

ROYAL AIR FORCE  
INSTITUTE OF AVIATION MEDICINE  
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An assessment of the immersion  
suits and lifejackets worn by  
survivors from the ditching of  
G-BDES on 10 November 1988

(Project 95/07)



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An Assessment of the Immersion Suits and Lifejackets  
Worn by Survivors from the Ditching of G-BDES  
on 10 November 1988  
(Project 95/07)

Reference:

ALLAN, J R (1982). A simple test of the watertight integrity of immersion suits. Royal Air Force Aircrew Equipment Group Report No. 478.

INTRODUCTION

1. On the 10th of November 1988 a Sikorsky S61N helicopter (G-BDES) ditched in the North Sea close to the Claymore oil platform. The ditching took place in conditions of poor visibility, strong winds and heavy seas and as a result the helicopter immediately took in water and inverted with the cabin submerged. All 13 men on board (11 passengers and 2 crew) managed to escape through the emergency exits but only 6 were subsequently able to board a liferaft. The remaining 7 stayed in the water supported on their lifejackets until rescued approximately 40 minutes after the accident. Air and water temperatures were estimated to be less than 8°C but only one person required treatment for hypothermia. However several survivors reported various amounts of leakage into their immersion suits and also failures in the buoyancy of their lifejackets. As a result the Air Accident Investigation Board requested assistance from the RAF Institute of Aviation Medicine in assessing the condition of the immersion suits and lifejackets worn by the survivors.

DESCRIPTION

2. Passengers' immersion suits. All of the passengers were wearing Beaufort Transuits. The suit is a single layer one-

piece coverall made from a neoprene coated nylon material. It has integral socks, wrist seals, a hood with a neoprene face seal and a front opening through-neck zip. Mittens are stowed in pockets on the forearms for use in an emergency and 2 vent valves are located on the upper chest to release air trapped beneath the suit on immersion. In routine use the suit is worn over normal working clothes with the hood off and the fastening zip undone at the top. In an emergency it is necessary prior to immersion to pull on the hood and close the zip completely to produce an effective face seal.

3. Pilot's immersion suit. After the rescue one of the aircrew reported that he was dry beneath his immersion coverall and therefore his suit was not submitted for assessment. The other crew member was wearing a Multifabs Helicopter Pilot's Suit. This is a single layer, one-piece coverall made from a Goretex material with waterproof tapes applied to all internal seams. It has integral socks, wrist seals, a split neck seal with neoprene edging and a front opening through-neck zip.

4. Passengers' lifejackets. All of the passengers were wearing RFD Type 102 Mk2BA lifejackets. This is an "over the head" type of lifejacket manually inflated from a CO<sub>2</sub> cylinder by pulling a toggle.

#### TEST METHODS

5. Immersion suits. The AIB requested the IAM to conduct a visual inspection of the suits to detect any signs of damage or wear. Therefore, each suit was submitted to careful

examination of both its external and internal surfaces, the zip was checked for ease of operation and closure of the vent valves confirmed by applying suction to their inner surface. In addition, it was decided to undertake a leak test on the suit worn by the hypothermic survivor and this was done on the IAM Bench Test described at Reference. The test involves turning the suit inside out, closing the zip and securing the neck and wrist seals over rings positioned 36 cm above the surface of the test bench. The suit is then laid out along the bench and carefully filled with water through the neck. Leakage from the suit is measured for a period of 20 minutes by collecting all water draining from the bench. At the same time the sites of all leaks are recorded.

6. Lifejackets. Each lifejacket was checked to confirm the CO<sub>2</sub> cylinder had fired and that the toggle and lanyard were still intact. A visual inspection was also made for any signs of damage or wear. Finally, each lifejacket was fully inflated orally and left overnight. Jackets which had deflated but had no visible damage were then immersed in water in order to locate the leak.

