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Editorial

ARE WE TAKING OURSELVES TOO SERIOUSLY?

A YOUNG man in a fit of rage murdered his father and mother and at his trial he asked for leniency on the grounds that he was an orphan! He took himself very seriously.

It may be my age but in recent years it has been very noticeable that a significant number of the so called midpiece officers of the Corps seem to have the cares of the world on their shoulders and seem determined to be miserable. "A crown! What is it? It is to bear the miseries of a people"—Hannah More. In civilian life the equivalent group of engineers seem to be suffering from the same disease.

There must be a reason or combination of reasons for the malady. Military Engineering is a serious business, but surely there must be some fun in following a chosen profession. It may be that military engineers are worried about their future, it may be the demands of the pace of life nowadays, it may be increased awareness of responsibilities or that we are shielded from responsibility for too long in our youth, it may be the inability to "switch-off" at the end of a working day and relax. It is difficult to believe that the basic cause lies in these areas. There must be a more deep rooted reason.

Is it that military engineers are taking themselves too seriously? Is it that we are becoming too professional? Are we making a twenty four hours a day, seven days a week, fifty two weeks a year job of peace (?) time soldiering. I believe that the latter two "possibles" are dependent on the first "probable" and that we are taking ourselves too seriously. Brigadier Henniker, in his letter published in the March *Journal* commented on engineers "who bemoan their status". Many articles and letters in professional Journals and Magazines follow a depressingly similar line. Status! status!! status!!! Are we taking ourselves too seriously?

It may be that because of the current attitudes we are allowing some of the fun to go out of our lives, that our way of life is beginning to lack fun, flare and style. I hasten to exclude 63 Young Officer Course from this condemnation. On Thursday 24 February 1977 the doors of the Dining Room in RE HQ Mess opened for the first meal for Mess Members after the disastrous fire some fifteen months earlier. 63 YO Course, based at Chattenden, rose even earlier than usual and travelled over for the occasion. They were determined to make some gesture to celebrate and to enjoy themselves. They had champagne, bacon, eggs, mushrooms, kidneys and all the trimmings! They didn't take themselves too seriously!

It may be that the "old and bold" look back through rose tinted spectacles but I would suggest that the old and bold and the young have more in common with each other than they have with the "in-between". At least we have fun and do not take ourselves too seriously!

This issue of the *Journal* has been increased to eighty pages. The Editor was faced with the problem of an embarrassment of "riches" and some slightly longer than usual, but very good, articles. To maintain the seventy-two page format would have made a "nonsense" of at least one article. In particular your attention is drawn to the "lead" article on the Restoration of the Dining Room in REHQ Mess. The restoration has been quite amazing and all who were involved in the work are to be congratulated.

Restoration of RE HQ Mess

ON 3 December 1975 a disastrous fire broke out in RE HQ Mess which severely damaged the Dining Room and Kitchens. The work of restoration is now completed. The restoration was well planned and well executed by people who really cared. Three of those involved were invited to contribute articles describing their part in the work. This is not intended as the complete story but to show some of the problems which were faced and overcome.

The Fabric

J R BROWN, OBE, C Eng, FI Mun E, FI Nuc E
AREA WORKS OFFICER

ON the morning of Wednesday 3 December 1975, I was making my way to the office when I heard over the car radio that a fire had taken place at the Officers Mess at Brompton. I immediately went there and on arrival went into the Dining Room and spoke with the Fire Brigade Chief and our own Fire Officer. The source of the fire was thought to be in the single storey link between the 18th century building and the new kitchen block which had been constructed in the late 1960s. The link and its basements had been virtually destroyed. Although the fire had spread slightly into the kitchen it had not caused any visible damage to the structure but the equipment would require to be completely overhauled and renovated.

In the other direction the fire had spread into the Dining Room and was of such intensity that it melted the chandeliers and spread into the roof trusses although the slate roof did not appear to be badly affected. Obviously extensive damage had been caused to the ornamental plaster, heating and ventilating systems and the electric installation, but the maple floor was protected by a fire-proof carpet which bore the brunt of the damage and penetration of water. Plans were prepared giving a rough indication of the damage caused in the various areas of the Dining Room. It was fortunate that the big doors into the Conservatory had been closed otherwise the Conservatory, Ante Room and Silver Display would have been seriously damaged. It was gratifying to note that the Fire Brigade was withdrawing and arrangements for the cleaning-up were being organized by the Mess Staff together with help of Unit Personnel.

From the works point of view it was apparent that the work would have to be carried out in phases:—

(a) To clear out the debris

(b) Make the building safe and weatherproof, this work to be put in hand immediately on completion of (a)

(c) To have the building structurally surveyed to ascertain the scope of the structural reinstatement work that was necessary. This, combined with internal surfaces and services comprising the remedial work, was estimated to cost £100,000.

It was necessary to provide some temporary kitchen and dining room facilities in the undamaged portion of the Mess whilst work on the restoration was being carried out. The Regional Works Officer from Headquarters Hastings visited the site and we had a meeting of the "Ways and Means" Committee to decide how the restoration work would be carried out. The Director, Defence Services 1, had indicated that it was highly likely that reinstatement of this magnificent building would be authorized, particularly in view of the environmental aims.

