



AP 101A-0800-1

Feb 72

# AIRCRAFT TRANSPARENCIES

GENERAL AND TECHNICAL INFORMATION

BY COMMAND OF THE DEFENCE COUNCIL

Ministry of Defence

Sponsored for use in the  
ROYAL NAVY by HAD(N)  
ROYAL AIR FORCE by D Air Eng (RAF)

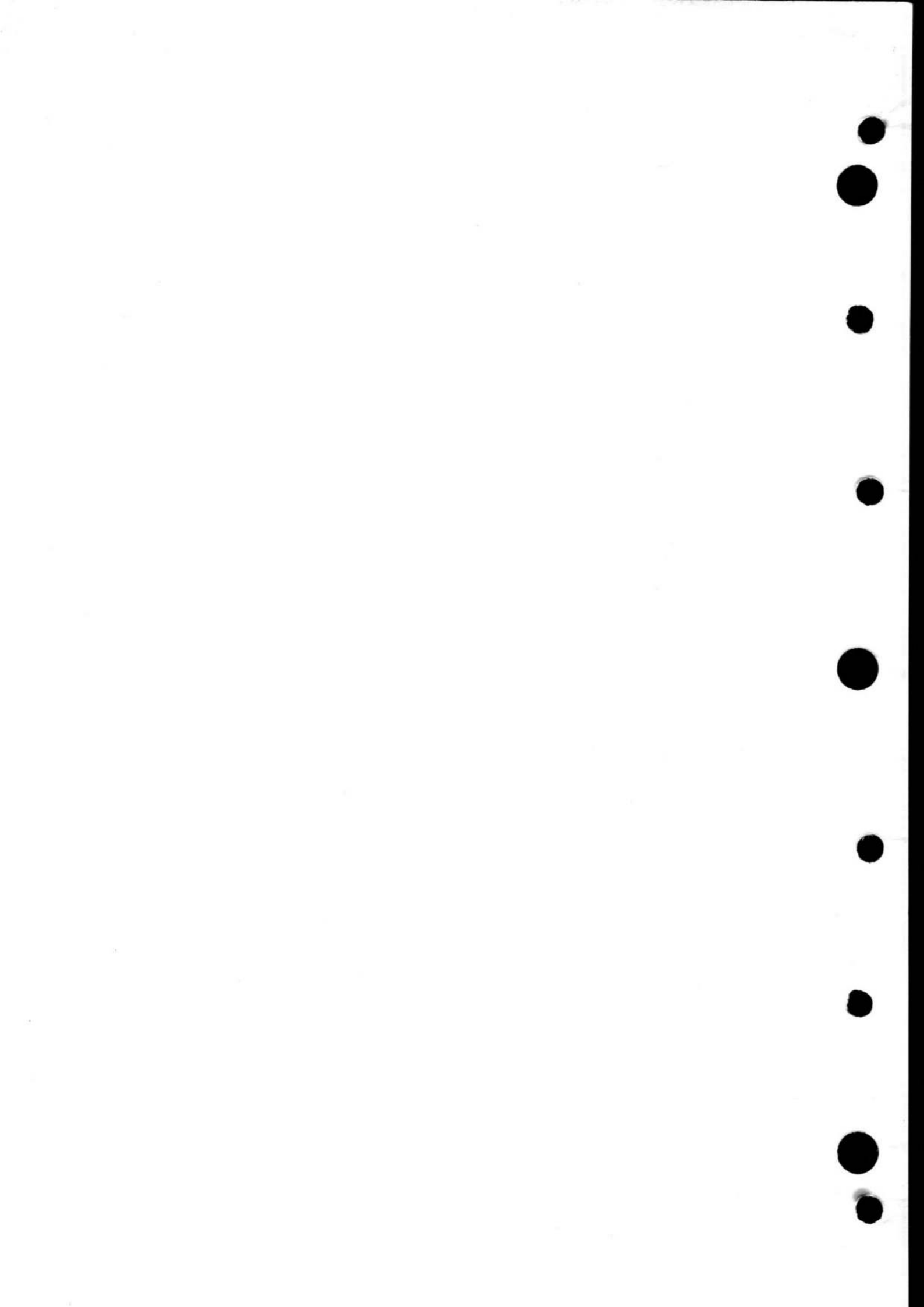
Prepared by Lucas Aerospace Ltd  
Publications authority: ATP/MOD(PE)



Service users should send their comments through  
the channel prescribed for the purpose in:  
Naval Aircraft Maintenance Manual(RN)  
AP 100B-01 Order 0504 (RAF)

Oct 77 (Amdt 1)

