Conoco/ BP Integrated Suit System.

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This paper gives the background behind the integrated survival suit developed by Shark for Conoco and BP during the last 18 months.

Background

Following the Piper Alpha incident and subsequent public inquiry led by Lord Cullen, new legislation covering offshore installations was introduced in 1992. The overriding statutory instrument for offshore installations and their operations is the Safety Case Regulations. Under this are several other statutory instruments which relate to the assessment of hazards associated with offshore operations and the management of these hazards. The requirement for rescue and recovery provision following an incident offshore where rescue from the sea would be required falls under the PFEER (Prevention of Fire and Explosion and Emergency Response Regulations), PFEER 17 states that all incidents requiring rescue and recovery from the sea must be identified.

The majority of offshore personnel travel to an installation by helicopter. One of the foreseeable circumstances where rescue from the water is required is a helicopter ditching. Under PFEER 17, it must be possible for all personnel to be rescued and recovered to a place of safety (somewhere where immediate medical treatment is available) in a time that demonstrates a good prospect of rescue and recovery. Good prospect is defined as recovery within two thirds of the survival time which allows for the many uncertainties associated with the estimation of survival time.

Since the introduction of the safety case regulations, the equipment worn by helicopter passengers has increased over the years in an attempt to mitigate the hazards associated with helicopter ditching therefore increasing survival time. Improvements in suit design have decreased leakage into the suit, increasing survival time. Lifejacket design has improved to raise the mouth higher out of the water and provide the body with greater stability to protect against drowning. A thermally insulated garment, or TIG, is worn under the suit to provide better thermal protection and therefore lengthens survival time by mitigating the effects of cold shock on immediate entry into the water and hypothermia over longer time periods. A personal locator beacon is worn round the neck. This helps the rescue boat to locate personnel in the water, thus reducing the time to rescue. The latest piece of equipment to be added to this assembly was the Airpocket+ which assists in helicopter underwater escape where breath hold time is severely reduced by cold shock.

It was during trials with the Conoco workforce of this latest addition that comments were made on the number of separate pieces of equipment that must be worn during helicopter travel. The equipment takes a long time to don and is not particularly comfortable to wear especially during the summer months where the TIG can cause passengers to feel uncomfortably hot. It was determined that there was no piece of equipment that the workforce would wish to lose. Shark were present during these discussions and explained the SISS suit developed for Shell some years ago which integrated all parts of the equipment currently worn for offshore travel.

Shortly after these trials an industry-wide diagonal slice meeting was held where the equipment worn on helicopters was discussed. As well as a large number of different pieces of equipment, there was also a discrepancy in the equipment worn by different operators. The SISS was also shown and it was agreed by management and the workforce that trials of this should be carried out as the starting point in an attempt to standardise and minimise equipment used for helicopter travel through out industry. Trials of these suits were carried out by members of the Conoco and BP workforces.

Following the trials the workforce defined their requirements of an integrated suit. The Conoco and BP offshore workforce challenged Shark Group to develop a survival suit that integrates all the items of PPE required for helicopter travel while providing a survival time in water of at least three hours. The suit was to be breathable, fire retardant, inflatable, durable, and comfortable and comply with the necessary legislation. The suit was not only to be suitable to getting into and out of a helicopter but also for operations on normally unmanned installations where helideck duties are carried out by the personnel on the helicopter while they are wearing the suit.

Multifabs, the other manufacturer of the survival suit for offshore travel has been involved in the suit development process to ensure compatibility of the developed equipment with their product.

Input from the workforce has continued throughout the suit’s development. The initial concept was shown on all offshore installations and comments gathered. These comments have been fed back to Shark and where practical, have been included in the design. A small team from the workforce has been brought in at critical stages such as design finalisation so their opinion can be sought on practical matters.

Regular updates on the suit development have been communicated to the workforce via posters that are displayed on each installation and the more involved members of the workforce have also kept their fellow crew members updated on progress. Workforce involvement has been crucially important in ensuring the success of the suit.

The development of the suit as described in the following sections of the paper was funded jointly by BP and Conoco. It is envisaged that the suit will be brought into use by Conoco and BP for their Southern North Sea operations by the second quarter of 2002.

System Development

The CAA’s definition of an integrated immersion suit is an immersion suit which incorporates the functionality of a lifejacket. The wearing of a separate lifejacket is not required.

