

#### 40 Survival at sea: The effects of protective clothing and survivor location on core and skin temperature

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A comparison of different types of protective clothing was made for maritime personnel exposed to three different survival environments: 1) immersion in cold, rough seas; 2) exposure to cold wind and spray atop an overturned boat in cold, rough seas; and 3) exposure to cold air and cold, rough seas in an open, one-man life raft. The protective garments tested were: 1) uninsulated flight suit coverall (FS); 2) two-piece wet-suit (WS); 3) insulated, loose-fitting aviation coveralls (AC); 4) insulated, loose-fitting boatcrew overalls (BC); 5) uninsulated dry-suit (NI); 6) uninsulated dry-suit with a 5 cm tear in the shoulder seam (NX). All garments were worn over cotton thermal underwear; an additional layer of insulated short-sleeve underwear was worn with NI and NX. An inflatable flotation device was worn with all garments except BC. The protective garments were tested in the survival environments as follows: Water immersion (**FS**, WS, AC, BC, NI, NX); Wind, spray and wave exposure atop the boat (**FS**, WS, AC, BC); within the liferaft (**FS**, WS, AC, NI, NX). Eight volunteer Coast Guard crewmen were used as test subjects: mean age = 23.5 ± 0.7 years; mean height = 175.0 ± 2.2cm; mean weight = 71.7 ± 3.7 kg; mean body fat = 11.1 ± 2.2%. Water temperature was 6.1 ± 1.2°C; air temperature ( $T_{wb}$ ) was 7.7 ± 2.7°C; air  $T_{wb}$  was 7.2 ± 1.5°C wind speed was 7.5-10 m.sec<sup>-1</sup>. Sea-state consisted of 1.5 m swells and 1.5m breaking waves every 30-45 seconds of sufficient force to totally submerge subjects in the water and to often engulf subjects atop the capsized boat; waves swamped the liferafts only infrequently, however. Dependent variables were rectal temperature  $T_{re}$ , mean weighted skin temperature  $T_{sk}$  (from chest, forearm, thigh and lower leg) and subjective evaluation of garment performance. Tests were terminated after 2 hours or when subject  $T_{re}$  = 35.0. The results showed linear  $T_{re}$  cooling rates (°C.hr<sup>-1</sup>) for cold-water immersion as follows: FS=6.1 ± 1.7; WS = 1.7 ± 1.0; AC = 2.7 ± 1.8; BC = 2.9 ± 1.4; NI = 0.8 ± 0.4; NX = 3.3 ± 1.3. Cooling rates atop the capsized boat were: **FS** = 2.7 ± 2.1 ; WS = 1.0 ± 0.3; AC = 0.7 ± 0.3; NI = 0.7 ± 0.2; NX = 1.2 ± 0.4. Significant differences (p<0.05) between cooling rates in the water and those atop the boat or in the liferaft were found for all garments except NI. Significant differences were found between NI and NX for all environments.  $T_{re}$  changes paralleled those of  $T_{sk}$  for each garment/environment. The results demonstrate that survivors have a slower onset of hypothermia out of the water, even when exposed to continuous cold wind and spray and occasional breaking seas, than when remaining immersed. With respect to protection against immersion hypothermia, tight-fitting "wet" suits are better than loosefitting "wet" garments, and intact "dry" suits are better than "wet" suits. Leaky "dry" suits, however, provide no better protection than do loose-fitting "wet" suits in cold, rough seas.