## RESULTS

7. Passengers' immersion suits. Proforma showing the detailed results of the visual inspections for each individual suit can be found at Annex A (1-11). After the external examinations all 11 suits were found to have operational zips and vent valves. Actual damage to the material of the suit was evident in M2900, which had a hole in the right shoulder and a large tear (10 cm x 7.5 cm) at the

rear of the left thigh. One suit, L846 had a damaged wrist seal and 2 suits, L4186 and L8629 had signs of wear associated with seams on the face seal of the hood. All 11 suits were found to be showing signs of wear of the fabric and sealing tapes of the socks. Internally all 11 suits were found to have had repair patches applied, ranging in number from 1 to 16. Additionally 2 suits had tapes lifting; L846 from the hood attachment seam and L8687 also from the hood attachment seam as well as the heels and toes of both feet.

8. The bench test conducted on suit L7078 resulted in a leak of 80 g in 20 minutes which is well within current limits for this test (100g). Leaks occurred along the seams on both sides of the entry zip, the crotch and inner aspects of both legs. Also both socks seeped water from numerous pinholes.

9. Pilot's immersion suit. This suit was found to be in very poor condition. The wrist and neck seals felt sticky to the touch; an indication that the rubber was perished. Also the edge of the neck seal was frayed, the rubber of the seal was peeling away from the neoprene underneath and it was split in 3 places. In addition, the tape covering the join between the neck seal and the suit showed signs of excessive wear with its surface coating having been worn away in several places (Figure 1). The zip operated satisfactorily until it reached a position 8 cm from the top where it was deformed (Figure 2). Closing it from here was extremely difficult and after this had been accomplished the zip immediately parted at this point. Coinciding with this damage the rubber border of the zip on the left-hand side had been worn through to the fabric backing. Also the sealing tapes on either side of

the zip showed signs of excessive wear along their entire length with their surface coating having been worn away. Finally, there were 4 holes in a line across the left hip. The proforma showing the detailed result of the examination of this suit can be found at Annex A-12.

10. Passengers' lifejackets. Three of the 11 lifejackets had been cut in order to remove them from the survivors which meant they could not be subjected to inflation tests. Visual inspection showed that all the lifejackets had been fired and still had the toggle and lanyard connected to the firing mechanism. One lifejacket had a tear 6 cm long at the attachment point of the CO<sub>2</sub> bottle pouch and the stole (Figure 3), while another had an abrasion and a hole on the right side of the stole below the central reflective patch. Three of the lifejackets were found to have no reflective patches, although positions had been marked for their attachment (Figure 4). Finally, inflation tests showed a third lifejacket to be punctured; this being a pinhole in the front neck of the stole (circled in Figure 4).

#### DISCUSSION

11. In general the condition of the immersion suits worn by the passengers was good considering they are used regularly, if not almost continually, and probably subjected to rough handling. Signs of wear were consistent with this use with all the suits having problems associated with scuffing and lifting of the tapes over the external seams in the socks. Similarly 4 suits had tapes lifting from the seams at the attachment point of the hood and also the face seal. After each flight, before issue to

the next passengers, suits are subjected to a visual check as well as being returned on a regular basis for more comprehensive leak tests. How thorough these visual checks are is not known and although tapes lifting away from seams is not in itself indicative of a leak, they should warrant close examination. Unquestionably these suits had undergone servicing at some time as all 11 had repair patches in them. These were not confined to any common area but were to be found throughout the suits mostly in acceptably low numbers. However 2 of the suits, M398 and M2900, had been repaired in 12 and 16 places respectively and it would be of interest to know at what point the operators decide a damaged suit should be replaced.

12. Actual physical damage was evident in 2 suits. M2900 had a hole in the shoulder and a large tear behind the left thigh, damage which had almost certainly occurred during the escape from the helicopter. The other suit, L846, had a small hole in a wrist seal and although it would be impossible to say that it did not happen during the accident, because of its size and position it is most unlikely. It is more probable that either it was already present when the suit was last issued or it happened during donning or subsequent doffing.