A Term Contractor was entrusted with the work of making the building safe and carrying out the construction of a temporary kitchen in the basement. The matter was discussed with the Commandant and it was agreed that the object was to provide facilities for the thirty living-in members. It was decided to provide a temporary

kitchen in the cellars and to convert the old Billiard Room into a Dining Room. This work was carried out by the Term Contractor and was available for use after the Christmas break.

As soon as the cleaning-up work was completed, tenders were invited, contractors were interviewed on site and shown the work involved. On 11 February 1976 the tender was let to Messrs Leggetts and work commenced on 22 March 1976.

Our brief was that we should endeavour to restore the Mess to its original condition using 1976 methods. Many branches of the MOD and PSA Departments were involved and worked in harmony and in complete co-operation. We received excellent guidance on the finishing colours from the Director of Ancient Monuments and other members of his staff.

The finishing trades included ornamental plastering, french polishing, floor laying and polishing and many others. It was a delight to see the skilled tradesmen at work. After months of hard work by very many people the Officers Mess was finally handed back on the 7 February 1977. The Mess, in their usual generous way, invited all the workers to a "Topping-Out" Ceremony which took place at lunch time on the 18 February 1977. Finally I would like to pay tribute to the Mess Secretary and the Mess Staff who went out of their way throughout to be helpful.

Photo 1. The Dining Room on morning of 3 December 1975. In the corner, behind the pillar in the centre of the photograph, is the door to the single storey link. The damage to the ceiling and plasterwork is clearly seen.

Ceiling and Decorative Plaster Work

L TOMKINS ESQ, PAN STUDIOS, BROMLEY

IT was with an immense feeling of pleasure that I heard the decision of the DOE to accept our tender for the reinstatement of the decorative ceiling in the Officers Mess at Brompton Barracks which had been destroyed by fire some six months earlier. It would not be an easy task but it offered a challenge and the prospect of much personal satisfaction.

When I first visited the site, the task appeared somewhat daunting. It was with mixed feelings that I surveyed the extent of the damage and appraised the situation (Photo 1). There were no plans, drawing or photographs to assist us. The time factor was impressed on us as being most urgent, we had twenty weeks to complete. Little wonder that the Officers seemed quite convinced that it would be impossible to restore their "Mess" to its former glory, even the officials of the DOE did not appear over-confident with our assertions that the final result would be a replica of the original!

On commencement the first, and most important, task was to make a detailed drawing with accurate measurements of every section of the ceiling. Every item was checked and double checked as any mistake at that stage would have been disastrous. The next problem was to cut out, where possible, sections of the different mouldings, and to carefully number them and cross-reference each with the detailed drawing.

It was likely in view of the deterioration of the plasterwork due to its age and as a result of the fire, that the sections would crumble as we attempted to remove them, so we decided to photograph each piece beforehand. Our fears were justified. In one particular instance, all the intersections but one of the decorative circular bands on the main ceiling had been destroyed. We photographed it with the intention of returning the following day to try and remove it in one piece. Unfortunately for us, the workmen on site started work on the joists above and the vibrations dislodged it. It was scattered in small fragments on the scaffolding. The pieces were carefully collected, and with the help of the photograph our craftsmen, using clay, rebuilt and remodelled the complete intersection (Photo 2). Most of the sections did in fact disintegrate when we tried to remove them, and in these cases, plaster casts or "squeezes" were made in situ.

After the scaffolding had been erected, the decorative moulding set on the cove running around the main hall together with the main cornice below, as well as the arches and window mouldings, (all of which had been scheduled for repair by the main contractor), were found to be too badly damaged and would have to be replaced. This doubled the amount of work which had to be done. It was in no small part due to the complete co-operation of Mr Ellwell and Mr Crapnell of the DOE that we were able to complete the whole contract within two weeks of the original date despite the extra work.

Our next task was the knocking down and clearing of the remains of the old ceiling, and this was undoubtedly the dirtiest job in which we had ever been involved. For three days we worked with masks on in the thickest "smog" imaginable. The original ceiling had been formed in situ by nailing wooden laths to the joists and hand plastering over. The nails "numbered thousands" and had been hammered in all over the lower surfaces of the joists at barely half inch intervals; the job of pulling them out seemed unending! We consoled ourselves by thinking of the workers who had to hammer them in in the first place!

The new ceiling was made in sections of approximately six feet by five feet at our works using laths, plaster, and scrimcloth; they were transported to the Mess; manhandled into position and screwed to the joists. As we had anticipated, the joists were by no means level, and the process for levelling the complete ceiling was long, slow, and tedious. The floor boards on the top of the joists had to be removed (and they were well and truly fixed). The screws holding the sheets in position were then