Prelim  
Page 1/2

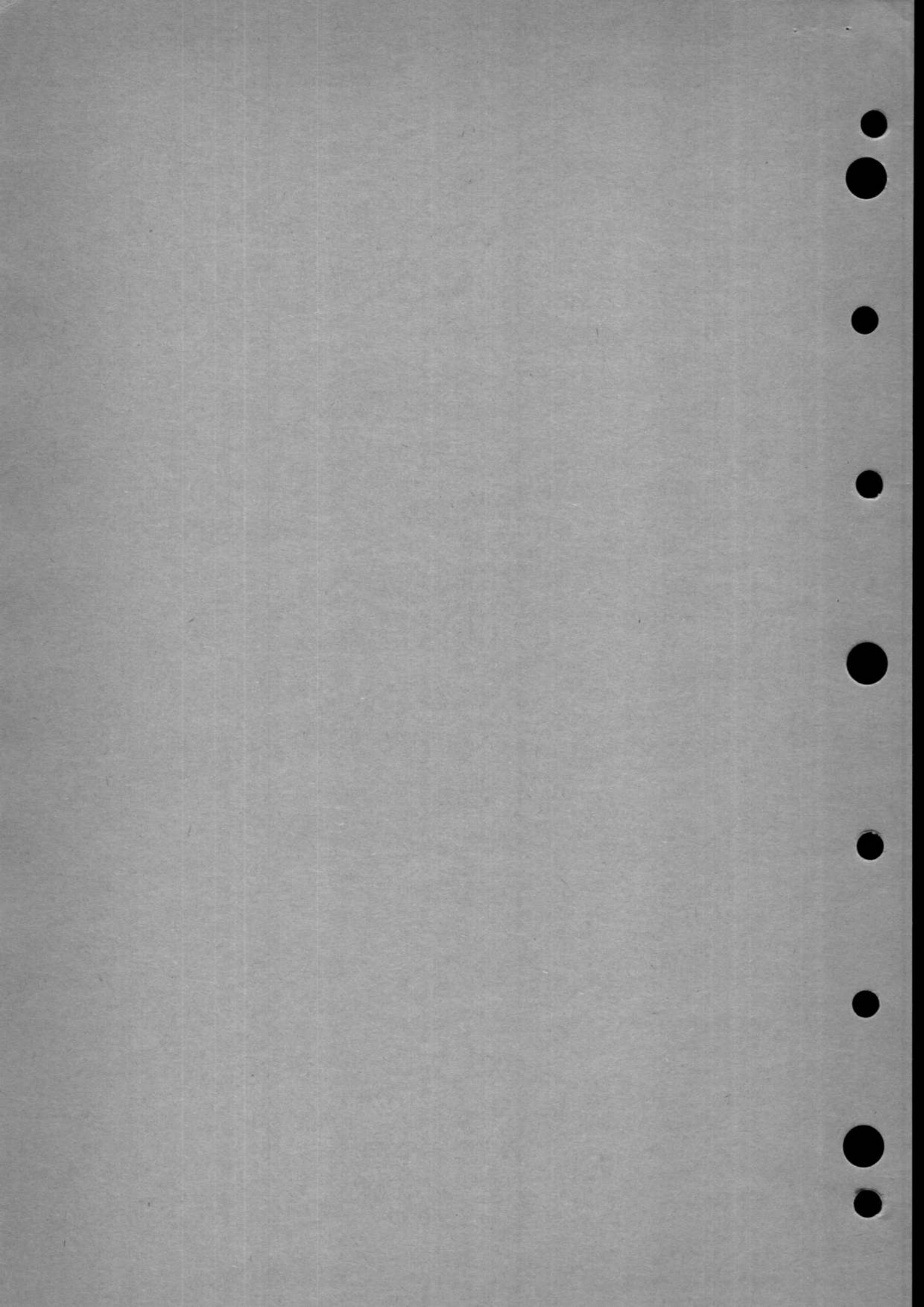


AMENDMENT RECORD SHEET

Record the incorporation of an amendment list by inserting the date of making the amendments and by signing in the appropriate column.

A.L.No.	AMENDED BY	DATE
1	<i>F. Hamann</i>	2 <sup>12</sup> / <sub>77</sub>
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		
31		
32		
33		

A.L.No.	AMENDED BY	DATE
34		
35		
36		
37		
38		
39		
40		
41		
42		
43		
44		
45		
46		
47		
48		
49		
50		
51		
52		
53		
54		
55		
56		
57		
58		
59		
60		
61		
62		
63		
64		
65		
66		