13. The result of the bench test on suit L7078 showed a leak of 80 g in 20 minutes, this being within the maximum acceptable limit of 100 g allowed by the test. This suit had been worn by one of the survivors who, unable to board his liferaft, had spent 40 minutes in the water. When rescued he was reported as being hypothermic and it was noted that there was a lot of water in his

suit suggesting a leak rate far greater than was evident from the bench test. It should be remembered that during flight the passengers usually wear the suit undone and in an emergency are then expected to pull on the hood and close the zip completely to produce a water-tight immersion coverall. It is therefore probable that in the confusion preceding the ditching this passenger either failed to close the zip properly or the closure failed to produce an effective seal.

14. Of perhaps more concern was the immersion suit worn by the pilot. This appeared not to have been recently serviced. The rubber seals were perished and torn and the zip damaged. It is probable that the pilot regularly wore the suit partially undone and that the deformation of the zip and the adjacent wear of the rubber border was caused by his using that point as a hand hold when unzipping the suit. The zip could not be closed completely without a great deal of effort although this is essential to produce an effective neck seal. In addition, the suit had 4 holes across the left hip which were probably produced during the struggle to escape from the helicopter. Similarly the tears in the already fragile neck seal could have resulted from the exertions of the escape or the subsequent rescue operation. In conclusion, the pilot should consider himself fortunate to have been able to board a liferaft. To have spent 40 minutes immersed in cold water wearing that immersion suit could have been extremely dangerous.

15. The lifejackets worn by the passengers also gave cause for concern. Of the 8 which could be tested by inflation 3 were found to be punctured. One had a large rip in the stole which was almost certainly caused by the pouch containing the CO<sub>2</sub>



bottle snagging on something during the escape, whilst the second had an abrasion mark and a puncture which also probably resulted from the struggle to escape. The third, (Ser. No. 211929) however, had a pinhole at the front of the neck and, although impossible to prove, because of its size and location it is unlikely to have resulted from snagging or abrasion during escape from the helicopter. The records show that this particular lifejacket had undergone an annual service only days prior to the ditching. (Annex A-13).

16. Another defect present in 3 of the lifejackets was the absence of reflective patches. Inked outlines showed the positions they should have occupied but no traces of any adhesive were found. It is understood that the patches are normally applied by the manufacturer.

#### CONCLUSIONS

17. Of the 11 suits worn by the passengers from the ditching of G-BDES, 2 were found to have holes in them. One had suffered tears to the shoulder and thigh during escape from the helicopter. The other had a hole in a wrist seal which probably existed before the accident.

18. The suit worn by the hypothermic survivor passed the standard RAF bench test for immersion suits. Over a 20 minute period this suit leaked 80 g, the maximum allowable for the test being 100 g. It is probable that prior to immersion the suit had not been fully zipped up or this had not produced an effective seal.

19. All of the suits worn by the passengers had undergone servicing in the past as they had all been patched internally. Two of the suits had in fact been repaired 12 and 16 times each.

20. All of the suits worn by the passengers showed some wear, with partial lifting of the tapes on the socks.

21. The suit worn by the pilot was in an extremely poor condition with perished and torn seals and a damaged zip. Additionally it had 4 holes in the material on the hip which probably occurred during escape from the helicopter.

22. Three of the lifejackets worn by the passengers were found to be punctured. Of these 2 had damage which had almost certainly been caused during the escape. The third had a pinhole in the neck of the stole which probably existed before the ditching.

23. Three of the passengers' lifejackets had no reflective patches; positions had been marked for their attachment but no traces of adhesive were present.