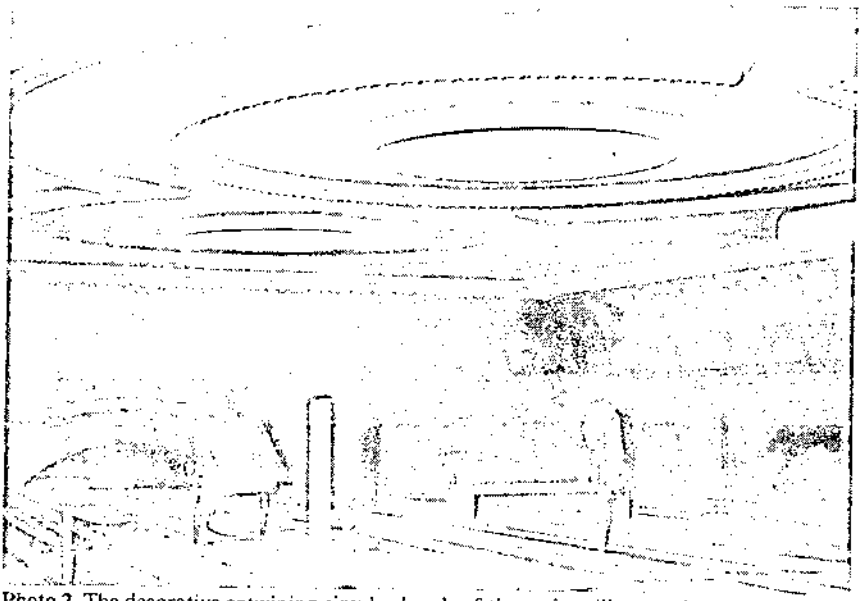


Photo 2. The decorative entwining circular bands of the main ceiling nearly completed. The "V" on the left is one of the intersections referred to in the text.

loosened, and by using long wooden levels and placing wedges between the sheets and the joists, the sections were eventually evened up. All the wedges had then to be wadded into position and the floorboards replaced. The spaces had then to be wadded and filled, and finally the whole ceiling checked for abrasions, surface cracks etc which were all filled and smoothed put.

The majority of the remainder of the work needed to be done in the works. Skilled workmen painstakingly removed the charred paint from the damaged sections of the different mouldings; the sections were repaired and remodelled; rubber or glass fibre moulds were then made, depending on the "undercut". Casts were then taken and the process repeated until perfect moulds were obtained from which the final casts were made. These were then cleaned, sharpened, and stacked ready for removal to the site.

The work involved is more easily understood if we take a particular item, in this case the decorative band which runs on the face of the main ceiling adjoining the cove (Photo 3). It is of a plain moulded format with an intricate floral pattern running along through the centre. A cast of the band without the floral section was made on site, and a short section (12in), of the damaged floral moulding was carefully removed and taken to the works. From the cast a drawing was made and a zinc profile cut with a projection in the centre which was to form a rebate to take the decorative moulding. A core of approximately ten feet in length was formed on the workbench, and using the zinc template, a pattern was run in fibrous plaster matching the original. The charred paint was then carefully removed from the section of the floral moulding. It was repaired and remodelled and a rubber mould made, from which a dozen casts were taken. These were carefully inserted into the rebate, and blended together by the modellers to form an exact mock up of the original bands. This was then coated with shellac in order to seal it. After drying it was covered with paper and ⅛in of clay was carefully layered over the top. A case covering the whole section was then made in plaster. When dry, the case together with the clay and paper was removed. Holes were cut and drilled in the case to take funnels for pouring in the hot rubber and to create air outlets. The case was then carefully located back over the pattern, screwed and sealed down, and the rubber mould poured. Casts were

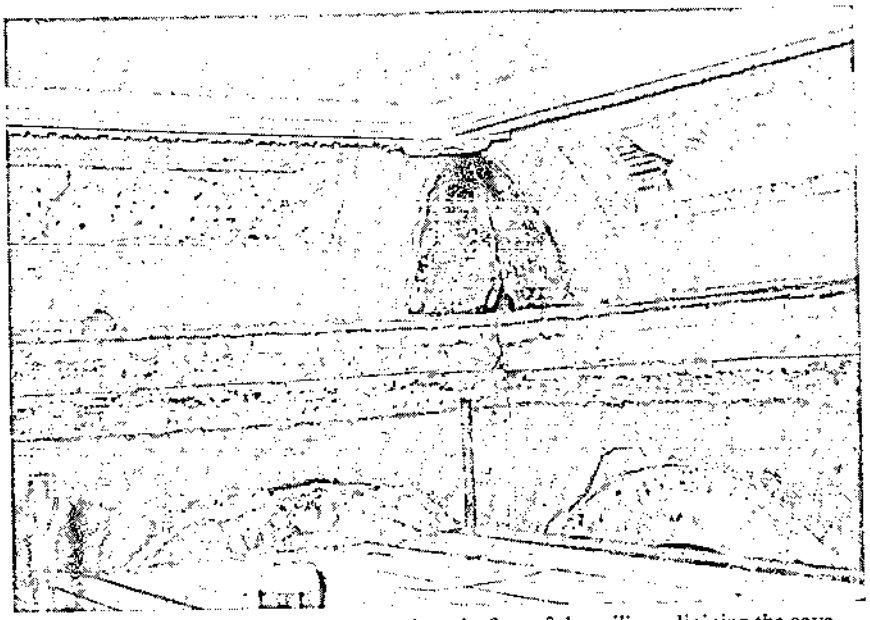


Photo 3. The completed decorative band on the face of the ceiling adjoining the cove

then taken from the mould, cleaned, sharpened up, and stacked for transporting to the site.

Except for three "saucers" all the work was executed in fibrous plaster. The three "saucers" which fit in the centre of the moulding in Photo 2, above the chandeliers, had to be kept as light in weight as possible. They were fabricated in glass fibre which was specially treated and painted to match the colour and texture of the surrounding ceiling.

The Dining Room, like most rooms is not "square". A great deal of time was spent viewing the whole from all angles at floor level before final fixings could be made.