CONTENTS

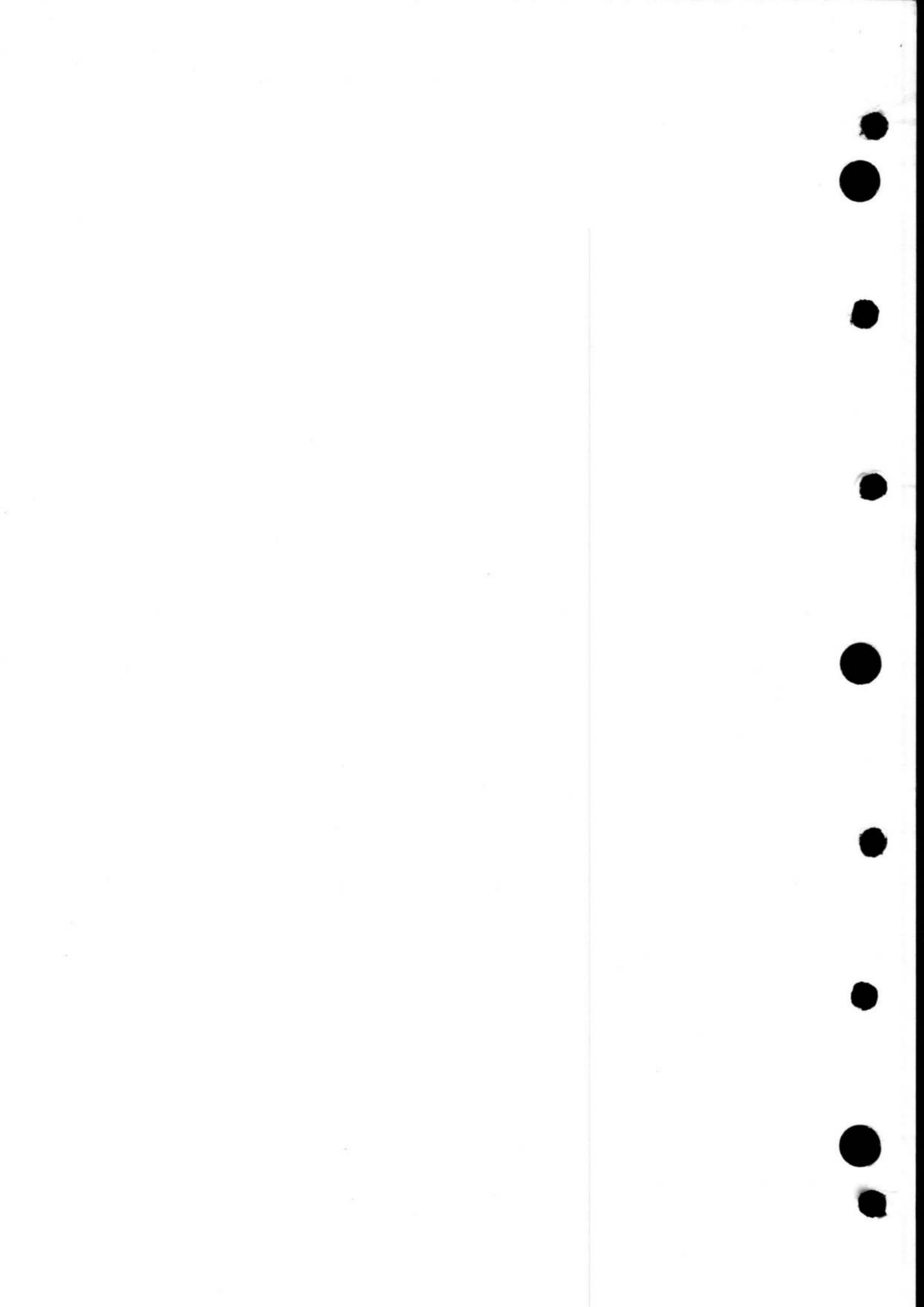
PRELIMINARY MATERIAL

Title page  
Amendment record sheet  
Contents (this list)

GENERAL AND TECHNICAL INFORMATION (-1)

Chapters

- 1 Care and maintenance of transparent plastic panels
- 2 Cockpit windows and windscreens



## Chapter 1

## CARE AND MAINTENANCE OF TRANSPARENT-PLASTIC PANELS

## CONTENTS

	Para.
Introduction ... ..	1
Causes of damage	
Physical contact ... ..	5
Precautions against damage ... ..	7
Crazing ... ..	8
Safe materials ... ..	9
Prevention of crazing ... ..	10
Cleaning and polishing	
Removal of coarse dirt ... ..	11
Plastic polishing set ... ..	12
Handling and repair ... ..	16

## ILLUSTRATION

Fig.		Page
1	Plastic polishing set ... ..	4

Introduction

1. The conditions of panels during an operational flight have a very great effect on the visual location and recognition of other aircraft. The optical standard and standard of cleanliness of panels on all operational aircraft should therefore be very high. The maintenance of these standards is the responsibility of the ground crew.
2. A hazy panel blurs the details, reduces black to grey and generally dims outlines. A slight coating of dirt or fine scratching scatters the light and may make it impossible for the pilot to see when flying towards the sun, even if he wears anti-sun goggles. Scratches, dirt, oil and paint specks all impair the clearness of a plastic panel and cause haziness or dazzle.
3. Damage to a plastic panel may also cause sufficient weakness to result in the component bursting, due to differences in internal and external pressures during normal operational conditions.
4. The exceptional softness of plastic panels (as compared with glass) make them prone to scratch damage and solvent attack.

## CAUSES OF DAMAGE

### Physical contact

5. Great care must be exercised when handling or working in the vicinity of plastic panels, as the surface is easily scratched or damaged. Visible scratches may occur when a new panel is rubbed with a clean handkerchief. Some of the common causes of scratch damage are as follows:-

- (1) Contact with any hard object.
- (2) Contact with rough cloth or clothing.
- (3) Contact with dirty hands.
- (4) Movement of protective covering materials.

6. Over-stressing or careless handling may result in crazing and, in extreme cases, the destruction of a plastic panel.

### Precautions against damage

7. To avoid unnecessary scratch damage to plastic panels the following precautions are to be observed:-

- (1) Do not clean or polish the panels with anything except approved polishes, or polishing cloths.
- (2) Always use aircraft type covers where available.
- (3) Do not cover the panels with rough canvas covers unless absolutely necessary. The panels are often better left uncovered. If the use of a rough cover is unavoidable, do not drag it along the panels but lift it over them. If flannelette covers are available, they should be used, alone in dry weather, and with the canvas cover in changeable or frosty weather. In damp weather, prolonged rain or fog, the panels should be left uncovered if possible.
- (4) When working in the vicinity of plastic panels, do not touch or allow equipment to come into contact with them.

