

Development of the new RAF Search & Rescue Winchman Immersion Suit: A COTS Procurement Case Study.

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Summary

The UK MOD Search and Rescue service exists primarily to assist military and civilian aircrews that get into difficulty. In reality, this is a rare occurrence and most of the rescues are of civilian, non-flying related. The Royal Navy and Royal Air Force SAR helicopters are located at eight bases across the UK. The service area extends from the Faeroes in the North, to the English Channel in the South, about halfway across the Atlantic Ocean and halfway across the North Sea.

What the SAR crews wear, and the personal protective equipment they use, is controlled by the Survival & Airborne Delivery Integrated Project Team (S&AD IPT). Based at RAF Wyton, Cambridgeshire, the S&AD IPT's role is to supply essential safety equipment that the SAR crews are reliant upon, as part of a 'duty of care' commitment to crews.

Following successful trials, Multifabs secured a Contract to supply the SAR winchman with a 'Commercial-off-the-Shelf' (COTS) immersion dry coverall similar to those currently in service with the UK HM Coastguard civilian SAR winchmen.

Multifabs Survival Limited has over 30 years of experience in designing and manufacturing immersion dry coveralls for specialist applications, from helicopter occupants for the offshore oil and gas exploitation, to the emergency services and defence departments worldwide.

The old suits being replaced (the Mk. 2 Helicopter Winchman Immersion Suit), were heavy, non-breathable, and not flame retardant. Developments in textile technology can now offer higher levels of protection. The new immersion suit is manufactured from a Gore-Tex® Nomex® laminated fabric that offers both flame retardancy, waterproofness and breathability.

As well as developments in the main fabric technology, Multifabs also offer computerised bespoke tailoring to offer mass customisation. This means that the end user can wear a personally tailored garment, delivered in the same time scale as a standard sized garment.

The Company

Recently acquired by Canadian Helicopters Corporation (CHC), Multifabs is now part of the world's largest provider of helicopter services to the global offshore oil and gas industry, with aircraft operating in 30 countries and a team of approximately 3,400 professionals worldwide.

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Application Background

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Existing Garment

For some time RAF SAR helicopter rear crew have been equipped with the Mk. 2 Helicopter Winch man Immersion Suit. This garment is manufactured from heavy duty butyl rubber laminate with integral soft rubber boots. An S&AD IPT review of SAR Rear crew clothing highlighted certain performance inadequacies. Whilst the garment fabric was waterproof and durable, it was also heavy, no-breathable and not flame retardant.

The nature of the main fabric material had the effect of causing the winch man to sweat profusely in even moderate workload situations, particularly when wet winching, being a strenuous undertaking when performing in the water, on the winch and in the cabin. The effect of this was to limit the capacity of the winch man to carry out his duties in multiple casualty situations due to the onset of fatigue and exhaustion. Following a period of arduous work, the induced sweating soaks the undergarments, significantly degrading their thermal insulation properties. As the sweat cools, it chills the winch man causing discomfort, as well as having implications for reduced survival when immersed. Time, space, and the need to administer paramedic care as soon as survivors are on board the helicopter often preclude the winch man suit from changing into alternative clothing after wet winching.

The inherent buoyancy of the current suit was seen to be dangerous as it could prevent a winch man from affecting his own escape from a capsized, ditched helicopter.

Using a lighter-weight waterproof and breathable material to mitigate this discomfort was seen to be beneficial.

For this reason the S&AD IPT initiated action to replace the current suit on Flight Safety and Duty of Care grounds. Their research into analogous products in service led them to discussions with the HM Coastguard and the immersion suits used by their civilian SAR helicopter crews: the Multifabs Type 450 immersion suit.

The Type 450 Immersion Suit

This particular style of immersion suit is a classic configuration that has a long pedigree in the civilian sector, particularly for use by helicopter aircrews and paramedics servicing the offshore oil and gas logistic support worldwide. A variant has been in use with the rear crews/winch men HM Coastguard for about ten years. In conjunction with S&AD IPT a garment design specification was formulated and agreed.

Key performance criteria for the fabric specified flame retardant qualities, combined with waterproof, breathable features. This was achieved by utilising Goretex Farnborough. Three layer laminate developed for UK MOD:

- Outer Face fabric - Nomex Comfort with anti-static properties.
- Gore-Tex® bi-component membrane.
- Inner knit face, aramid.

The basic features of the immersion suit are:

- Latex neck and wrist seals,
- Waterproof, breathable Goretex fabric,
- Front diagonal waterproof main entry zipper
- Padded, reinforcement knee and elbow pads.

Additional features when using FR material:

- Stand collar
- Wrist over-cuffs
- Ankle over-cuffs

Unique Features:

- Rank/Insignia
- Pocketing
- Retro-reflective tape,
- Floatation Knife
- Line cutter

Materials

The garment is stitched together using high tenacity aramid thread and seam sealed using machine applied hot melt adhesive seam seal tape.

Civilian Performance Standards

The Type 450 immersion suit is a UK Civil Aviation Authority Approved garment.