The decorative entwining circles on the surface of the main ceiling were probably the most difficult item of all, particularly at the intersections where a lot of adjustments and remodelling was required on site. The large decorative panel on the small ceiling behind the main hall was also complex, fortunately we were able to form this on the workbench and could fix on site.

We felt somewhat saddened as we drew near to the end of the contract. It had afforded us a lot of satisfaction and pleasure as each section was fitted and completed. We hope the Officers of the Mess will enjoy looking at the completed work as much as we enjoyed executing the restoration of their ceiling and decorative plasterwork.

The Portraits

MICHAEL LESLIE ESQ, PICTURE RESTORER, BRASTED

With technical notes by James Wray

ON 4 December 1976 I received a telephone call from the Mess Secretary who told me the sad news that the Officers Mess at Brompton Barracks had been badly damaged by fire and asked me to come as soon as possible to inspect the collection of portraits that they had managed to save.

The following day I witnessed the scene of devastation. The once magnificent Dining Room was reduced to a blackened shell, the great chandeliers lay in gro-

tesque heaps on the floor, plaster hung in folds from the ceiling and worst of all four frames hung empty, their portraits totally destroyed. From there I was led to one of the ante-rooms where the paintings which had been rescued had been taken. The portrait which came immediately to my notice was of the Queen painted in 1972 by Narroway. Only a few months previously I had relined this painting as a result of some minor damage caused in transit from an exhibition in Tokio. As it was only three years old, and therefore the paint layer was still fresh, it had not only burnt right through, but paint had also run in rivers down the entire surface. It was quite clear that the picture was beyond redemption. A great shame but at least the painter was still alive to replace it!

The problem was the remainder of the portraits which were all painted before the turn of the century. They were of Lord Kitchener, The Duke of Cambridge, Prince Albert, Queen Victoria, Lord Heathfield, Lord Napier and most important of all, Chinese Gordon.

On close inspection the paintings, although subjected to intense heat, survived remarkably well with the exception of Gordon. The reason why all the other portraits had escaped relatively unharmed in comparison was due to their substantial layer of varnish which had been applied many years ago and this protected the paint layer from the worst effect of scorching. The greatest problem was Chinese Gordon. At this time I must admit I did not realize the special significance of this picture to the Royal Engineers.

Before continuing with the description of the restoration of these paintings, it may be of interest to those who are not acquainted with the anatomy of oil paintings and the basic modern techniques of restoration methods to read the following descriptions:—

(a) An oil painting is a complex sandwich of different materials. There are four main types of support: canvas, wooden panel, copper and millboard (paper mache panel). Generally speaking before 1480 easel paintings were always painted on wood. However, progressively after this stage canvas became increasingly popular, not only because it was cheaper but also it is more tolerant towards changes in temperature and humidity. Copper is almost entirely confined to the Dutch and Flemish schools used between the late 16th and the latter part of the 18th century. Millboard was used in the late part of the 18th and well into the 19th century.

(b) The average old master painting of say the 17th century painted on canvas was constructed as follows:— The canvas, having been strained over a stretcher, was coated with a glue size acting as a sealer. Then the ground would be applied. This was either gesso, a mixture of chalk and size made from animal skins, or white lead. That having dried, a coloured wash was often painted on taking away the forbidding white glare of the ground. Onto this the basic outlines of the picture would be added. From then on the painter would add form, light, and shade, increasing detail all the time. He would reach a point when the picture looked almost finished but looked strangely opaque. This was the completion of what is called the dead painting. The next stage involved the application of the glazes. These are colours essentially transparent like dark blues, reds, greens and browns that, when diluted and applied over dense, opaque colour, gave great depth and luminosity. A large part of the magic of the old masters lies in their use of glazing, a skill understood by few painters today. The painting was finished and allowed a year or so to dry and finally a coat of varnish was applied to provide a protective film and also to bring out the true colour value in the picture. This is only the simplest of descriptions of the anatomy of a picture. Diagram A shows a cross section through an oil painting and gives an idea of the various layers.

We now come to the restoration of oil paintings which as a profession did not really emerge until the beginning of this century. Before that time restoration of a very basic kind was generally carried out by painters themselves. Some of the methods used were damaging to the pictures, for instance cleaning with marble dust or caustic soda. Another misconception of the time was the idea that early paintings

should have a "golden glow". This was in reality a darkened varnish sandwiched with wood smoke and grime. To maintain this appearance a cleaned picture would sometimes be covered with a tinted varnish. However, in informed circles it became increasingly clear that this concept was false and the old masters enjoyed painting in beautiful and often bright colours. With this thinking also dawned a more responsible attitude towards the structural conservation of paintings, which is now considered to be of prime importance. Progress in restoration has been greatly advanced by modern technology, for example the knowledge and use of solvents, radiography, spectography, and the various methods of lining.

A painting presented for restoration is examined to assess:

(a) the stability of the paint layer

(b) the condition of its support, ie canvas and stretcher, panel, copper or millboard

(c) detection of earlier retouching or overpainting

If a painting is found to be lifting from its canvas support, then a new backing is adhered to the old canvas by a process known as relining (described later). Small holes or tears in an otherwise sound canvas can be mended by applying a waxed patch of canvas with a heated spatula. The wooden support of the canvas known as a stretcher sometimes weakens with age and has to be replaced. Flaking paint on a wooden or copper panel or on millboard backing is re-adhered by the injection of melted wax. Wooden panels are sometimes found to be infected with woodworm, these are injected with an appropriate insecticide. The main damage found among panels is a tendency for them to split or warp. This is remedied by either battening or cradling, the latter being a network of crisscross spars so arranged to allow the natural expansion and contraction of the panel but to prevent warping.