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[REDACTED]  
Environmental Sciences Division  
for Commandant



Figure 1. Pilot's Immersion Suit - Condition of Neck Seal

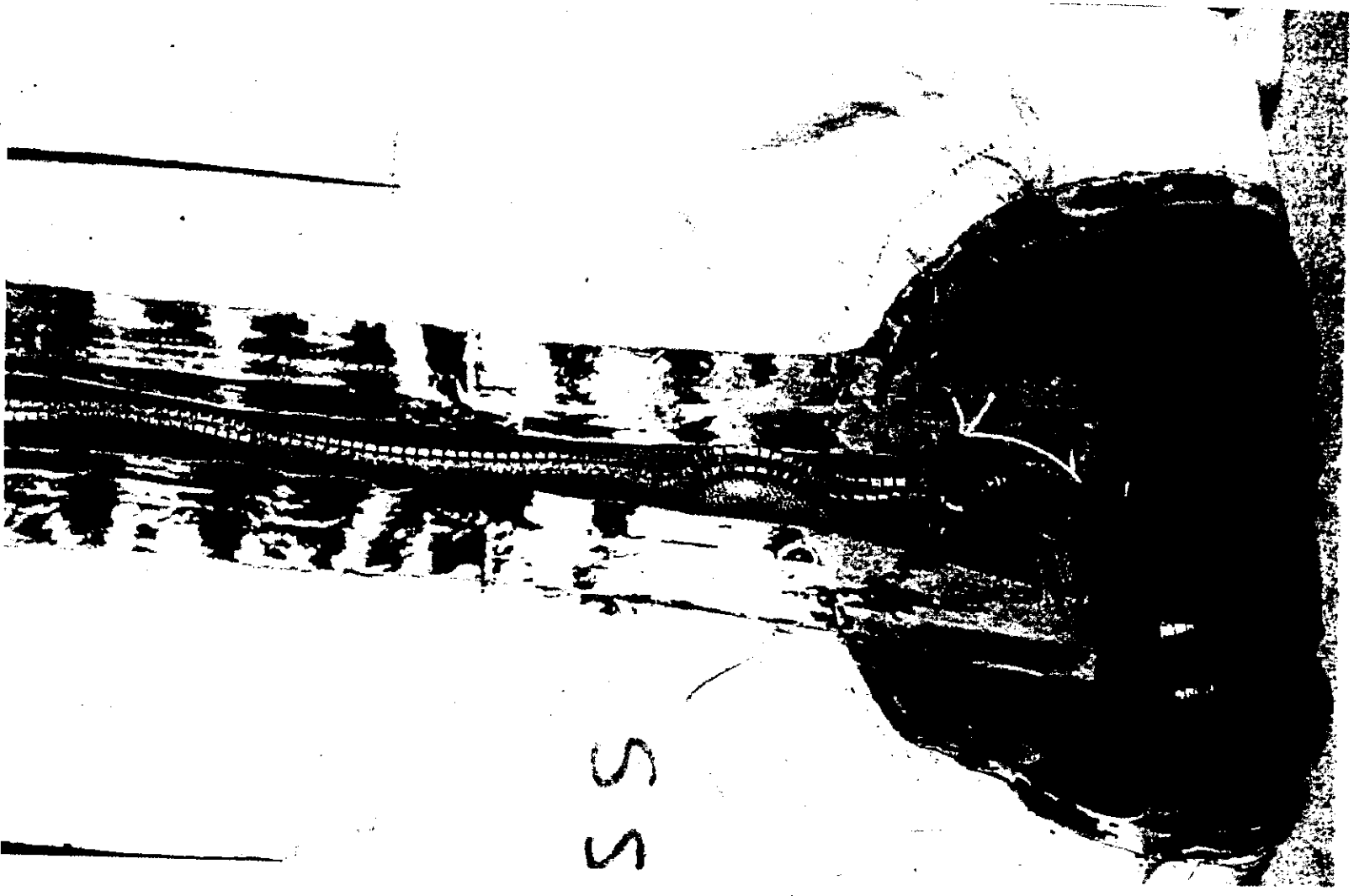


Figure 2. Pilot's Immersion Suit - Condition of zip



Figure 3. Passenger's Lifejacket - Tear in Stole

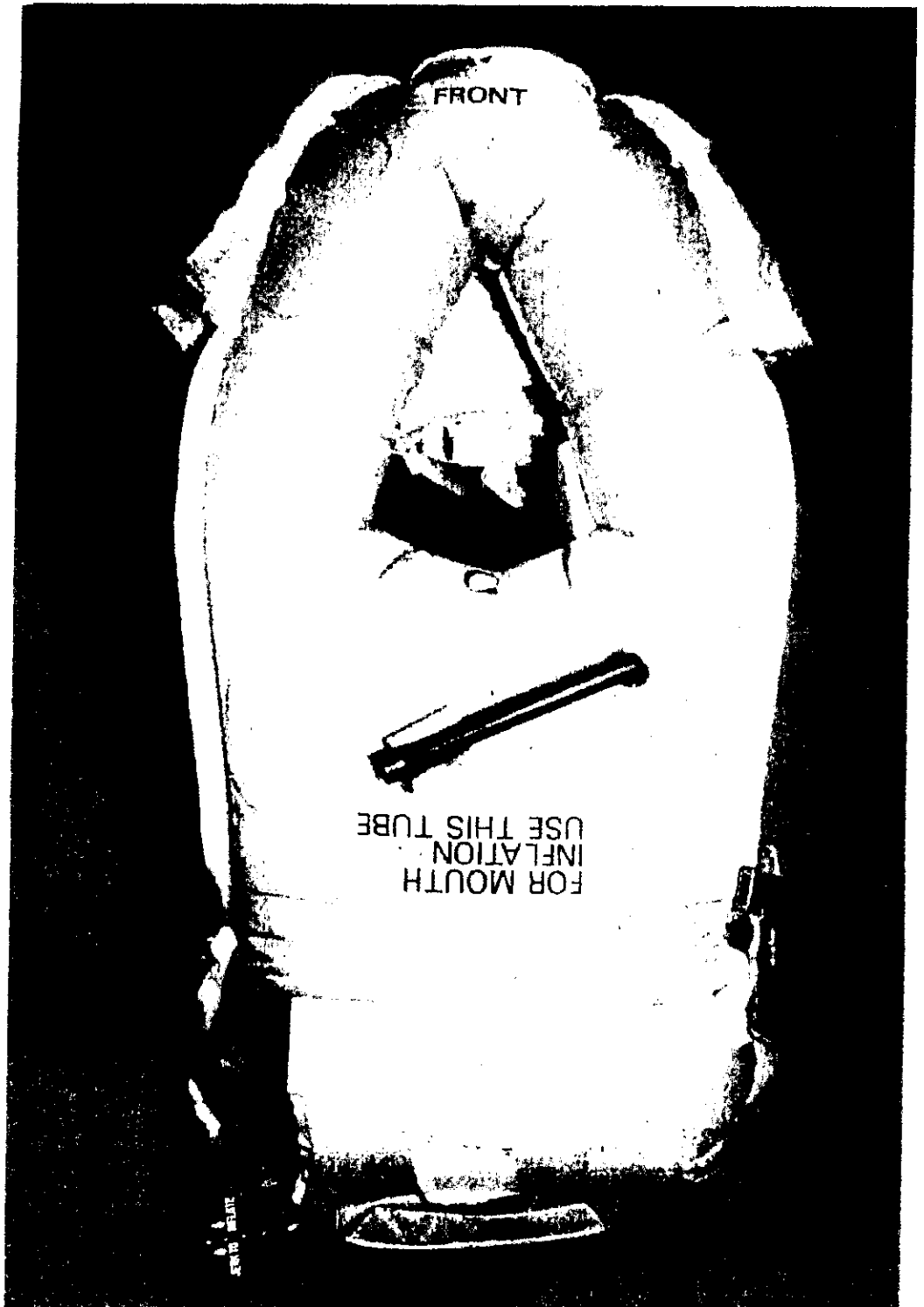


Figure 4. Passenger's Lifejacket - Missing Reflective Patches  
and Site of Pinhole Leak (circled)

ANNEX A-1 TO  
IAM/013/89  
DATED MAR 89

SUIT TYPE Beaufort Transuit

SERIAL NO. M398

EXTERNAL INSPECTION

1. GENERAL APPEARANCE Good. Slightly grubby.
2. ZIP OK. No resistance.
3. WRIST SEALS Right: OK. No tears.  
Left : OK. No tears.
4. ARMS Right: OK. Glove stowed.  
Left : OK. Glove stowed.
5. HOOD Face seal OK.
6. TORSO Front: OK.  
Back : OK.
7. LEGS Right: OK.  
Left : OK.
8. FEET Right: Beginning to wear on toe.  
Left : Beginning to wear on heel  
and toe.
9. VALVES OK.