### Crazing

8. The defect known as 'crazing' is the formation of a multiplicity of fine cracks, which extend in a network over or under the surface of a plastic, or indeed through it. When a crazed panel is held against the light, the faulty area appears sparkling and iridescent. Crazing is caused by mechanical stresses or by the action of chemical reagents. Solvent crazing may occur if the plastic is exposed to the action of certain liquids or their vapours, the more common of which are as follows:-

*Acetone	Evostick
Ammonia	Gasolene
Amyl acetate	*Glacial acetic acid
Benzine	Kerosene
Butyl acetate	Methol alcohol

*Carbon tetrachloride	Methylated spirit
Cellulose finishes, primers and thinners	Paint solvents
Chromic acid	Rust removing solutions
*Cresol	Synthetic (ester based) oils and greases
Deoxidine	Synthetic finishing materials
Ethyl alcohol and de-icing fluid	Tautening dopes
*Ethylene dichloride	Toluene
	*Trichlorethylene
*Polymethyl methacrylate is dissolved by these liquids	

#### Safe materials

9. The following materials in current use are considered to be safe for direct contact with perspex panels:-

- (1) Masking tape to Specification B.S.2.J.11.
- (2) Polish to Specification D.T.D. 770A (Ref. No.33C/1205).
- (3) Protective lacquer (Ref. No.33C/1111).
- (4) Solventless sealants, e.g. PR1221 (Ref. No.33H/191) and PRI 1422 (Ref. No.33H/131).

CAUTION ...

Brushing type sealants (BT) are NOT safe.

#### Prevention of crazing

10. To prevent crazing, the following precautions are to be taken:-

- (1) Never allow solvents or their vapours to come into contact with plastic panels.
- (2) Install panels correctly, avoiding local stresses.
- (3) During aircraft refinishing operations, protect the panels with the approved masking tape. Whenever possible, the work is to be preceded by the application of two coats of the approved protective lacquer.
- (4) Ensure that aircraft are well ventilated.

#### CLEANING AND POLISHING

##### Removal of coarse dirt

11. Coarse dirt such as grit, mud splashes, oil mixed with dust, etc., should be rinsed off the panels with water. The panels should not be rubbed in any way as this will produce scratches. The water should be

allowed to run down the panels, which may, if necessary, be dabbed with a cloth. Wherever possible, the panels should be left to 'air dry' and should not be wiped dry. Grease etc., may be washed off with warm soapy water. In order to prevent grit and dirt from being picked up by polishing cloths it is necessary to periodically clean the panel frames.

### Plastic polishing set

12. The plastic polishing set (Stores Ref. 33D/390) consists of two 4 oz. bottles of polish to D.T.D.770A, and a supply of application cloths to D.T.D.763, all contained in a metal box (Fig. 1).

13. When the materials supplied with the box have been used, spares may be demanded as follows:-

Polish, 4 oz. bottles (Stores Ref. 33D/391).

Cloths, polishing, 18 in. x 18 in. (Stores Ref. 33D/392), coloured white ('A' store).

Cloths, application, 8 in. x 5 in. (Stores Ref. 33D/393), coloured blue ('C' store).

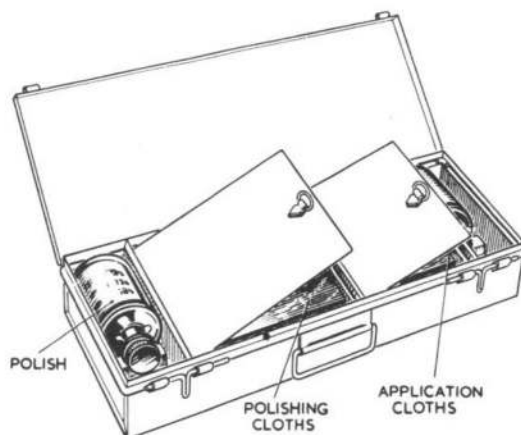


Fig. 1. Plastic polishing set

14. The panels should be treated as follows:-

(1) Rinse, or spray the panels with clean water. Do not rub.

