SPUMS-COMEX MEETING, MELBOURNE NOVEMBER 1980

Dr Joel Griselin, Director of the Comex Hyperbaric Research Centre and Dr Maurice Comet, Operations Medical Officer for Comex Services, visited Australia in November 1980. A meeting was arranged at short notice to be addressed by Dr Griselin.

He gave a short presentation of what Comex is doing, mentioning all their activities. This was followed by a short question and answer session. After supper a film was shown which gave a good idea of the type of jobs Comex is involved in.

Dr Griselin first outlined the Comex organisation. The Comex group consists of the parent company called Comex SA and three sister companies which are Comex Services, Comex Industries and Comex Pro. These companies have different activities all related to underwater work. Comex Services, the biggest of the three, is mainly devoted to underwater work and services. Comex Industries manufactures heavy equipment for Comex Services and also makes equipment for the use of competitors and for the navies of different countries. Comex Pro, the smallest company, manufactures light equipment.

Slides were shown covering the activities of Comex Industries. One slide showed part of a hyperbaric complex with the two main chambers and the console units that had been made for the Argentine Navy. Another slide showed a number of chambers being prepared for off-shore work with Comex or other companies. Another line is small submarines, including lock-out submersibles with a compartment behind the atmospheric pressure sphere where up to four divers may lock out. These submarines also have a mechanical arm that allows manipulation underwater at great depths. They have built another type of submarine, a rather big one, for the Swedish Navy, to recover the personnel of military submarines which have sunk. This can operate in a depth of 600 metres.

Comex Pro manufactures light equipment such as a new helmet which can be fitted with a gas recovery system which can save up to 90% of the gas used by the diver. They also build small compact therapeutic chambers which are widely used all through the world.

Comex Services is the diving arm of the Comex Group. Comex operates all through the world but the general philosophy of the company is to have operational areas. These areas are the North Sea, France and the Mediterranean, Western Africa, the Middle East, Asian-Pacific, Australia, North America and Southern America. Comex tries to have the best co-operation possible with the local companies in order to bring all available expertise together. Comex in Marseilles, where all the information that comes from these areas is collated, is now much more a think tank where expertise is concentrated to back up the different areas. Comex performs between 15,000 and 20,000 dives per year. This is between 350,000 and 450,000 man hours under pressure.

The majority of Comex diving is surface demand bounce diving. If local legislation allows, wet bell bounce diving can be used to go down to 90 metres. For instance, this type of bell was used in the North Sea inside the protective wall that surrounds a concrete platform. The closed bell bounce diving method is used to 120 metres. If the conditions are right, Comex has used bell bounce diving to 240 metres for bottom times of up to two hours.

Saturation diving is used on construction jobs where divers may have to work up to 24 hours a day for many weeks, if not many months. A slide was shown of a huge saturation complex that was built in modules containing eight big chambers and eight small chambers connected together which allowed a crew of 24 divers to work continuously on a large construction job.

Another slide showed part of the control room of a big saturation complex. This showed all the different pneumatic controls that are under the supervision of a chamber operator as well as part of the atmospheric control terminal.

Comex has developed as an underwater constructor or entrepreneur for many years. For this purpose, Comex has developed a number of tools and methods which are not only used by divers. They have an atmospheric pressure bell which is a cross between a diving bell and a submarine. It allows people to go down to 1,000 metres. They are building one which will go down to 2,000 metres. These are mainly used in support of deep drilling operations. The atmospheric bell is equipped with large windows so that the occupants have good visibility. Television or movie cameras can be used through the windows. The bell has manipulators so it can recover all sorts of things from the sea bed or operate valves, etc.

Comex also has a fleet of submarines. They range from very small submarines to huge submarines. These can be built by putting modules together which means that it is relatively simple to produce a submarine for a specific job. It can be fitted with a manipulator, or with special tools designed just for the specific job. A slide was shown of one such submarine which can go to 400 metres. Comex Industries has sold three big submarines to different companies around the world. Some three weeks before the meeting, the deepest lock out ever done, at 210 metres, was performed from one of these submarines.

Comex Industries has built special tools for a given operation. They have constructed a

burying machine which can trench the bottom and bury a cable or a small pipeline at the same time. They have also developed a machine just to anchor pipelines on the seabed. This can fix up to 40 anchors on huge pipes a day.