INTERNAL INSPECTION

10. PATCHES Bottom of zip  
Centre back seam  
Left lower arm x 2  
Right lower arm  
Left heel x 4  
Right heel  
Right toe  
Crotch (lifting)
11. SEAM TAPE OK
12. OTHER FAULTS None

SUIT TYPE Beaufort Transuit  
SERIAL No. M2900

EXTERNAL INSPECTION

1. GENERAL APPEARANCE. Good. Slightly grubby.
2. ZIP. OK. No resistance.
3. WRIST SEALS Right: OK. No tears  
Left : OK. No tears
4. ARMS Right: Hole in fabric on shoulder.  
Glove stowed.  
Left : OK. Glove stowed.
5. HOOD Face seal OK.
6. TORSO Front: OK.  
Back: OK.
7. LEGS Right: OK.  
Left: L-shaped tear 10cm x 7.5cm on  
rear thigh.
8. FEET Right: Tapes worn and lifting at heel  
and toe.  
Left: Fabric worn at toe.  
Tapes worn and lifting at heel  
and toe.
9. VALVES OK.

INTERNAL INSPECTION

10. PATCHES Right abdomen. Crotch x 3  
Right elbow x 3. Right buttock.  
Right wrist. Right calf.  
Right armpit x 2. Left toe.  
Left armpit. Left instep.  
Left waist.
11. SEAM TAPES OK.
12. OTHER FAULTS Excessive glue on left wrist (to seal  
leak?).  
Material worn at hood/neck attachment  
on right side.  
Material worn on leg seams.



SUIT TYPE Beaufort Transuit  
SERIAL No. M8426

EXTERNAL INSPECTION

1. GENERAL APPEARANCE Good. Slightly grubby.
2. ZIP OK. No resistance.
3. WRIST SEALS Right: OK. No tears.  
Left : OK. No tears.
4. ARMS Right: OK. Glove stowed.  
Left : OK. Glove stowed.
5. HOOD Face seal OK.
6. TORSO Front: OK.  
Back : OK.
7. LEGS Right: OK.  
Left : OK.
8. FEET Right: Tapes beginning to lift at heel  
and toe.  
Left: Tapes beginning to lift at heel  
and toe.
9. VALVES OK.

INTERNAL INSPECTION

10. PATCHES Left collar bone  
Left armpit  
Crotch  
Left shin  
Left sock/leg seam (lifting)
11. SEAM TAPES OK.
12. OTHER FAULTS None.

SUIT TYPE Beaufort Transuit  
SERIAL No. M9871

EXTERNAL INSPECTION

1. GENERAL APPEARANCE Good. Slightly grubby.
2. ZIP OK. No resistance.
3. WRIST SEALS Right: OK. No tears.  
Left : OK. No tears.
4. ARMS Right: OK. Glove stowed.  
Left : OK. Glove stowed.
5. HOOD Face seal OK.
6. TORSO Front: OK.  
Back : OK.
7. LEGS Right: OK.  
Left : OK.
8. FEET Right: Tapes beginning to lift at heel  
and toe.  
Left : Tapes beginning to lift at heel  
and toe.
9. VALVES OK.