The English Dictionary meaning of the word integrated is to make or form into one whole, to take the sum of the parts to form a single entity.

The development of the Conoco/BP Integrated Survival System, which meets these definitions in full and works as a composite survival system, has been necessary for two reasons – to address a gap in the survival in the sea scenario and to meet the requirements of the offshore workforce.

The challenge from the Conoco and BP workforces resulted in the production of a specification and a wish list. A concept suit system was produced to meet the proposed specification and to obtain workforce approval, which was achieved. The CAA were then approached in order to assess their response to the proposals and for their confirmation of which specifications must be met.

The new draft JTSOs were not considered appropriate, since they were still at the draft stage and were subject to change. The CAA Specifications 5, 8 and 19 would have to be met; if the development process resulted in improvements to Specifications 5 and 19, in line with the draft JTSOs, these would be recognized.

Work then commenced on the development of the integrated system, against the specification:

(a) A Survival Suit Integrating all the elements required for helicopter travel to and from working offshore platforms.
(b) Lifejacket.
(c) Thermal insulation to provide a survival time of at least three hours.
(d) Re-breather
(e) Suit should be breathable, fire retardant, durable, comfortable in air and comply with the necessary legislation.
(f) The design to take into account the existing suit stocks and existing CAA Specification suits such as the Shark 93204 and the Multifabs GNX 459.
(g) To be fitted with an inflating lining.
(h) Fitted with an externally mounted Air Pocket Plus and incorporating the elements of a lifejacket.

Work started on the inflating liner, taking into account two key design factors, comfort in air and thermal performance in water.
An in air trial was carried out, with an ambient temperature of 30 deg C, a relative humidity of 60% and a wind speed 5 Metres per second. Although data was already available on the passive liner, the previous trial temperature of 21Deg C was regarded as being too low.

Various liners were trialled in combination with the 93204 Nomex Goretex suit, including inflating liners, one of which had been modified to give a level of breathability. The results are shown in Figure 1.

