 feet.

c. *Water.* A minimum of 20 galls, for use in an emergency, is to be carried on all launches except where carriage or use is prohibited by CA Release, Section C.

d. *Launch Planning.* Launches are to be planned using the ODM, Section 11. If required, the MALS and deck endspeed can be obtained from CA Release, Section G, Fig 4.

e. *Maximum Wind Components.* The following maximum wind components (knots) are not to be exceeded:

Head	Tail	Cross
35	Not cleared	5

f. *Minimum Authorised Launch Speed and Trim Setting.* The MALS and tailplane trim settings are shown in Table 4.

g. *Ship Trim.* To maintain the required safety margins when the ship is not trimmed level in pitch, the margin over MALS must be increased if the ship is bow down, but may be decreased if the ship is bow up. The ODM, Section 11, gives the required margin over the MALS.

h. *Power Setting.* Short lift dry or 97%  $N_p$  may be used as appropriate.

i. *Launch Technique.* See Part 3, Chapter 4, para 10.

18. *Vertical Operation.* Vertical operations are to be conducted within the following limitations:

a. Vertical operations are to be conducted normally into wind and on the centreline.

b. Vertical operations are not to be conducted at weights above those given by the VSTOL computer for the prevailing ambient conditions and VTOs are to be restricted to those weights specified for 'GOOD GO' with no allowances added for wind. When ship pitch motion is greater than  $\pm 1/2^\circ$ , the VL and VTO weights given by the computer must be reduced by 500 lb.

c. Wind limits for vertical operations are as follows:

Aircraft Direction	Maximum Speed (Knots)	Wind Over Deck	
		Red	Green
Facing forward	35	0° to 5°	Not cleared
Facing aft	35	175° to 180°	Not cleared
Cross deck	15	Not cleared	90° to 135°

d. Vertical operations are not to be conducted in the wake of the island or any other obstruction.

e. VTO is not to be conducted immediately beside the island or any other obstruction because of the possibility of undemanded roll.

**WARNING:** Transitions to and from the ship are to be conducted well clear of parked aircraft. All gear in catwalk areas which may be affected by jet blast is to be adequately secured.

19. *Approach Limitations.* CCA are cleared down to the following minima (see Notes 1, 2 and 3):

	Day/IMC Conditions	
	Cloud Base	Visibility
20° Nozzle approach	400 ft	1.5 nm
60° Nozzle approach	300 ft	1.0 nm

Note 1: For IMC operation see Chapter 2, para 34.

Note 2: As an aid to ship radar tracking during CCA, the aircraft I-band transponder should be serviceable and operating.

Note 3: Approach limitations assume that an LSO is monitoring the approach.

◆ **Operation from RFA Argus**

20. The aircraft is cleared for VTO and VL operations from the RFA Argus by day in VMC only. VTO and VL must be carried out into wind within the maximum wind over deck limitations specified in the CA Release for each of the five deck spots. Vertical operations are limited to those configurations specified in the CA Release, Section E. The following criteria are to be applied:

a. VTO and VL are to be carried nominally into wind.

b. Operations are limited to weights below those given by the VSTOL computer for the prevailing ambient conditions, and VTO is restricted to those weights specified for 'GOOD GO' with no allowance added for wind. When the ship's pitching motion exceeds  $\pm 1/2^\circ$ , the VTO and VL weights given by the computer are to be reduced by 500 lb.

Note 1: The ship's crane must be clear of the flight deck.

Note 2. Transitions from and to the ship must be made well clear of parked aircraft, and all gear in the catwalk areas which may be affected by jet blast is to be adequately secured.

21. *Ship's Motion.* Ship's motion limits for flying operations are:

Pitch -  $\pm 1^\circ$   
Roll -  $\pm 2^\circ$

◆ 22. **Aircraft State.** The 3-axis autostabiliser and rudder pedal shakers are to serviceable and engaged before take-off.

23. **Wind Over the Deck.** the wind over the deck limitations are detailed in Table 5.

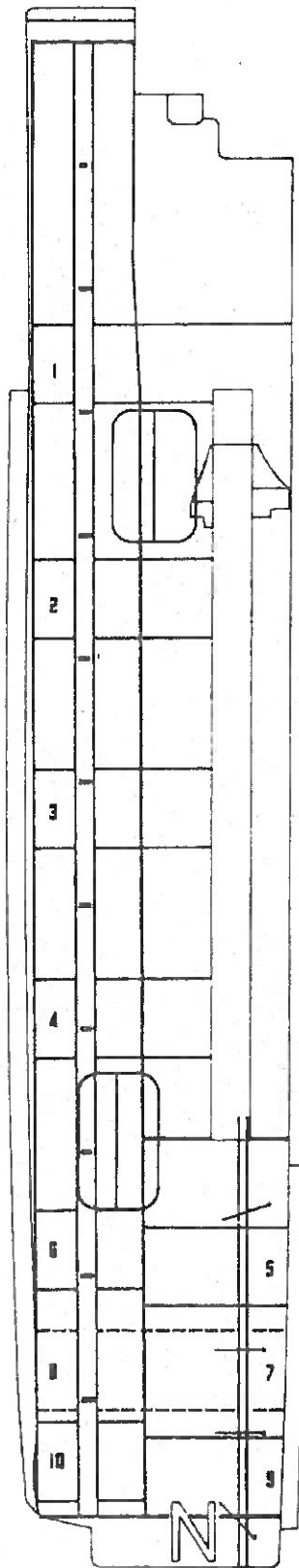
**Table 5 - Wind Over the Deck Limitations for Operation from RFA Argus**

Operation	Spot	Maximum Wind Over Deck (kt)	Red	Green
Day VTO Facing into Wind	1	10	-	80° - 90°
	2	10	-	-
	3	10	30° - 110°	90° - 110°
	4	10	60° - 120°	30 - 110°
	5	10	140° - 180°	60° - 180°
Day VL Facing into Wind	1	15	-	80° - 90°
	2	15	-	150° - 160°
	3	15	30° - 100°	90° - 110°
	4	15	60° - 120°	60° - 120°
	5	15	-	60° - 120°

Note: The wind over the deck limits given are 'free-stream' values: the indicated values to which they correspond must be determined from the appropriate ship's anemometer calibrations.