Once the painting is structurally sound cleaning can be carried out with appropriate solvents in the following stages:—

(a) Removal of surface dirt

(b) Removal of varnish

(c) Removal of retouchings

This is often aided by the use of radiography or filtered ultra-violet to detect original paint which may have been covered by later overpainting.

This being done, any areas of deep paint loss must be filled with a type of putty to give the picture an even surface before any retouching can take place. Pigment analysis by spectography of the paint surrounding an area of paint loss can give great assistance in accurate retouching by enabling the restorer to use the correct pigments.

The painting is now revarnished and the process of retouching, ie the exact replacement of paint loss can begin. Some paintings, through earlier overcleaning or age, have become worn. In this case it is not the restorers work to repaint the picture but a well considered reconstruction may be carried out rendering the painting visually correct without entering into deception.

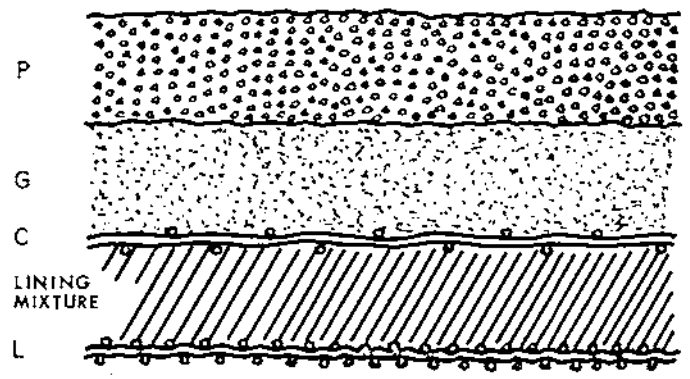
Returning to the work in hand, after the close examination of the paintings I submitted my report describing the degree of success we were likely to achieve with these portraits. The one exception was Chinese Gordon. This painting was not protected to the same extent as the others by a thick varnish. The heat had penetrated through the paint layer and horrifying blisters considerably worse than on the other paintings lay in great mounds over the entire surface. In my report I suggested that the picture was probably a write-off.

Shortly after submitting this I was discussing the various problems of the fire damaged portraits with my father, a keen military historian. When he was told that I thought Chinese Gordon was beyond redemption he became most concerned and explained that the picture was unique and at all costs must be preserved even as a scorched relic. To be truthful, until this moment I had not realized the importance of the picture, so I phoned the Mess Secretary and asked to examine the painting again. After this second inspection and some head scratching I reported to the Corps that we would somehow preserve Gordon and present him in a viewable state, which was at least better than the prospect of a rather dead looking copy.

Shortly after this we got the go-ahead for the work. The portraits arrived in the "ration wagon". The first problem was to photograph them and due to their size this could not be done in my studio. So on a bitterly cold February day they were photographed on the village green, much to the fascination and bewilderment of passers-by.

After this our work started in earnest, the first stage was to prepare the paintings for relining. This involved the laying of the worst blisters by injecting wax and gently ironing with spatulas, then removing the worst effects of carbon deposits on the surface. The next stage involved a highly skilled process of vacuum lining. This work was carried out by James Wray, a leading expert in this field and the following description of this process and treatment has been written by him.

DIAGRAM A: SECTION THROUGH AN OIL PAINTING ON CANVAS.



P. Paint layer (various pigments suspended in linseed oil or poppy oil with the addition of drying oils and resins)
G. Ground or priming (usually lead white in linseed oil or chalk in size or emulsion of both)
C. Original canvas
L. Lining canvas

The lining of oil paintings on canvas

A *Aims*

(1) To re-affix areas of flaking paint (layer P) and ground (layer G)
(2) To lay blisters of paint caused by burning of the paint layer
(3) To repair tears or holes in the canvas (layer C)
(4) To add support to damaged, partly rotten, or brittle canvas
(5) To flatten disfiguring craquelure and buckled canvas
(6) To achieve the above, using materials which are easily removed for the benefit of future conservators.

B *Techniques employed to achieve above.*

(1) & (2). Flaking or blistered paint is re-affixed by manipulating a warm wax/resin (see note (i)) mixture between the layers P, G and C with an electrically heated spatula resembling a soldering iron with a large "foot".

By applying hot wax/resin in this way, not only adhesion but impregnation is effected which consolidates the ground (layer G) by replacing the original animal glues where partial or total breakdown of the adhesive qualities occurred.

(3) To repair tears, wherever possible broken threads are darned together and fixed with a minute amount of glue (see note (ii)).

(4) To support the degenerating canvas it is necessary to stick another canvas (L) to it's reverse, using a wax resin mixture.

(5) To flatten the painting and effect adhesion and impregnation a vacuum lining table is used.

(6) All materials used are easily soluble in mild solvents.