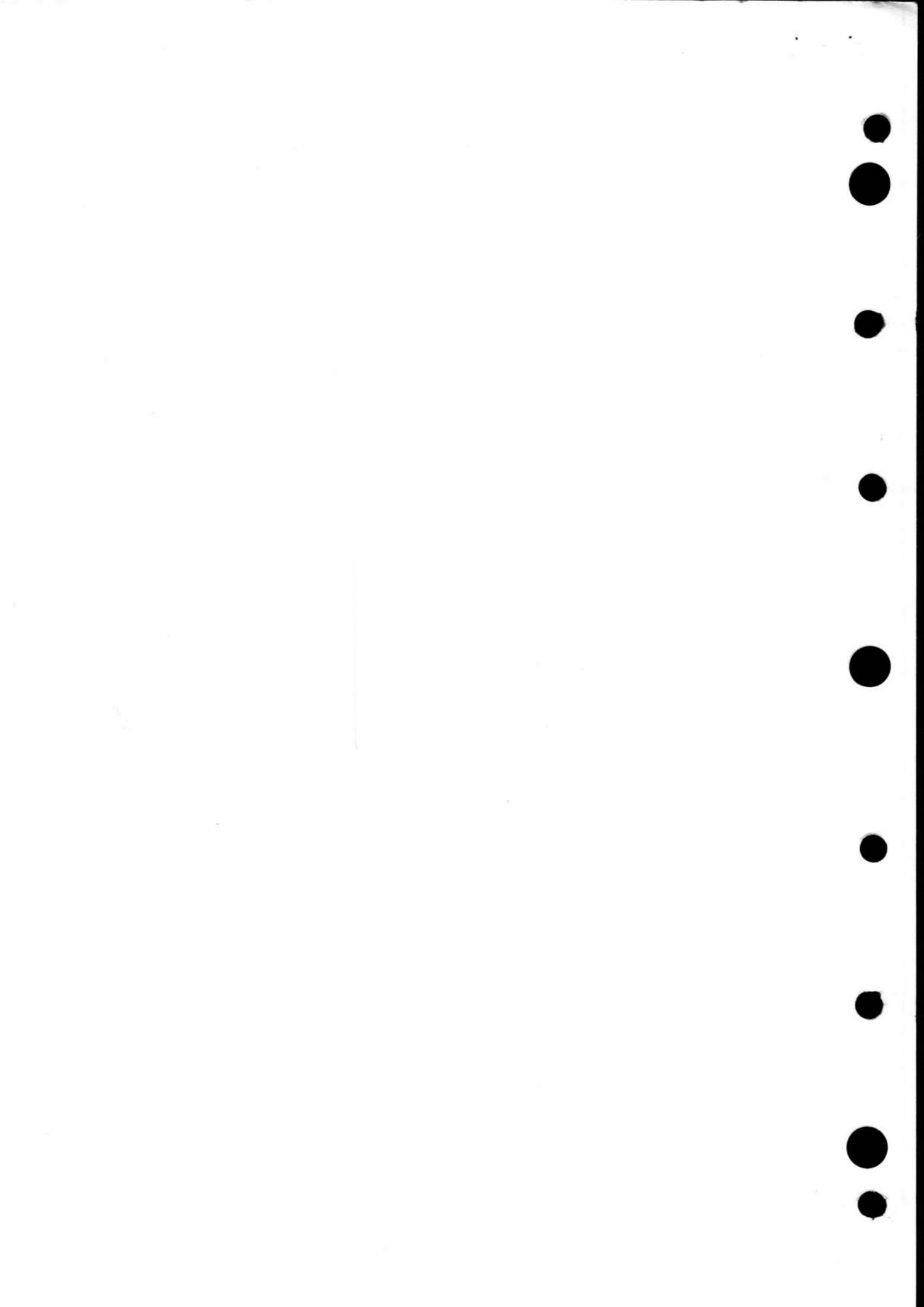
(2) When the panels are dry, apply the polish with a clean application cloth, first shaking the bottle well. Use sufficient polish to keep the surface moist, applying it frequently in small quantities. Vary the pressure according to the number of scratches on the surface, but always finish with a light pressure. The application cloth is to be used only once, and must be discarded afterwards.

(3) Leave the panel to dry, and then rub over lightly with a polishing cloth to remove all traces of the polishing compound. The cloth must be discarded when it becomes soiled.

15. To ensure the best results when polishing perspex panels it is essential to observe scrupulous cleanliness. Traces of dirt or dust on the application or polishing cloths may mean that the panels are scratched or scored. The cloths must be kept in their appropriate compartments in the box. Ensure that the cap of the polish bottle is screwed firmly back in place.

Handling and repair

16. The handling and repair of transparent plastics is described in AP. 1464B, Vol.1, Part 2, Sect.4, Chap.5, (later to become AP 119A-0504-16) to which reference must be made.



Chapter 2

COCKPIT WINDOWS AND WINDSCREENS

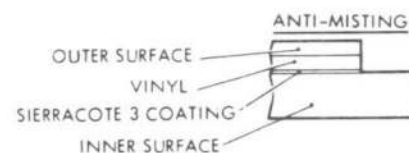
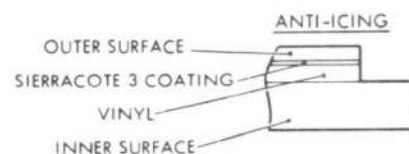
CONTENTS

	Para.
Glossary of terms ... ..	1
Description	
General ... ..	2
Film heated transparencies ... ..	3
Wire element heated transparencies ... ..	5
Operation - heated transparencies ... ..	6
Data ... ..	7
Unpacking ... ..	8
Acceptance checks ... ..	10
Storage instructions	
Conditions ... ..	12
Limiting period ... ..	13
Installation procedures	
General ... ..	14
Check/tests before installation	
All transparencies ... ..	15
Heated transparencies ... ..	16
Installation ... ..	17
Checks/tests after installation ... ..	18
Maintenance	
Schedule ... ..	19
Cleaning and polishing	
Materials ... ..	20
Material vendors ... ..	21
General ... ..	22
Procedure ... ..	23
Defect investigation	
General ... ..	24
Insulation and resistance checks	
Test equipment (typical requirements) ... ..	29
Resistance check - temperature sensing elements ... ..	30
Resistance check - heating element ... ..	31
Insulation resistance checks ... ..	32
Scratches or abrasions ... ..	34
Delamination ... ..	35
Removal ... ..	37
Heated transparencies ... ..	38
Overhaul period ... ..	40
Return to manufacturer ... ..	41

1. GLOSSARY OF TERMS

Anti-icing: Prevention of ice formation on the exterior surface of a transparency.

Anti-misting: Prevention of condensation on the interior surface of a transparency.



As-cast acrylic: Acrylic sheet (polymethyl methacrylate) manufactured by casting techniques to the requirements of the American specification MIL-P-8184 B.

Bird-proof transparency: A transparency which, after impact by a bird of a quoted weight and speed will not necessitate abandonment of the aircraft through damage or crew injury, although replacement may be necessary before the next flight.

Braided conductor: Part of busbar which extends from silver strip into supply terminal block.

