The nominal pass/fail mark for these tests are 200mls and by establishing such a standard manufacturers have been encouraged to produce garments of improved design.

This is most noticeable by studying the results of a recent series of leak tests of four helicopter immersion suits for Shell UK Exploration and Production.

The Project consisted of 8 subjects wearing in turn four different suits whilst carrying out a 20 minute swim test and a simulated helicopter underwater escape, thus producing 64 separate leak test results.

	Water Ingress During 20 Minute Swim Test			
	A	B	C	D
	14	60	96	28
	78	74	914	78
	102	92	1114	80
	186	106	1450	88
	188	110	1648	146
	192	154	1748	284
	206	212	1796	292
	740	352	2382	422
Mean	213	145	1398	177
SD	224	96.5	691	139

From the above results it can be seen that suit Type C (the in-service suit) had a totally unacceptable leak rate. Indeed such a leak rate represents a loss of initial insulation of between 40% - 50% (Allen, Higenbottam and Redman 1984). As the maintenance of adequate insulation is a significant factor in the survival equation, leaks of the magnitude of Suit C above will significantly decrease the survival expectations for survivors from the hypothermia viewpoint. Suits A, B and C have been designed to meet the specification requiring no greater leak than 200mls and in most cases these suits achieve this acceptable figure.

33 A new immersible thermal manikin

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The Nova Scotia Research Foundation Corporation, under contract to the Cord Group Ltd. of Dartmouth, Nova Scotia, has developed an immersible thermal manikin test system for use in the contract testing of thermal protective clothing. The clothing can be anything from diving and survival suits to basic outdoor wear. The system is computer based and so can complete tests and produce ready-to-read reports in a minimum of time. A basic description of hardware and software is presented, along with a discussion of some operational experience with the system.

34 Effects of laundering on the thermal insulation of clothing

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Most studies on the thermal insulation of clothing have been done with new, unwashed clothing. At the Institute of Occupational Health the effects of wear and laundering on the insulation of cold protective clothing have been studied and how material thickness and garment shrinkage change in relation to insulation has been determined.

The thermal insulation values of clothing were measured on a thermal mannequin. The tests were carried out in two stages. In the first stage the effect of wear and laundering on three different cold protective clothing types was measured:

a) cotton/nylon outer fabric and quilting
b) cotton/nylon outer fabric and pile, quilted sleeves
c) nylon outer fabric with a polyurethane coating on the inside, pile lining

Thermal insulation was measured when the suits were new, after three launderings, and after eight launderings. The suits had been worn in a cold store.

In the second stage the tests were carried out for four different cold protective clothing types:

d) nylon outer fabric with a polyurethane coating on the inside and a lining quilted wadding with cotton
e) outer fabric of 100% polyester, pile lining
f) same as type c
g) cotton/nylon outer fabric, special quilted wadding polyester lining

Thermal insulation was measured when the suits were new and after three, five, ten and twenty launderings. After launderings dimensional changes and the changes in fabric thickness were measured.

After wearing and three launderings, there were no significant differences in insulation values when compared to new suits. After wearing and eight launderings, insulation values were 10-15% lower.

When the effects of laundering were tested without wear, the changes in thermal insulation were slight, being 0-2% after three launderings for both pile and special quilting lined suits. The decrease in thermal insulation after suits with regular quilted linings had undergone three launderings was 9%.

The decrease in thermal insulation for all of the suits except the one with the special quilted lining (type g) was near 10% after ten launderings and 10-15% after 20 launderings. The decrease in thermal insulation for the suit with special quilted lining was only 3.5% after 20 launderings.

The dimensional changes of all the suits were under 5%. The suits did not differ in this respect. The changes in material thickness were notably greater, being 6-20%.

The compression of fabrics while being worn and laundered decreases the thermal insulation of cold protective suits somewhat faster than launderings alone. The decrease was greater for normal quilted linings than for pile linings. The thermal insulation of the suit with the special quilted lining decreased under 5% after 20 launderings, whereas the thermal insulation of the other suits was 10-11% lower.

Session VII
Physiological Basis for Performance Standards of Immersion Protective Clothing
Abstracts 35-42

35 **The physiological basis for the development of immersion protective clothing**

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The purpose of immersion protection clothing is to minimise the occurrence of cold shock, prevent hypothermia and non freezing cold injury, and in conjunction with personal buoyancy aids prevent drowning from wind and wave splash as well as from facial immersion. Several analyses were performed on predicting model data which related survival time to the environmental, anthropometric and clothing characteristics.