To enable the firm to accomplish the diving operations and the subsea works requested throughout the world, Comex has a fleet of ships generally owned in joint ventures with ship-owners. Most of these ships have operated in the North Sea or in the Asia-Pacific areas or off Mexico or Africa. The French dynamically positioned vessel Talisman has been doing a lot of work in the North Sea, and was then working in the Gulf of Mexico. Besides small barges and small ships, Comex also works from a specially designed semi-submersible vessel called "Uncle John". This is at the same time a semi-submersible and a dynamically positioned vessel. "Uncle John" has been working for two years in the North Sea and it has been designated as the most efficient ship in the North Sea. Dr Griselin has seen the vessel work in rough seas, up to sea state 9 and 10. It is equipped with two diving bells and an atmospheric bell as well as many wet bells. A slide was shown of "Uncle John" using its capabilities of ballasting to lower a spool piece of 240 tons into the water.

One of the most important operations that Comex performs underwater is welding, either joining pipes or repairing structures. There are two situations where underwater pipeline welding is required. With new pipe, which is just dumped on the bottom, the two ends are sometimes very close together and sometimes very far apart. The operation is to do the "tie-in" of these two lines, which means binding the pipes, aligning them, bringing them together, making the pipe, fitting and welding it, coating it and taking gammagraphs and so on. The other operation is to repair a pipe which has been damaged in the middle of the line. The work is almost the same cutting out one piece of the pipe and replacing it with a new piece. To do this type of work Comex has designed a number of heavy tools. "H" frames which are able to grip a pipe, pull it up and to displace it sideways on the bottom, effectively walking with the pipe. Generally two of these are used in conjunction to roughly align the pipes. When the rough alignment has been made, a small alignment spread which contains the welding chamber is lowered. This alignment spread has two jaws on each side which do the fine alignment of the pipe. With this equipment one can align huge pipes from 36 to 42 inches to within two or three degrees. (Slides were shown of these various pieces of equipment).

Comex has developed two different methods of underwater welding. One is hyperbaric welding where the welders work in a bubble of gas, which is at the same pressure as the sea outside. Divers who are also trained as fitters and welders are sent down to work on the pipe, to align it and the pipe fittings and to do the chambers, one needs to have a very thorough control of the environmental atmosphere. Comex has developed methods so that the welders need not wear any breathing masks. They have developed a refrigeration system or an environmental control unit which can clear the lethal gases which are produced during welding. This unit has been developed as an easily attached and detached module. It can be sent down to the chamber and attached underwater and taken back to the surface if it is necessary to leave the chamber empty on the bottom to avoid a mis-alignment of the pipe when bad weather interrupts diving. The divers and pipe fitters and welders are sent down to these chambers by means of a diving bell. The refrigeration unit, which can be sent down or recovered, has all the energy and all the functions necessary for people to work in the chamber. (The film showed how such a chamber operates, with the people inside joining a pipe and welding). Having the environmental control unit as a module, Comex can build very small chambers or special chambers on request, with the provision for the costly environmental control modules to be attached.

The other method of welding is atmospheric pressure welding. This method has been developed so as to be able to go very deep without having problems related to hyperbaric physiology. A slide was shown of men welding in atmospheric conditions at a depth of 300 metres taken in actual conditions in 1978 in a fjord in Norway. To do such a weld at great depths at atmospheric pressure requires machinery to align the pipes to which is attached a working module which is normally filled with water. This can either be a module to cut the pipe or a module to weld the pipe. The atmospheric transfer module attaches to the top of the working module. Then the transfer module connects to the plexus stem, the working module is then pressurized with gas so that the water is forced out. Once it has been pressurized with gas at the same pressure as the one which exists on the bottom, the working module is then vented through a pipe to the surface so that the inside is at atmospheric pressure. The men can then enter and work in atmospheric conditions. Crews can work up to 24 hours a day on the bottom and they are transferred to the mother ship through the atmospheric transfer module, which may be either a submarine or an atmospheric bell.

Another field for Comex is a non-destructive testing. There are now a lot of structures off shore. Their safety depends on frequent regular inspection and sometimes repairs are needed when defects are detected. Divers use a water jet to clean the wall of the concrete platform just before taking any measurements or any pictures. Divers have to clean the metal of a structure very thoroughly to be able to detect any small defect.