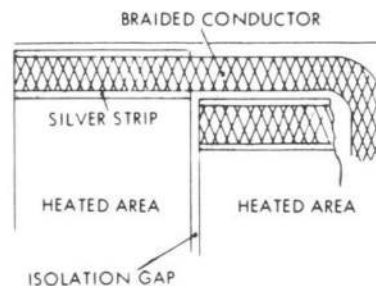
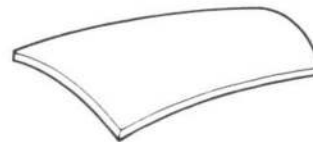
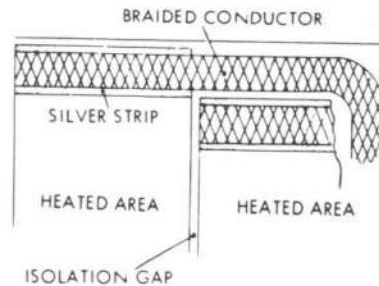
Busbar: Used to feed electricity to the heating film. Flat wire braided conductor in contact with a silver strip which distributes current to the film.

Double-curved: Transparency curved in two directions.

Heating intensity: Watts/cm<sup>2</sup> required to produce design heating requirements.

Isolation gap: Gap electrically separating coated areas, e.g. two phases. Formed by leaving a line 0.4 mm wide uncoated where separation is required. Virtually invisible when looking through a transparency.

Laminate: Transparency formed from two or more sheets (plies) of transparent rigid material laminated together by a layer(s) of polyvinylbutyral (vinyl) or other suitable interlayer material.

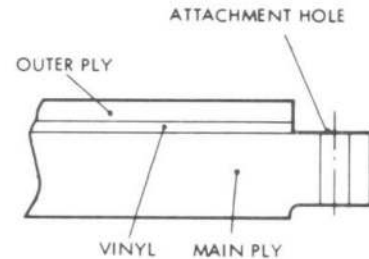


Main ply or plies One or more plies in a transparency subject to pressurisation and aerodynamic loading.

Monolith: Transparency formed from a single sheet (ply) of transparent rigid material.

Outer ply: Outer surface of a transparency. Not normally load bearing.

Interlayer: Layers of polyvinyl-butyril (vinly) interposed between adjacent plies.



Resistivity: The resistivity of a given coating (heating film) represents the busbar to busbar resistance which a transparency would have if it were square. Resistivity is expressed in ohms per square and its numerical value is a convenient measure of the characteristics of a given coating.

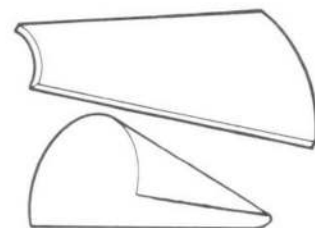
Sensing element - wire grid: Thermally sensitive wire grid with a positive temperature co-efficient. Used in conjunction with an external temperature control system.



Sensing element - thermistor: Thermally sensitive semiconductor with a negative temperature co-efficient. Used in conjunction with an external temperature control system.



Heating film: Electrically conductive, transparent, metallic coating. When carrying current produces heat for anti-icing and anti-misting facilities. Seen in a transparency as a light straw coloured tint.



Single-curved: Transparency curved in one direction only.

Transparencies: General term referring to all forms of aircraft glazing, i.e. Front Windscreen, Quarterlights, Windows, etc.

Wraparound One piece profiled windscreen.

Stretched acrylic: Acrylic sheet produced by hot stretching bi-axially or multi-axially as-cast material, to impart superior craze and crack propagation resistance. Produced to the requirements of American specification MIL-P-25630A.

Wire heating element: Electrically conductive fine wire applied to an inter-layer in a regular grid pattern. When carrying current produces heat for anti-icing and anti-misting facilities.

## DESCRIPTION

### General

2. Aircraft cockpit windows and windscreens vary in construction from a single ply of transparent plastic to multi-ply laminates of all plastic, plastic and glass and all glass. Where anti-icing or de-misting is required they can be electrically heated by either transparent metal film or wire heating elements. Windows and windscreens can be formed to both single and double curvature, constructed with failsafe characteristics in pressurised areas and made resistance to bird impact.

### Note...

Unless otherwise stated the description and instructions given hereafter in this manual apply to all variants of windows and windscreens. Reference will be made to TRANSPARENCIES which will include all variants.

### Film heated transparencies

3. The process utilises a transparent conductive coating which is deposited by evaporation on to a transparent plastic or glass sheet. This sheet then forms one of the layers (ply) in a laminate comprising a number of sheets of transparent plastic or glass interposed by layers of polyvinyl-butylal (vinyl). The conductive coating is within the laminate for electrical insulation and protection against damage, and is positioned relative to its requirements, i.e. de-icing or de-misting.

4. Electrical supplies are fed via busbars, forming continuous strips along opposite edges of the heated area, which are connected directly to the coating. Flat braided wire conductors leading from a terminal block are laid along the full length of the busbars to accommodate the current require-

ments. The terminal block provides for connection of the aircraft electrical system to the transparency and is designed to prevent ingress of moisture to the film.

#### Wire element heated transparencies

5. These heated transparencies have the same basic construction as film heated transparencies but to provide the heat required for anti-icing and/or de-misting have an electrically heated wire element embedded within the laminate in a position relative to the heating requirements. Electrical supplies are fed from busbars along opposite edges of the heated area with flat, braided wire conductors leading from each of the busbars to an input terminal block.