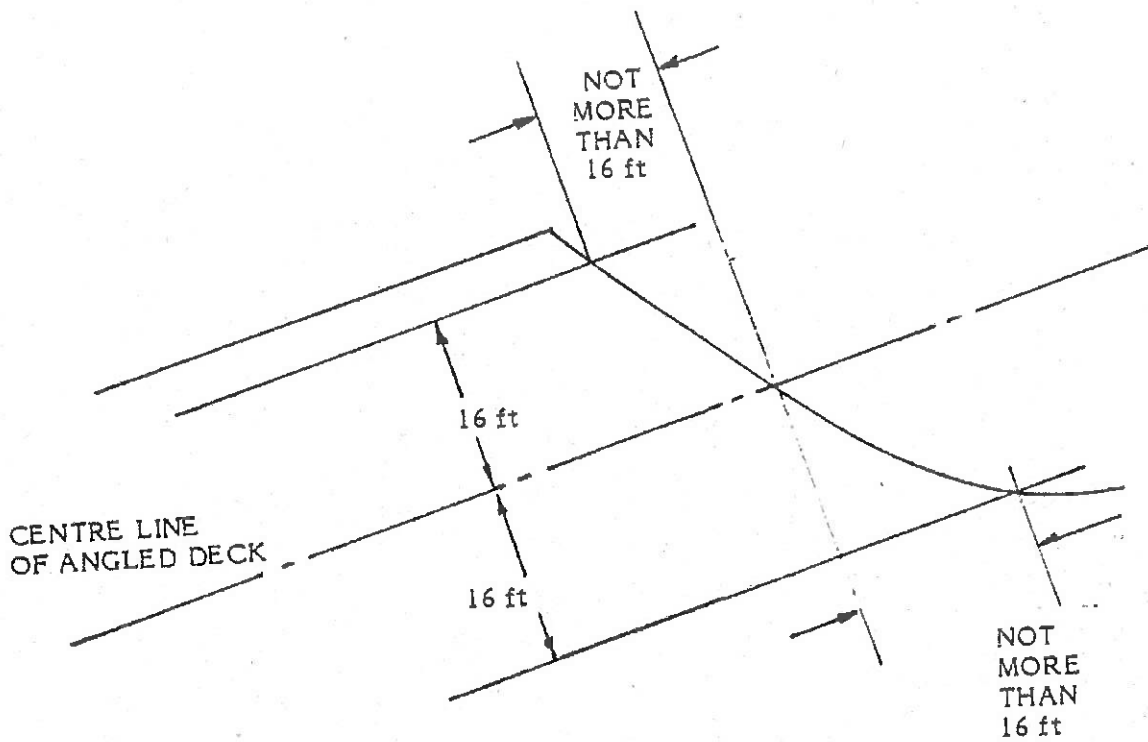
#### **Emergency Escape**

24. The aircraft is not to be ditched. If sea-strike is inevitable, the ejection seat must be used.

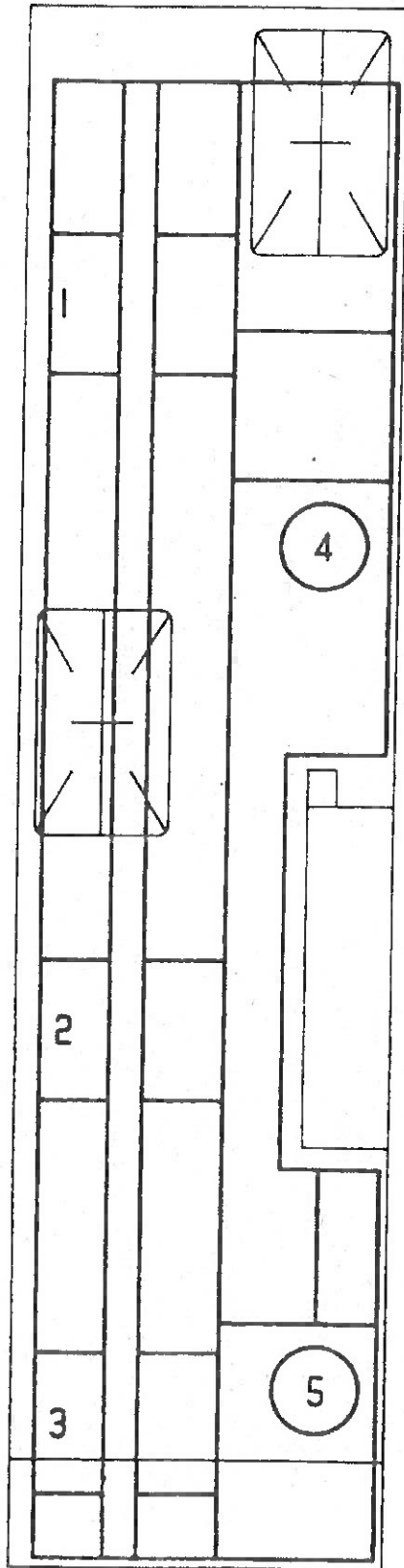


2 - 4 Fig 1 Deck Spots on HMS Invincible Class Ships





2 - 2 Fig 2 Angled Deck Limitations for STO



2 - 3 Fig 3 Deck Spots on RFA Argus