In the field of non-destructive testing, Comex works with a number of techniques and in association with laboratories and universities.

Among the techniques used is the magnetic particles inspections (MPI) technique.

Among other tasks, Comex was requested to recover the cargo of a tanker which sank off the Western coast of France. They had to devise very rapidly a method to recover the oil that was inside the tanker. The problem was that they had many problems to solve at the same time. The tanker was in 100 metres of water, the sea state was very, very rough, the temperature on the bottom was around 6° C and the crude was almost solid at this temperature. They used a dynamically positioned vessel which was in fact a drilling vessel. They injected hot water through the drilling line into the oil tanks. Once the crude oil was liquified again it was brought back to the surface where it was separated and then burnt off. This was in 1978. Unfortunately, another tanker sank off the same coast in 1980. Comex once again has been pumping the crude out of that tanker.

Comex has been involved in deep diving for many years. In 1972 they went to 2,000 feet. Since that time they have placed much more emphasis on the working methods used in diving as well as safety, rather than in trying to go deeper. The Engineering Department, the Diving Method Department, The Medical Department and the Safety Department all work together in association with universities as well as with foreign laboratories. This work is mainly conducted in Marseilles at the hyperbaric centre.

Comex has a big chamber called the hydrosphere, 5 metres in diameter, which can be filled with water up to the midline. The water can be cooled to minus 10°C. The conditions inside this hydrosphere can simulate exactly those in the North Sea as a welding chamber, with regard to the humidity, the gas and the temperature. There is a huge double lock which enables them to take big pieces of pipelines up to 42" in diameter in and out of the hydrosphere. A slide showed another part of the hyperbaric centre, with the two deep spheres where most of the deep experiments have been conducted in the past. The third wet pot was not visible in this picture taken during the preparation for the Janus 4 operation. There is also another chamber which is rated to 1,200 metres and where Comex conducts a lot of experiments in physiology, mainly on monkeys. In addition, there is a big sphere rated for 5,000 metres which is used for experiments on equipment.

Most of the experiments conducted in the hyperbaric centre are physiological. Comex works with universities or with foreign laboratories. At the same time, Comex is developing methods which are to be used when diving, such as welding at 450 metres. During the Janus 4 experiment, men performed work at 160 metres and also went to 500 metres. This was an actual operation in the open sea. One of the tasks that they had to do was cut a piece of pipe and to make a connection with another piece of pipe. The working table was lowered down to 500 metres and the divers had to cut the pipe and make a connection. They had to do mechanical cutting, oxy/cutting, and some welding. Of course this was in-water welding and Comex was testing the ability of the divers to do the job and at the same time testing some pieces of equipment.

Question

Do you see hyperbaric welding in an atmospheric environment replacing hyperbaric welding in a pressurized environment within the foreseeable future?

Dr Joel Griselin

People are always asking if divers will be replaced in the future, if methods of working underwater at ambient pressure can be replaced by methods which can be done either automatically or by remote control or at atmospheric pressure. Without any doubt I think that in the future deep operations, common operations, will be done either by remote control vehicles or by automatic means and also at atmospheric pressure. But for a while I think that divers, as well as work done under pressure, will still remain a very good way and an efficient way and a cost effective way to do operations. We have been developing sub-sea wells and different systems which allow atmospheric intervention in these systems. I would say that very deep welding or deep welding on pipes will be done in the future at atmospheric pressure. I should also say that in the near future we will still stick to hyperbaric welding on structure repair but a little bit later we will have atmospheric welding on structure repair.

Question

What about the medical aspects of Comex research?

Dr Joel Griselin.

On our own or in conjunction with other laboratories, we are researching many subjects in physiology. One of the main subjects is research in the field of thermal exchange underwater. We feel that the thermal problem underwater, especially at deep depths when breathing helium, is a very big problem, and that perhaps it has not been looked at in the past and that one should have done it. So we are looking at this problem from the point of view of the physiology and from the point of view of the technical solution that one might use when diving at great depths and in cold water. Another subject which we are studying and which also pertains to safety, is fire hazards in hyperbaric environments. As more

and more welding is performed underwater in hyperbaric environments having an increased partial pressure of oxygen, there is a higher fire risk. We are performing some experiments on how to fight a fire efficiently and rapidly without putting the divers in danger from toxicity of the products that we might use to control the fire. A certain amount of research in pure physiology is being conducted on drugs and their efficiently for the treatment of decompression sickness. We are now at a stage where we are using rabbits and miniature pigs for these studies and they seem very promising.

