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Development of Technical Standards  
for Immersion Protective Clothing  
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**30 The technical basis for the development of performance standards for Immersion protection \***

*J.R. Allan*, Environmental Sciences Division, RAF Institute of Aviation Medicine, Farnborough, Hants, United Kingdom

The International Maritime Organisation (IMO) has promulgated regulations for immersion protection together with recommended test procedures to ensure adequate performance. The regulations envisage two standards of immersion protection, an insulated immersion suit to provide six hours protection in water between 0 and **PC** and an uninsulated suit to provide one hour's protection in water at **PC**. Protection is defined as prevention of a fall in body core temperature of more than *PC*.

The IMO recommendations for test procedures require thermal performances to be demonstrated on human subjects exposed to the above test water temperatures and exposure durations. The IMO tests present difficulties in that the use of calm water, even though stirred, is highly unrealistic both in terms of heat loss from the test subjects and because calm water will not induce the level of leaking in poorly designed suits that would occur under more realistic conditions. Furthermore, the use of human subjects imposes high financial costs, difficult ethical considerations and methodological difficulties. The latter include the difficulties of body temperature measurements under immersed conditions and problems arising from the selection of subjects with differing body composition and differing levels of cold experience and tolerance.

Faced with these difficulties several international authorities have sought alternatives to the IMO test proposals. One such alternative, put forward by the RAF Institute of Aviation Medicine, has been to replace the human subject tests of thermal performance by a measurement of immersed clothing insulation and to use modelling techniques to determine the required level of immersed clothing insulation necessary to achieve the prescribed survival times. The model developed by Professor Wissler has been used for this purpose and suggests that immersed insulation values of *.3* do and *.7* do would meet the IMO requirements for uninsulated and insulated immersion suits respectively. Recent developments of the Wissler model indicate that these figures may be a little high.

Recommended techniques for the measurement of immersed clothing insulation have generally been based on the use of multi-sectional thermal manikins which allow measurement of insulation in the various body regions. Such regional measurements may then be entered directly into the thermal model which will then make allowances for substantial differences in insulation, for example, between the legs and the trunk. Such measurements have the great advantage of being obtained under realistic circumstances in water and thus allow for the effects of the multi-layer clothing systems, trapped air and hydrostatic compression. However, serious difficulties can arise when substantial differences in regional insulation are combined to give a single "mean" figure, for example by area weighting the measured regional conductances. Such a procedure may be satisfactory when the level of insulation is reasonable even over the body surface but could be grossly misleading in the presence of large regional differences.

An attractive alternative to the complicated and highly expensive multi-section manikins would be to use a single section manikin of which an example has been developed at the RAF IAM based on a water filled fabric construction, with internal heating, water circulation and temperature measurement systems. Such a device is open to the same difficulties in measuring an overall "mean" conductance when there may be substantial

differences in conductance between one region and another.

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.