#### OPERATION - HEATED TRANSPARENCIES

6. Transparencies are heated by passing an electrical current through the film or wire heating element. In most cases the upper temperature limits of transparencies are governed by the materials used in their construction. To guard against overheating and to provide normal operating temperature control, thermistor or wire grid sensing elements which work in conjunction with an external controller may be built into the laminations. Suitable controllers for use with wire grid sensing elements are Lucas Thermal Controllers Mks.6 and 10 and, for use with thermistors Lucas Thermal Controllers Mks.8 and 14. (See AP 113D-0420-1 and 113D-0421-1.) Alternatively, some form of thermostatic switch can be attached to the surface of transparencies.

#### DATA

7. Details of specific aircraft transparencies are contained within the relevant publication. Refer to List of Associated Publications.

#### UNPACKING

8. Transparencies are individually packed in boxes with their polished transparent surfaces (vision areas) protected by latex backed paper. Flat transparencies are supported and protected against shock by expanded polystyrene blocks and curved transparencies by padded jigs which protect against shock and maintain the profile curvature during storage.

9. After unpacking the following handling instructions must be strictly observed.

- (1) Do not remove the protective paper from the vision areas until installation in aircraft is complete.
- (2) Always rest a transparency on suitably padded supports, ensuring that the padding is clean and free from abrasive matter.

#### ACCEPTANCE CHECKS

10. The function of transparencies will only be impaired if they have sustained physical damage in transit or storage. Normal acceptance checks may, therefore, be confined to a visual inspection. Any physical damage will be indicated by the condition of the protective paper, but this should not be removed unless further investigation is required.

11. Should any physical damage be apparent return transparency to the manufacturer.

## STORAGE INSTRUCTIONS

### Conditions

12. (1) Retain transparencies in their original packing throughout storage.  
(2) Store in a dry area where the temperature does not exceed 40°C. Keep away from any process area which could set up solvent fumes or abrasive particles likely to damage the polished transparent surfaces.

### Limiting period

13. Care must be taken to ensure that transparencies are adequately packed for long term storage (in excess of 1 year) and in this context, consultation with the manufacturer is advised.

## INSTALLATION PROCEDURES

### General

14. Details of installation procedures for specific aircraft transparencies are contained within the relevant publication (see List of Associated Publications). The following procedures cover generally that information which is common to all aircraft.

### Check/tests before installation

#### All Transparencies

15. Visually examine transparency for evidence of damage, noting that any damage to the transparent surface will be indicated by the condition of the protective paper. Do not remove the protective paper unless further examination of suspect damage is required.

#### Heated transparencies

16. Carry out resistance checks on heating element, sensing elements, and insulation, as detailed in paras.30 to 33.

## INSTALLATION

### CAUTION...

When installing transparencies care must be taken to prevent damage to the polished transparent surfaces. When removing protective paper as detailed in para.9(1) do not allow sharp instruments to come into contact with these surfaces.

17. (1) Remove only sufficient protective paper to permit fitting of transparency into mounting framework.  
(2) For detailed installation procedures refer to the appropriate section of the aircraft manual.  
(3) For tightening attachment bolts, first obtain, by sampling, the average torque loading required to overcome nut stiffness. To this figure, a general maximum torque loading of 5 kp.cm must be added to

obtain a maximum applied torque loading. The general maximum torque loading may be varied for specific installations and values stated in specific aircraft manuals must be adhered to.

### CHECKS/TESTS AFTER INSTALLATION

18. (1) Remove the remaining protective paper then clean and polish as detailed in para.20 to 23.  
 (2) Carry out any tests specified by the appropriate aircraft manual.

### MAINTENANCE

#### Schedule

19. No routine maintenance checks are required on transparencies but routine cleaning and polishing should be undertaken as detailed in Paras.20 to 23.

#### Cleaning and polishing

##### CAUTION...

Polishes of a more abrasive nature than that given below must not be used or the optics of transparencies may be seriously damaged.

##### Materials

20. (1) Cellulose wadding or 2-ply facial tissues.  
 (2) Mild detergent - recommended - Lissapol NX used 10% by volume in water.  
 (3) Meguiar 'Mirror Glaze' Plastic Cleaner MGH.17.  
 (4) Meguiar 'Mirror Glaze' Plastic Polish MGH.10.  
 (5) Indosil 21 Compound - Plastic Cleaner and Polish.  
 (6) Isopropanol.

##### Note...

Indosil 21 Compound is an alternative to MGH.17 and MGH.10. When used, operations (4) and (5) under Procedure become one operation.

##### Material vendors

21. The recommended plastic polishes MGH.1, MGH.3, MGH.10 and plastic cleaner MGH.17, are manufactured by and obtainable from:-

##### Manufacturer:

Mirror Bright Polish Co  
 Pasadena  
 California  
 USA

##### UK Distributor:

Ferro (Great Britain) Limited  
 Mirror Glaze Division  
 Wombourne  
 Wolverhampton Staffs  
 England

Indosil 21 compound - acrylic cleaner and polish is manufactured by a  
 obtainable from:-

Indosil Co, PO Box 951, 19547 Victory Boulevard,  
 Reseda, California 91335, USA

## General

22. (1) Only light hand pressure should be applied when cleaning or polishing.
- (2) Renew paper tissues and wadding swabs frequently so that clean working surfaces are maintained at all times.