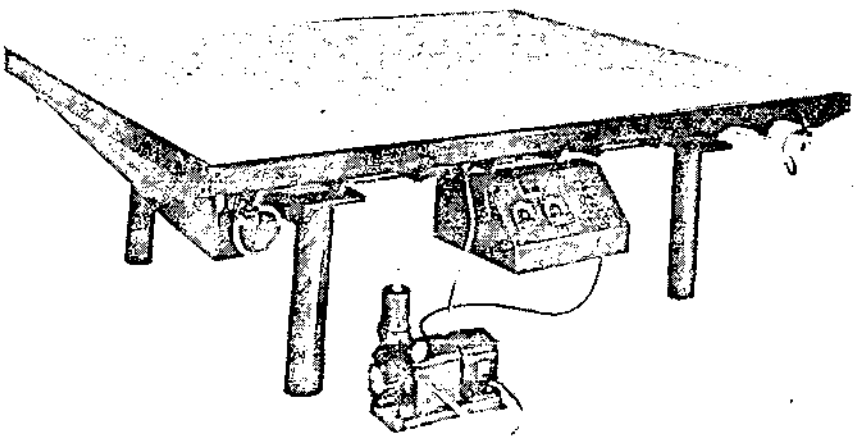


Diagram B. The Vacuum Lining Table.

Method

Firstly loose, flaking or blistered paint is attached as in (B 1 & 2). Secondly the painting is faced by sticking tissue paper or papers with melted wax to the surface in order to protect it from abrasion and to hold paint and ground together in the event of further flaking or damage during the next operation.

If a painting has previously been lined, this would have normally been done using an animal glue and flour paste ("compo") between the original canvas and the lining canvas (L). The painting would have been ironed first with a hot, then with a cold iron. This old lining must be removed completely to facilitate the impregnation by wax/resin during the lining operation. Scraping or dissolving with water are the methods employed to do this.

Next, any tears are attended to on the reverse. Then the wax/resin mixture is applied to the original canvas (C) and to the new lining canvas (layer L) and the two are tacked together using a warm iron. The "facing" is now removed using white spirit or other suitable mild solvent.

The painting is now ready for the lining operation which bonds all the various layers together.

The Vacuum Lining Table

This is a large aluminium bench which is heated to the melting point of the wax/resin mixture using thermostatic control. Holes have been drilled through the surface and attached to a vacuum pump. (see Diagram B).

The protection of the natural texture of the paint film is at the very centre of

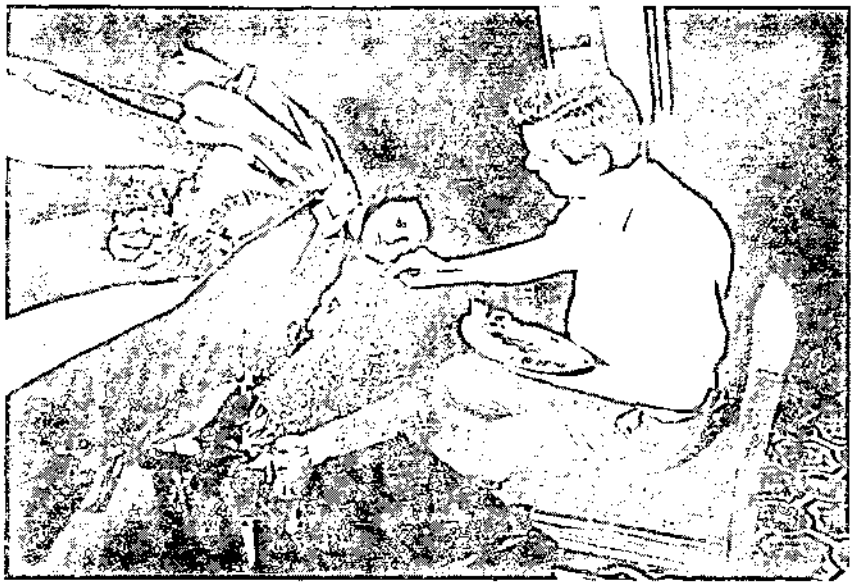


Photo 4. Michael Leslie at work on "Prince Albert".

picture lining technology. The way the lining table is "laid" with the painting varies, depending upon the materials used, the actual texture of the paint and even the texture of the original canvas. Basically though, two methods are used.

First a sheet of non-stick plastic film is placed on the surface of the table. In the first method the lining canvas is laid on this with the painting face uppermost on