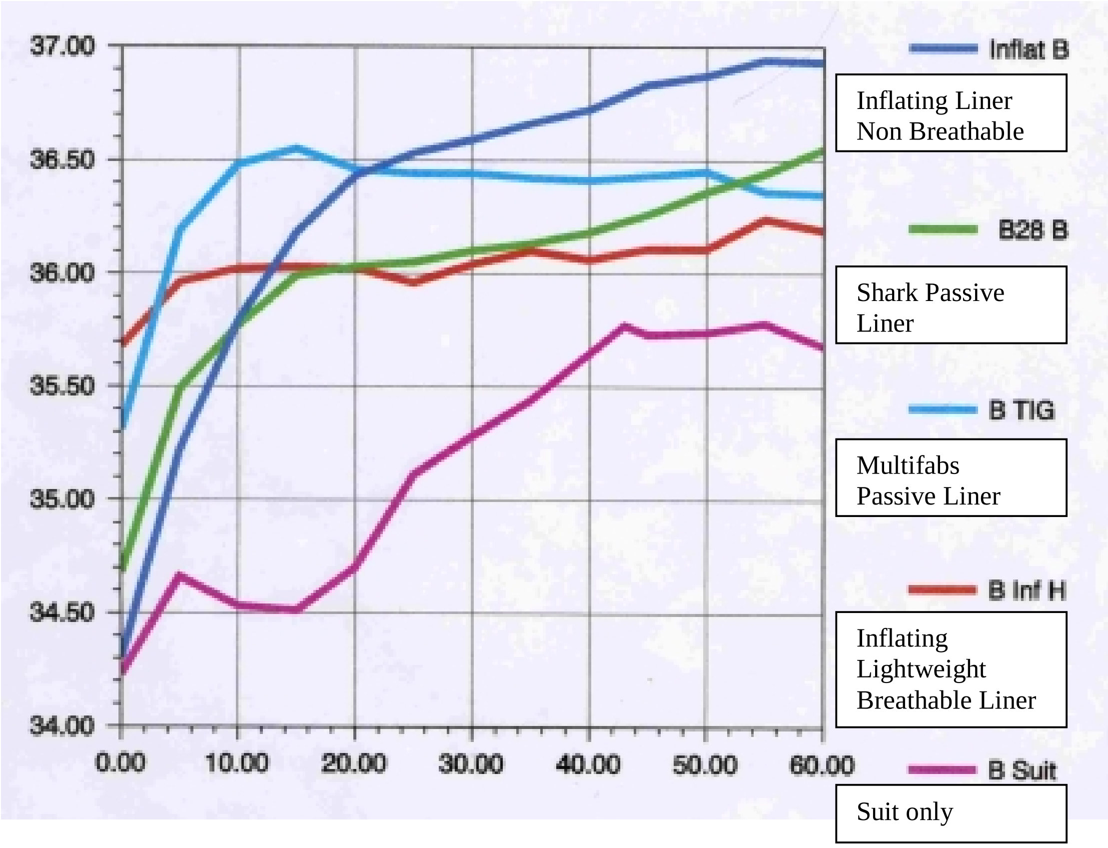


Fig 1: Thermal Performance in Air – Comparison of Various Thermal Liners

This data enabled the design and production of the definitive liner, incorporating ventilation to give maximum breathability in air without affecting the thermal performance in water. Once the newly designed liner was manufactured further trials were conducted to prove that an improved performance had been achieved. This is shown on Figure 2.

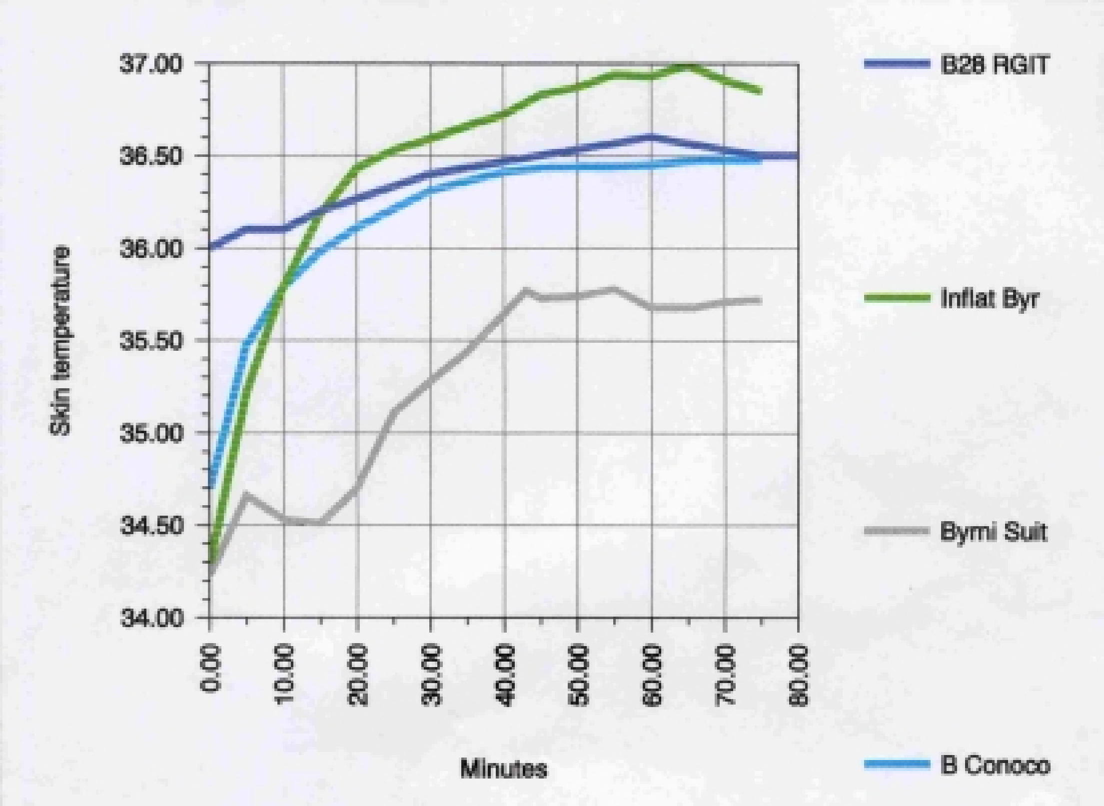


Fig 2: Thermal Performance in Air.

Thermal Performance in Water.

The thermal performance in water was then measured using the thermal manikin at the Institute of Naval Medicine (INM).