INTERNAL INSPECTION

10. PATCHES Crotch.
11. SEAM TAPES OK.
12. OTHER FAULTS None.

SUIT TYPE Beaufort Transuit

SERIAL No. M9879

EXTERNAL INSPECTION

1. GENERAL APPEARANCE Good. Slightly grubby.
2. ZIP OK. No resistance.
3. WRIST SEALS Right: OK. No tears.  
Left : OK. No tears.
4. ARMS Right: OK. Glove stowed.  
Left: OK. Glove stowed.
5. HOOD Face seal OK.
6. TORSO Front: OK. Half of belt cut off.  
Back : OK.
7. LEGS Right: Fabric OK. Hole in elastic of  
leg adjuster.  
Left: OK.
8. FEET Right: OK.  
Left : Tapes beginning to lift at toe.
9. VALVES OK.

INTERNAL INSPECTION

10. PATCHES Crotch.  
Back of right calf (sock/suit seam).
11. SEAM TAPES OK.
12. OTHER FAULTS None.

SUIT TYPE Beaufort Transuit.  
SERIAL No. L846.

EXTERNAL INSPECTION

1. GENERAL APPEARANCE Good. Slightly grubby.
2. ZIP OK. No resistance.
3. WRIST SEALS Right: Small hole in cuff.  
Left: OK. No tears.
4. ARMS Right: OK. Glove stowed.  
Left: OK. Glove stowed.
5. HOOD Face seal OK.
6. TORSO Front: OK.  
Back : OK.
7. LEGS Right: OK.  
Left : OK.
8. FEET Right: Tapes lifting at heel and toe  
Left : Tapes lifting at heel and toe
9. VALVES OK.

INTERNAL INSPECTION

10. PATCHES Right wrist.  
Crotch.  
Back of right knee.  
Left heel (lifting)  
Back of left calf (sock/suit seam)
11. SEAM TAPES Lifting along the hood attachment seam.
12. OTHER FAULTS Excessive glue on right heel (to seal leak?).

SUIT TYPE Beaufort Transuit

SERIAL No. L1575

EXTERNAL INSPECTION

1. GENERAL APPEARANCE Good. Slightly grubby.
2. ZIP OK. No resistance.
3. WRIST SEALS Right: OK. No tears.  
Left: OK. No tears.
4. ARMS Right: OK. Glove missing  
Left : OK. Glove attached
5. HOOD Face seal OK.
6. TORSO Front: OK.  
Back: OK.
7. LEGS Right: OK.  
Left : OK.
8. FEET Right: Tapes beginning to lift at heel.  
Left: Tapes beginning to lift at heel  
and toe.
9. VALVES OK.

INTERNAL INSPECTION

10. PATCHES Left shoulder blade.  
Crotch.  
Left calf.  
Right heel x 2.
11. SEAM TAPES OK.
12. OTHER FAULTS Excessive glue on left wrist (to seal  
leak?)

SUIT TYPE Beaufort Transuit

SERIAL No. L4186

EXTERNAL INSPECTION

1. GENERAL APPEARANCE Good. Clean.
2. ZIP OK. No resistance.
3. WRIST SEALS Right: OK. No tears.  
Left : OK. No tears.
4. ARMS Right: OK. Glove stowed.  
Left : OK. Glove stowed.
5. HOOD Face seal centre join beginning to part.
6. TORSO Front: OK.  
Back : OK.
7. LEGS Right: OK.  
Left : OK.
8. FEET Right: Tapes lifting at heel and toe.  
Left : Tapes lifting at heel and toe.
9. VALVES OK.

INTERNAL INSPECTION

10. PATCHES Right back  
Right wrist x 3  
Left wrist  
Bottom right of zip  
Right shin  
Right knee  
Crotch.
11. SEAM TAPES OK.
12. OTHER FAULTS None.

ANNEX A-9 TO  
IAM/013/89  
DATED MAR 89

SUIT TYPE Beaufort Transuit  
SERIAL No. L7078

EXTERNAL INSPECTION

1. GENERAL APPEARANCE Good.
2. ZIP OK. No resistance.
3. WRIST SEALS Right: OK. No tears.  
Left : OK. No tears.
4. ARMS Right: OK. Glove stowed.  
Left : OK. Glove stowed.
5. HOOD Face seal OK.
6. TORSO Front: Pin-hole on right-hand side  
(repaired).  
Back : OK.
7. LEGS Right: OK.  
Left : OK.
8. FEET Right: Tapes lifting at heel and toe.  
Left : Tapes lifting at heel and toe.
9. VALVES OK.