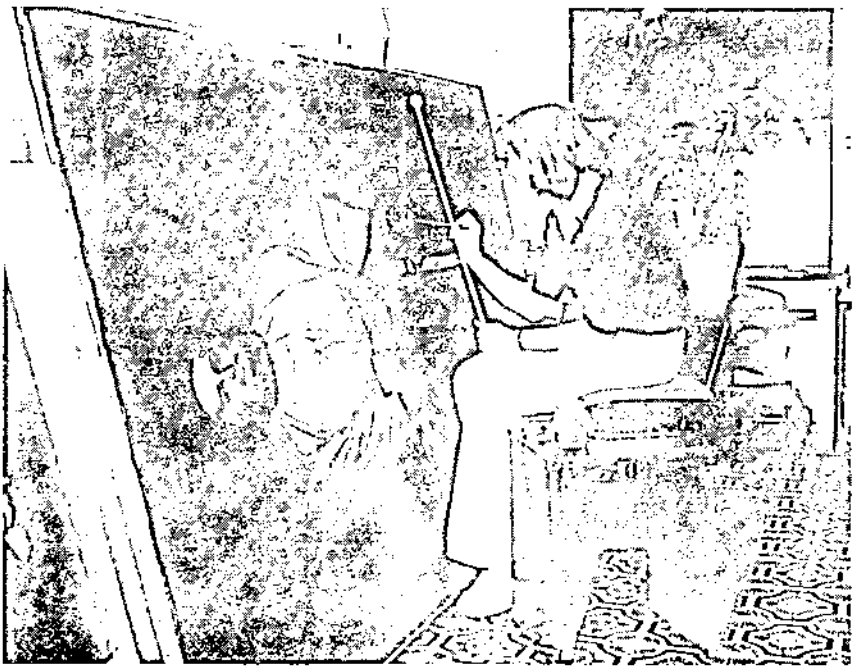


Photo 5. Jill Airey at work on "Gordon", "Napier" in the background.

Photo 6. Jean Kentish at work on "Prince Albert".

top. In the second a layer of suitable padding material is laid first, this is to prevent the crushing of highly textured surfaces. On this is laid the painting face downwards with the lining canvas on top. Finally whichever method is employed another layer of plastic film is layed overall and the whole thing sealed at the edges to the table, usually by clamping.

The table is now heated to the required temperature whilst the vacuum pump expels air from beneath the layers on the surface of the table. This causes partial vacuum (see note iv) and spreads atmospheric pressure evenly over all the undulation of the painting, thereby squeezing the various layers together without the disadvantage of a mechanical press which would apply more pressure to the thicker parts and less to the thinner. The table is heated to the temperature necessary to liquify and impregnate the wax/resin mix through all the layers. On reaching that temperature (see note (iii)), the table is cooled by fans whilst the picture is held under pressure, thereby solidifying the wax/resin mix and holding the canvasses flat. Once cooled, the painting is cleaned of surplus wax and the process of cleaning and restoring can continue.

Notes. (i). Various recipes can be used from refined beeswax plus gum Dammar, Micro crystalline waxes plus synthetic resins of the MS 2A type, to the more recently developed mixtures based on "hot-melt" Ethyl-Vinyl-Acetate adhesives. The condition and structure of the painting determine the mixture to be used.

(ii). Poly-Vinyl-Acetate based glues, although some conservators use Epoxy resins of the Araldite type but these are of course insoluble in the "safe" solvents used in picture cleaning.

(iii). Beeswax mixtures generally melt between 57°C–63°C. The micro crystalline waxes at higher temperatures.

(iv) Negative pressure of between 10in of Mercury and 25in are used depending on the painting and wax mixture used.

Returning once more to the job, all the portraits were delivered to James Wray's lining studio with all the major blisters re-layed. He set to work removing the old linings, a long tedious job as these linings were often attached with furniture glue. After this he applied a coat of wax adhesive to the back of the original canvasses and put each painting in turn on the vacuum table. This was set at low heat and vacuum

and had the effect of laying back all the thousands of little blisters. Under the negative pressure all the air was sucked out of them and they all relaxed back, leaving very little trace of disturbance. We then cleaned the pictures, removing the thick varnish that had saved the paintings from destruction.

Photo 7. "Gordon" before restoration.

This operation being completed the portraits were relined in the manner described by James Wray. All had responded wonderfully well including the portrait of General Gordon. Although this picture was very pitted, cleaning proved far more successful than at first had been thought. The upper part of the picture had suffered

Photo 8. "Gordon" after restoration.

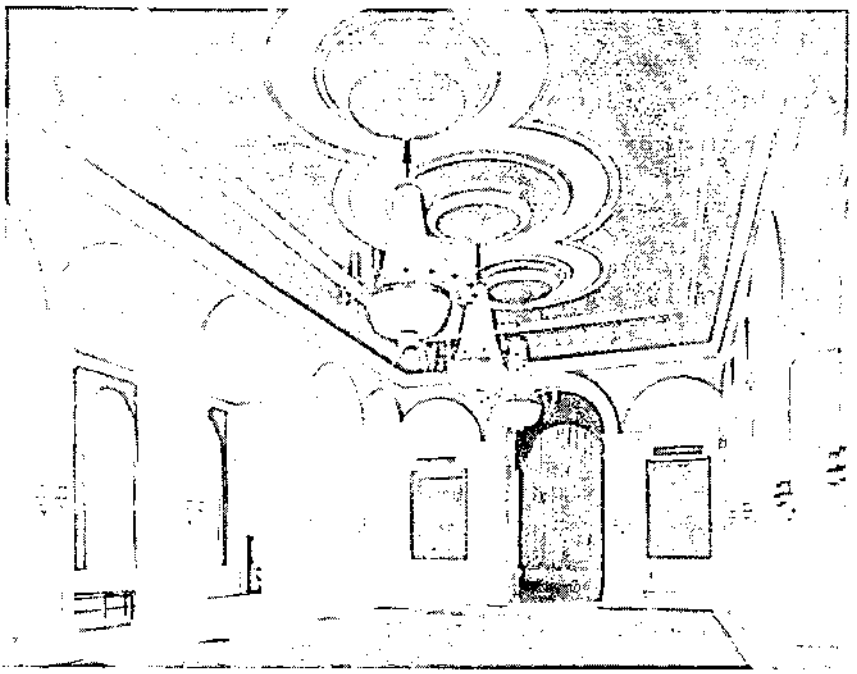


Photo 9. View of restored Dining Room taken from same angle as Photo 1.

through the intense heat and there was a colour change resulting not unnaturally in a rather tanned appearance, but all the features were intact.