Cold water trials, in 4DegC water, had been carried out at the INM in 1995, using human subjects wearing an orally inflated thermal liner inside the 93204 suit. Fig 3 shows that the orally inflating liner only performed as well as the passive liner, because the test subject was unable to put adequate pressure into the liner orally due to the hydrostatic pressure exerted on the suit. The hydrostatic pressure caused the main volume of air to inflate the area over the chest leaving only a thin insulating layer on the back.

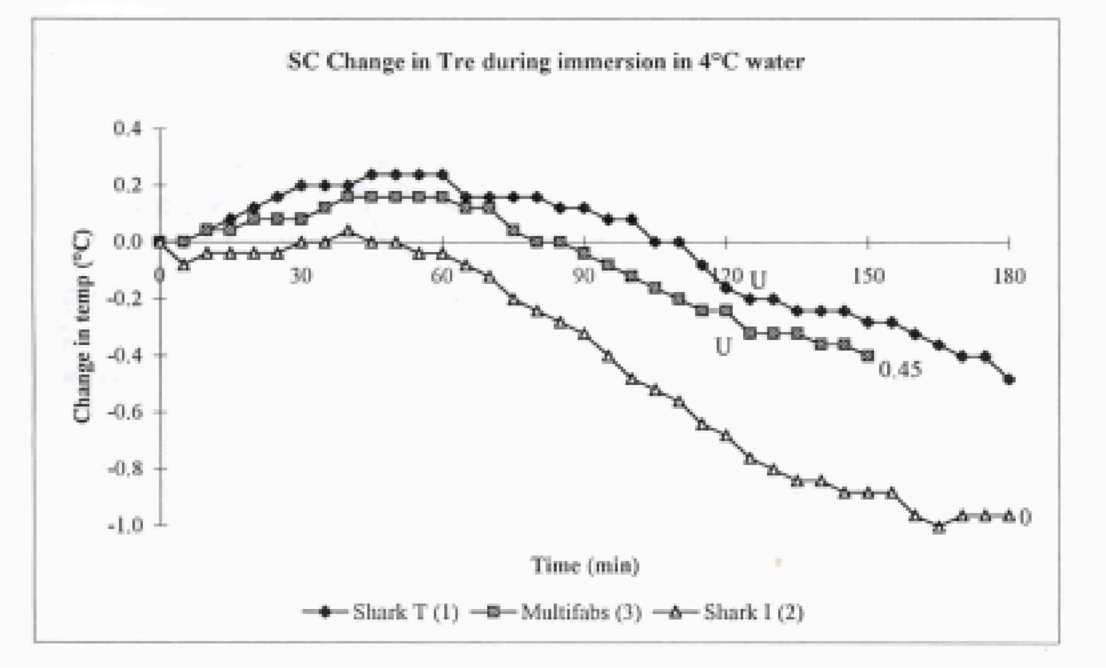
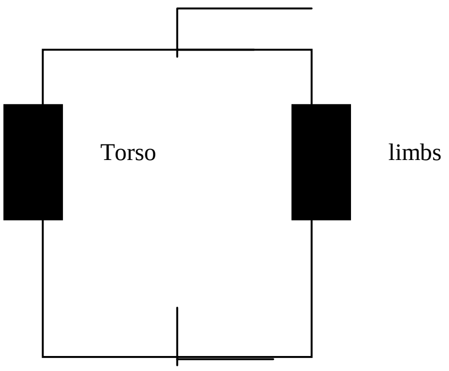


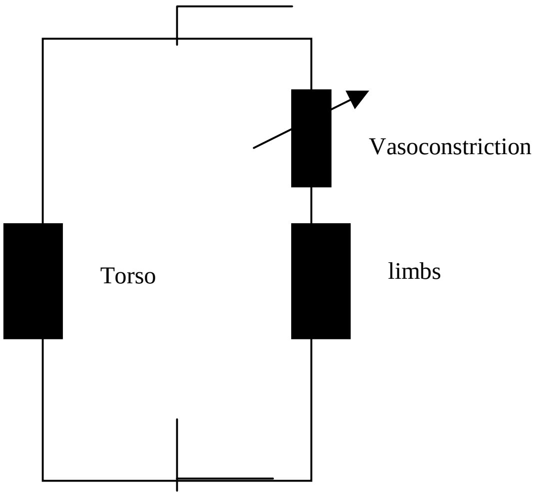
Fig 3: Comparative Performance Graph: Shark passive liner (Shark T (1)) against Shark orally inflated liner (Shark 1(2))

From this data it was recognised that the liner would have to be inflated with CO2 gas, which could be introduced from a small cylinder. CO2 gas has the added advantage of having a higher thermal performance than air. The liner would have to be designed with a fixed height when inflated in order to offer an equal thermal barrier around the torso of the wearer. This has been successfully achieved.