## Procedure

23. Note...

When cleaning the inner acrylic face of transparencies, use minimum quantities of water applied with a moistened swab and protect adjacent instrumentation with plastic sheets. Otherwise proceed as follows.

- (1) Clean transparencies using copious quantities of warm water and mild detergent to remove loose abrasive matter. Insect debris should be carefully dislodged with a wet swab of either cellulose wadding or soft paper tissue. Stubborn grime of a non-abrasive nature may be removed by increasing the percentage of detergent to water.
- (2) Where stubborn grime is of an adhesive nature (e.g. tar) and cannot be removed by detergent solution, lightly damp a swab with Isopropanol (see following CAUTION). After cleaning stubborn areas with Isopropanol wash transparencies with mild detergent solution.

### CAUTION...

The use of Isopropanol must be restricted to the removal of stubborn grime. Use sparingly applying liquid to swab. Do not use as a general cleaning agent or apply in quantity direct to transparencies.

- (3) Wash transparencies with clean water and dry with wadding.

### Note...

End of cleaning procedure for glass faced transparencies. For all other transparencies continue procedure as follows.

- (4) Apply Meguiar's 'Mirror Glaze' Cleaner MGH.17 using wadding to spread evenly over the surface. Rub with a clean swab until the surface is clean.
- (5) Apply Meguiar's 'Mirror Glaze' Polish MGH.10 using wadding to spread evenly over the surface. Rub with clean swab until a bright polish is obtained.

## DEFECT INVESTIGATION (Trouble Shooting)

### General

24. No remedial actions other than the removal of scratches and abrasions can be taken on a defective transparency. A suspect heated transparency can be checked for serviceability of its heating element and temperature sensing elements but if found defective must be removed from the aircraft and replaced with a serviceable component.
25. If delamination occurs reference should be made to the specific aircraft manual where the areas of allowable delamination for all transparencies in that aircraft are detailed.

26. A defective transparency should be returned to the manufacturer for investigation and possible repair.

27. Details of heating element and sensing element checks for specific aircraft transparencies are contained within the relevant publication (see List of Associated Publications) but the following procedures cover generally that information required for trouble shooting which is common to all aircraft.

28. Checks given under para.15 cover the pre-installation requirements and the testing of transparencies removed from aircraft.

#### Insulation and resistance checks

##### Test equipment (Typical Requirements)

29. (1) 250 volt d.c. Insulation Resistance Tester (transparencies still installed in aircraft).  
 (2) 500 volt d.c. Insulation Resistance Tester (transparencies removed from aircraft or on acceptance checks).  
 (3) Ohmmeter 0-1 k. or 0-100 k. with output voltage limited to 3 volts.  
 (4) Wheatstone Bridge or test meter of similar accuracy.

##### Resistance check - temperature sensing elements

30. This check is intended primarily as a continuity check and the actual measured resistance is unimportant provided that it falls within the limits of resistance corresponding to the appropriate range of ambient temperature given in the aircraft manual.

##### CAUTION...

Do not apply voltages in excess of 3 volts to wire grid or thermistor temperature sensing elements. Voltages in excess of 3 volts may damage sensing element.

- (1) Where applicable disconnect aircraft electrical leads from sensing element terminals.  
 (2) Using ohmmeter (see Test Equipment) check that the resistance of each sensing element (in turn) is as specified for the appropriate temperature range.

##### Resistance check - heating element

31. This check is specific to given aircraft transparencies and details will be contained within the relevant publication or associated engineering documents.

##### Insulation resistance checks

32. (1) Where applicable disconnect aircraft electrical leads.  
 (2) Using a 500 volt or 250 volt (see Test Equipment) insulation resistance tester and maintaining the test voltage for five seconds check:-

- (a) the insulation resistance between sensing elements
- (b) the insulation resistance between each sensing element (in turn) and heating element
- (c) the insulation resistance between each sensing element (in turn) and aircraft structure or simulated aircraft structure (metal plate)
- (d) the insulation resistance between heating element and aircraft structure or simulated aircraft structure (metal plate).

33. On completion of any checks, where applicable, reconnect aircraft electrical leads.

#### Scratches or abrasions

34. For repair procedures of scratched or abraded transparencies see aircraft repair manual.

#### Delamination

35. If delamination of plies occurs reference should be made to the aircraft manual where specific areas of allowable delamination are detailed.

36. Where unacceptable delamination of plies has occurred salvage of the transparency may be possible by the manufacturer. Care should be taken to avoid further damage on removal and despatch (see paras 37 to 41).

#### REMOVAL

37. Before removal, the inner and outer surfaces of transparencies should be suitably protected, preferably with latex backed paper.

#### Heated transparencies

38. Disconnect aircraft electrical leads.

39. For detailed removal instructions refer to the appropriate section of the aircraft manual.

#### OVERHAUL PERIOD

40. Transparencies are lified on condition, determined in accordance with the schedule of inspections integrated into the appropriate aircraft manual.

#### RETURN TO MANUFACTURER

41. If possible pack a transparency in the same packing and container in which it was received. Should the original packing not be available, pack in an oversize cardboard or wooden box with sufficient Cellosene wadding or similar material to protect against shock. Include any relevant inspection report or similar document detailing the work required.

This file was downloaded  
from the RTFM Library.  
Link: [www.scottbouch.com/rtfm](http://www.scottbouch.com/rtfm)  
Please see site for usage terms,  
and more aircraft documents.

