Whichever technique for measuring insulation is adopted, it must be capable of allowing for the adverse effect of water leakage into the insulation of dry suits or the effects of water flushing beneath wet suits. Techniques for making this allowance present difficulties.

31 The establishment of 137N as the Canadian General Standards Board maximum acceptable inherent buoyancy limit for passenger helicopter immersion suits

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When a helicopter ditches into water it usually inverts and rapidly sinks. Aircrew and passengers have to overcome inherent buoyancy to make their escape from a flooded compartment through cargo doors, access doors, windows or the windshield. Even if the crew and passengers are uninjured, escape is difficult due to the loss of vision, disorientation, the requirement to hold their breath underwater and the extreme terror imparted by the catastrophe.

The buoyancy of trapped air in between each layer of clothing and of deliberately trapped air in foam rubber type immersion suits for hypothermia protection are added to the inherent buoyancy of each individual. The total buoyancy may indeed be of such a high value that it decreases or could even prevent the ability to make an escape from an inverted cabin.

In 1984, to establish a preliminary standard, Brooks and Provencher conducted two sets of experiments simulating a helicopter escape, first in a closed flooded diving chamber and secondly in an open pool, using clearance divers and later naive swimmers. The conclusions were that the shell of the suit alone should not contain more than 89N of buoyancy; furthermore this figure should be confirmed in the dynamic situation of the Helicopter Underwater Escape Trainer.

This paper will review the latter work and report on the problems encountered with the development of a practical method of measuring the buoyancy of an immersion suit worn by a human, to confirm that the levels were representative of the conditions expected during underwater escape by dynamic measurement of subjects and suits in the Helicopter Underwater Escape Trainer; and finally, describe the recent experiment using four subjects (3 males, 1 female) which lead up to the establishment of the maximum inherent suit buoyancy figure conducive with safe escape, the figure of 137N being finally recommended to the Canadian General Standards Board.

32 Immersion suits - realistic and reproduceable leak testing

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The concept of the marine or helicopter passenger immersion suit is to provide a one-piece waterproof garment designed to cover the body surface with the exception of face and hands.

Over the last 2 years, the Offshore Survival Centre of the Robert Gordon's Institute of Technology, Aberdeen, Scotland, has carried out fifteen separate marine and helicopter immersion suit evaluations, and in so doing, has been actively involved in perfecting leak testing techniques which are realistic, and above all, reproduceable. The content of this paper encapsulates the recent work of the Centre in this area and considers the implications not only to the potential survivor but also to industry and policy makers.

In order to evaluate the water excluding properties of an immersion suit, three separate but inter-related forms of leak testing are carried out, namely:

a) Jump Test (marine suits only)
b) Simulated Helicopter Underwater Escape
c) 20 Minute Wave or Swim Test

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.