INTERNAL INSPECTION

10. PATCHES Crotch.  
Right-hand side of torso  
Right ankle
11. SEAM TAPES OK.
12. OTHER FAULTS None.

SUIT TYPE Beaufort Transuit  
SERIAL No. L8629

EXTERNAL INSPECTION

1. GENERAL APPEARANCE Good. Slightly grubby.
2. ZIP OK. No resistance.
3. WRIST SEALS Right: OK. No tears.  
Left : OK. No tears.
4. ARMS Right: OK. Glove stowed.  
Left : OK. Glove stowed.
5. HOOD Face seal beginning to detach from hood  
at right-hand bottom edge.  
Tape lifting on face seal centre join.
6. TORSO Front: OK.  
Back : OK.
7. LEGS Right: OK.  
Left : OK.
8. FEET Right: Tapes lifting at heel and toe.  
Left : Majority of tapes on sock  
beginning to lift.
9. VALVES OK.

INTERNAL INSPECTION

10. PATCHES Right shoulder  
Right elbow x 2  
Crotch  
Left knee  
Right knee.
11. SEAM TAPES OK.
12. OTHER FAULTS None.



SUIT TYPE Beaufort Transuit  
SERIAL No. L8687

EXTERNAL INSPECTION

1. GENERAL APPEARANCE Grubby.
2. ZIP OK. No resistance.
3. WRIST SEALS Right: OK. No tears.  
Left : OK. No tears.
4. ARMS Right: OK. Glove stowed.  
Left : OK. Glove stowed.
5. HOOD Face seal OK.
6. TORSO Front: OK.  
Back : OK.
7. LEGS Right: Ok.  
Left : OK.
8. FEET Right: Tapes lifting from heel and toe.  
Left : Tapes lifting from heel and toe.
9. VALVES OK.

INTERNAL INSPECTION

10. PATCHES Left wrist  
Crotch  
Right abdomen.
11. SEAM TAPES Lifting along the hood attachment seam.  
Lifting at heel and toe on both feet.
12. OTHER FAULTS Excessive glue on left heel (to seal  
leak?).

SUIT TYPE Multifabs Helicopter Pilot's Suit.

SERIAL No. Not present.

EXTERNAL INSPECTION

1. GENERAL APPEARANCE Well worn. Grubby.
2. ZIP Very difficult to close over the last 8 cm and once closed the zip parted at this point.  
Black rubber border to the zip was worn down to the fabric along its full length.
3. WRIST SEALS Right: No tears. Rubber feels 'sticky' (perished?)  
Left : No tears. Rubber feels 'sticky' (perished?).
4. ARMS Right: OK. Sewn-on epaulet removed.  
Left : OK. Sewn-on epaulet removed.
5. NECK SEAL Perished. Split. Frayed. Tape over seam worn.
6. TORSO Front: 4 holes in a line on left hip.  
Back: OK.
7. LEGS Right: OK.  
Left : OK.
8. FEET Right: OK.  
Left : OK.

INTERNAL INSPECTION

9. PATCHES None.
10. SEAM TAPES Some tapes beginning to lift.
11. OTHER FAULTS Top left-hand zip border worn through to the fabric (holding point for unzipping?)

LIFEJACKET

SERIAL NUMBER	211929
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TYPE	102	MK	23A
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DATE	SIGN.	REMARKS	A.S.S. No.
DATE OF MANUFACTURE		NOV 1983	
RECEIVED BY		GATWICK AND HEL No.	074755
ACCEPTANCE CHECK		07 DEC 1983	
JAN 85	812	Annual	# 072685x
DEC 1985	LS	REF - - -	
JAN 1986	812	ACCEPTANCE CHECK	# 098005x
AUG 1987	LS	ANNUAL SERVICE	14097617x
NOV 1988	LS	— — —	14096835x

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