The successful trials on the thermal manikin indicated that the design target of three hours of in water survival time would be achieved. Manned trials have been planned, to ensure that the predicted survival times are meaningful. Tipton et al have demonstrated that a manikin cannot vasoconstrict so that water ingress into the suit during testing makes the immersed Clo values unreliable in the prediction of survival times. The legs of the manikin continue to produce heat whereas a human will vasoconstrict shutting down the extremities. This means that the insulation values around the torso of a human test subject are more relevant than the overall CLO values of a manikin. Shown schematically:



MANIKIN



HUMAN

Because of this, overall CLO values for the manikin should not be used for survival calculations, but can be used as a guide to the values of torso and limbs. The only practical way to produce realistic times for the thermal element of survival is by human testing with due allowances for wind and wave conditions.

Breatheable inflatable lining

To further enhance the performance of the liner, a detachable, washable and absorbent skirt has been fitted to the liner, which will take up any moisture, whether from leakage, sweat or urine. It is a well established fact that water within the suit, from whatever source, can degregate the thermal performance by as much as 40%. The activation of the inflation of the liner is through the neck seal.

The Life-jacket Air Pocket Combination

The life-jacket Air Pocket combination is a totally new design which takes into account the relevant regulatory requirements. The Air Pocket Plus helicopter emergency underwater breathing system and the life-jacket have been integrated into a single package comprising:

(1) A separate life-jacket bladder for CO2 inflation which is manually activated.
(2) The bladder has a unique shape which offers stability in water is self righting even when the suit liner is inflated and has a capacity of 275 Newtons.
(3) The height of mouth above water exceeds the 120mm regulatory recommendations.
(4) It incorporates a lifting becket ,whistle, buddy line , strobe light and splash guard.
(5) The Air Pocket Plus has a redesigned counter lung of 9 litre capacity and is automatically activated on immersion in water.

Life-Jacket Air Pocket Combination

During the design and development numerous in water trials have been carried out to prove and refine the concept, using Shark's in house test tank or at NUTEC.

Considerable effort has been expended on the Life-jacket Air Pocket Combination to ensure its performance meets all regulatory and practical requirements.

The stages of immersion have been defined as:

(1)…………….Initial immersion 0-3 mins

(2)…………….Short term immersion 3-15 mins

(3)…………….Long term immersion 30mins +

(4) ……………Post-immersion

The responses to initial immersion, long term immersion and post immersion have been addressed and well recognised solutions found to overcome the problems identified. Problems remain to be solved in the short term immersion stage, in which the survivor is in the open sea, has to deploy the life-jacket and contend with the hostile environment of wind, waves and spray, which can result in the ingestion of water into the lungs and the possibility of drowning.

Recent trials to measure the ingestion of water into the lungs have shown that it is very difficult to obtain repeatable results due to the design and fit of Life-jackets, which can be adjusted in so many ways that consistent results are not obtainable. The Life-jacket Air Pocket Combination has been designed to overcome this problem.

To finalise this development, twenty offshore personnel from Conoco and BP/Amoco will carry out a pool evaluation and an offshore assessment of the integrated suit system. Once the concept is approved, arrangements to carry out environmental trials and cold water trials will proceed under the supervision of Professor Mike Tipton at Portsmouth University. The CAA deposition will then be produced and performance testing against CAA Specifications 5 and 19 will be carried out.

Training

To meet the CAA operational requirements it has now been agreed to deploy the Air Pocket Plus post impact rather than pre- impact.

This will mean that wet training will become the norm for all offshore personnel and it is understood that OPITO will now introduce a system of dunker training to incorporate in water training in the use of Air Pocket. This training will not be affected by the introduction of the life-jacket Air Pocket Plus combination.

Additional training will be required by the training establishments when the inflating liner is introduced.

Conclusion

The Conoco/BP Integrated Survival System Project demonstrates the effectiveness that results from integration between end users, oil companies, regulatory authorities and manufacturers when developing new products which need to meet a range of requirements. The new Integrated Survival System is expected to be in service during the second quarter of 2002.

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