We are also studying very deep diving. In order to have a systematic approach to deep diving, we are experimenting with monkeys. We are systematically studying all the parameters that might appear to have an influence on the high pressure nervous syndrome not only during the compression phase but also during the stay at pressure where some problems seem to appear during a long stay around or deeper than 1,000 metres.

Other research is being conducted in the range of 450 metres. At present Comex is experimenting with fast compression between 180 metres and 450 metres. The other research is mainly concerned with the effects of a long stay under pressure. We will have a dive in January 1981 where people who have been selected according to different criteria will be subject to thirteen days at 450 metres. There are other research subjects of less importance. During this 450 metre dive there will be neurophysiological research. Among other things we will be using electro-encephalography in relation to evoked potentials. Also there will be some research on other reflexes. There will be research on respiration, on the modification of the blood components as well as modification of the fine chemistry of the body. We have a large medical research programme during these experimental dives.

Question

What sort of therapeutic facilities do you have with each offshore set up?

Dr Joel Griselin

At each offshore set up we have at least a recompression/decompression chamber which is to be used as soon as possible when an accident happens offshore. That is the minimum equipment, but what is most important is the routine to be used. One must act very rapidly with the patient so as to put him in a situation where the effect of recompression, the effect of oxygen and the effect of drugs is as efficient as possible.

After supper, a Comex film was shown.

The film was about work on a pipeline in the North Sea. The situation was that there is a big gas line going from the oil fields to England. In the middle of this big trunk line there is a pumping platform, MCPO 1. An oil company (Occidental) wanted to flare gas from a field called Piper. However, the British government refused to allow an increased oil output unless the gas was not burnt. The gas had to be sent to the trunk line and so to England. So a line was placed between the Piper field and MCPO 1 to be fed into the big pipeline.
Comex was asked to make the riser connections. The line had been laid in 100 metres of water to the platform. Comex had to make the complete riser to the platform. One of the snags was that these big concrete platforms have anti-scouring walls. These are big walls. Also, inside these there is a wall with big holes in it at the surface to break the wave action.
The riser had to jump over those bottom walls, go along the outside wall of the platform, go through the pierced wall and then get inside the platform itself. All the pipe connections had to be done by hyperbaric welding. Two risers were prefabricated and brought to the platform. Heavy lift cranes were used to position the huge lengths of piping. One riser was installed within the perforated wall, the other riser was installed outside the wall down to the sea bed and connected to the pipe line. There were two hyperbaric welds to be done, one at 100 metres and one at 25 metres. The hyperbaric welds were done using a small welding chamber with the modular environmental control unit. On a number of occasions, the modular unit was disconnected when bad weather prohibited further operations, only to be rapidly reconnected when the weather improved. This allowed the pipe alignment to remain unaltered while not risking the costly environmental control unit with its umbilical connections. The film was made to show what Comex achieved. All this work was done on a lump sum contract. As one of the Comex representatives said, a lump sum contract has big advantages if the job goes well, cleanly and properly, then it makes money for the contracting company. If mistakes occur, the company goes down the drain!

DIVER SELECTION AND TRAINING, 1885

ZWS Moerkerk

This is extracted by kind permission of the Secretariat of the Safety and Health Commission for the Mining and Extractive Industries, from Mr Moerkerk's paper "Training the professional diver for inland-inshore operations", at the International Symposium, Luxembourg, October 1980.

They say that it all started in the era of Alexander the Great, who is said to have gone down in a diving bell around 330 BC to inspect the progress of his divers working in the harbour of Tyre (Lebanon). It was about 2,200 years later, in 1885, when the first diver went down in our company, then called WA van den Tak and now, Smit Tak. They were using the Siebe Gorman hard hat equipment and air was supplied to the diver by a hand pump. I can imagine that these divers at that time were observed in the