From 1991, the UK Civil Aviation Authority has had a performance standard for helicopter aircrew immersion suits, known as CAA Specification No. 19. Until 2002, Specification No. 19 was the only performance standard world-wide for this type of product.

As an acceptable means of compliance for EU PPE legislation, a Harmonised ISO 15027 standard was published 2002. However, the PPE Directive specifically excludes certain items from its scope, including PPE to be used specifically by the military.

European Aviation Safety Agency (EASA) created in 2002 (Regulation (EC) 1592/2002 of the European Parliament and of the Council), CAA Spec No. 19 will be superseded by ETSOs in 2Q 2005.

MOD Selection & Evaluation

Following a Company capability audit, two Commercial-off-the-Shelf (COTS) suits identified and awarded Aircrew Equipment Certification by S&AD IPT.

Safety Case (Safe To Fly) AEA compatibility undertaken by Rotary Wing Operational Evaluation Training Unit (RWOETU) evaluation conducted at the Search & Rescue Training Unit at RAF Valley, Feb - Apr '03. Criteria such as ground risk, risk on winch, underwater evacuation, cabin compatibility, ergonomics, were evaluated. The outcome of the testing was the selection of the Multifabs' suit for further trial.

Suit Burn Test

Using the Du Pont Thermo-Man®

Exposure time: 4 seconds

Exposure Heat Flux: 2 cal/(cm²*sec) [83.7 Kw/m²]

Underclothing: Long cotton underwear only.

Protection Evaluation Results: Manikin Burn Injury Prediction -

2nd Degree Burn 6%

3rd Degree Burn 7%

Total Predicted Burn Injury 13%

Note - Additional clothing will increase the all-important insulating air gap and significantly reduce further the degree of burn injury.

User Field Trials

Trial 'Sirens Flute': 40 suits, 4 locations, four months period.

Suits inspected and tested by RAF CAM prior to start of test.

The suit was checked for cabin integration, underwater escape & ease of maintenance.

Test conducted over 4 months, Sept to Dec '03

Sorties flown in Sea King Mk3/ 3A and Griffin Mk1/ 2

Worn in place of Mk2 Winch-man's coverall and Mk10 heli-coverall.

Total of 163 sorties were undertaken, accumulating over 250 hours of wear.

Operational effectiveness was assessed:

- Comfort
- Flight safety
- Buoyancy
- Integration
- Subjective comparison by each operator
- in the aircraft, during land operations and water operations

Trial Result Feedback

The new suit was found to be 50% lighter than the Mark 2 heli-coverall.

96% acceptance of the garment as suitable for the end-use.

AC/AEA Integration Issues

Mostly minor & required only small design modifications:

- Floating Dinghy knife: the biggest issue, rigidity of mounting now apparent on much softer garment.
- Wrist plain over-cuffs: recommended modification of storm cuff to prevent snagging hazard.
- Socks: some complaints of cold feet.
- Neck Stand Collar: issues with size, intrusion and irritation.
- High Wear Areas: Some incidents of puncturing during land training.
- Main Zip: Difficult to operate with cold hands, recommended addition of toggle.
- Lower Leg: Access to boots difficult because of ankle cuff.

- Right Upper Arm Pocket: Declared redundant.

MSL Corrective Action

Design refinements:

- Floating Dinghy knife - A component imposed upon MSL, existing carrier trimmed and mounted on softer carrier, angled position.
- Wrist over-cuffs - Velcro adjustment added.
- Neck Stand Collar - Was reshaped.
- High Wear Areas - Addition of reinforced seat and elbows using woven Kevlar with a Silicone Carbon coating.
- Main Zip - Pull toggle added to zipper slider tape.
- Right Upper Sleeve pocket replaced with loop velcro for insignia.

New service & maintenance regime developed to reflect the switch to a Goretex-based product.

New suit integrity test using air.

New seal replacement system that eliminates the requirement for cold cure adhesive.

New Product Implementation

520 suits to be introduced into service in 2004

Significant financial savings from procuring a COTS item - S&AD IPT demonstrated a whole life cost benefit.

The Company utilises a Mass Customisation (CAD/CAM) system to use mass production tools to cater for made to measure garments.

CAD pattern creation and fabric use optimisation software is linked with made to measure software to create individual bespoke tailored suit patterns in electronic format. This unique pattern is then imported into an automatic conveyor fed single ply cutting table.

This production planning tool ensures that the optimum delivery timescale for made to measure garments are essentially the same as standard size garments.

Summary

- The new heli-winchman immersion suit delivers tangible benefits to the wearer:
- Improved comfort and mobility
- New suit 50% lighter than the Mark 2 heli-coverall
- Inherent flame retardancy with anti-static properties
- Every suit made-to-measure, two suits per individual
- Optimised design offering maximum flexibility and mobility
- 100% testing of the completed suit
- Regular maintenance retains garment performance
- 96% acceptance of the garment as suitable for end-use
- New suit will be in service in 2004