The portraits were returned one by one causing great disruption in my studio. This being on the first floor of our building the banister of the staircase had to be removed. All the paintings were over 7ft 6in high and our ceiling height is 7ft. This meant that the restoration work was carried out with the pictures on their sides.

The pictures at this stage were perfectly flat and cleaned but there was one further problem. In the fire many of the blisters had burst, leaving literally hundreds of small areas of paint loss. We set about filling these small craters with a special cement to bring them up to the correct level. Then the entire paint surfaces were re-varnished, bringing out the true colour value. After this started a long and pain-stating task of accurately retouching these areas. This took weeks of work but was marvellously rewarding, especially in the case of General Gordon, seeing his features coming alive again.

By the middle of May all was finished and the "ration wagon" came and collected the seven portraits. A few days later my two dedicated assistants Jean Kentish and Jill Airey and I came over to the Mess and carried out the repairs of the frames and fitted the paintings back into them. This work was made all the more enjoyable by the splendidly stirring music provided by no less than four mass bands. At first we thought this was put on for our benefit but later learnt that apart from this they were practising for a very important parade for the following week!

On 18 February this year we were invited to the "topping out" luncheon at the Mess and met all the many other people involved in the re-building of the main Dining Room. We were astonished to find everything finished and simply could not believe the result. Our work simply fell into place with all the other skills employed. The fabulous new plaster mouldings on the ceiling faithfully copying the design of the original, the reconstructed chandeliers, the specially made new mess china and all the other expertise employed to make the Mess as magnificent as it ever was.

This is only a brief account of our work and this magnum opus carried out for the

Royal Engineers has been particularly memorable. The great enthusiasm, understanding and hospitality given by the Restoration Committee, Mess Members, Mess Secretary and Mess Staff was a wonderful source of encouragement to us and we are proud to have been associated with this great work of reconstruction.

The Jamaica Railway Disaster—1 September 1957

BRIGADIER C A LANGLEY, CB, CBE, MC, FCIT

ON Sunday, 1 September 1957, there occurred one of the most dramatic and appalling disasters in the history of railways. It happened near Kendal in the Island of Jamaica, and it shook the inhabitants to their foundations.

This is the scene in Jamaica's capital early that Sunday morning. Crowds assembled at Kingston Station to join an excursion to that world-famous resort, Montego Bay. A Church Society had organized the outing for the benefit of the poorer inhabitants of Western Kingston, and this was so popular that tickets for the full train accommodation had been sold in advance. The size of the train had to be increased from the original five to twelve coaches. These were soon filled, but the crowd at the station pressed on, rushed the barriers and filled the train to overflowing until eventually it was carrying some 1800 passengers, instead of its capacity load of 1000. People sat on others' laps, they crammed corridors and overflowed to the open platforms at the coach-ends, where some sat with their feet dangling over the side while others leant against the handrails.

The train, hauled by two new diesel locomotives, left Kingston at 5.30 am, half an hour late, and, apart from the behaviour of the passengers, the journey to Montego Bay was relatively uneventful; certainly one axle developed a hot box en route—a not uncommon occurrence on that railway—but that was put right at Montego Bay. The passengers enjoyed themselves in the usual excursion manner, though some witnesses afterwards described their behaviour as "unspeakable", "disgraceful", "atrocious"! Stories were told of fights, indecent language and abuse, pick-pocketing, and interference with the train equipment. Lights were put out in tunnels and twice the pulling of the communication-cord brought the train to a stand. At last, however, it arrived at Montego Bay, nearly three hours late, and the excursionists enjoyed their afternoon at this well-known resort according to their individual tastes.

Gradually they made their way back to the train in the evening, and eventually, at 6.30 pm, it pulled out of the station, crowded as before. There was much jollity to start with, and some people were drunk; pick-pocketing continued and the lights were interfered with, as on the outward journey. However, as night drew on, sleep overcame the weary travellers and some even got up into the luggage racks to rest in peace, little knowing that death and disaster lay ahead.

All went well as far as Greenvale, the summit of this mountainous standard gauge line, which climbs to a height of some 1700 feet at this point with gradients of 1-in-30 in both directions, and it traverses incredibly broken country, including the famous "Cockpit" area of the days of Captain Morgan. There are many sharp reverse curves, some of only 330 feet (5 chains) radius. In view of the long descent ahead, the brakes of the train were tested here, albeit in a somewhat cursory manner.

On leaving Greenvale, shortly before 11.0 pm, the train ran under proper control down a mile-long gradient of 1-in-30 and then along an undulating line with many severe curves for the next 3½ miles. The speed might have been a little high in places, but all seemed well until, on reaching the next 1-in-30 descent towards Kendal, the train got out of control. Speed increased, coaches lurched violently and on rounding the first bend of an "S" curve, the leading coach suddenly overturned, carrying the second coach with it, but leaving the two engines to run forward on the track for a

Photo 1. The general scene. A—Inspection Rail Car; B—Coach No 514; C—Coach No 500; D—Coach No 400; E—Coach No 300; F—Bulldozer at work; G—Coach No 302; H—Coach No 510 in cutting; I—Coach No 505 in cutting; J—Coach No 305.

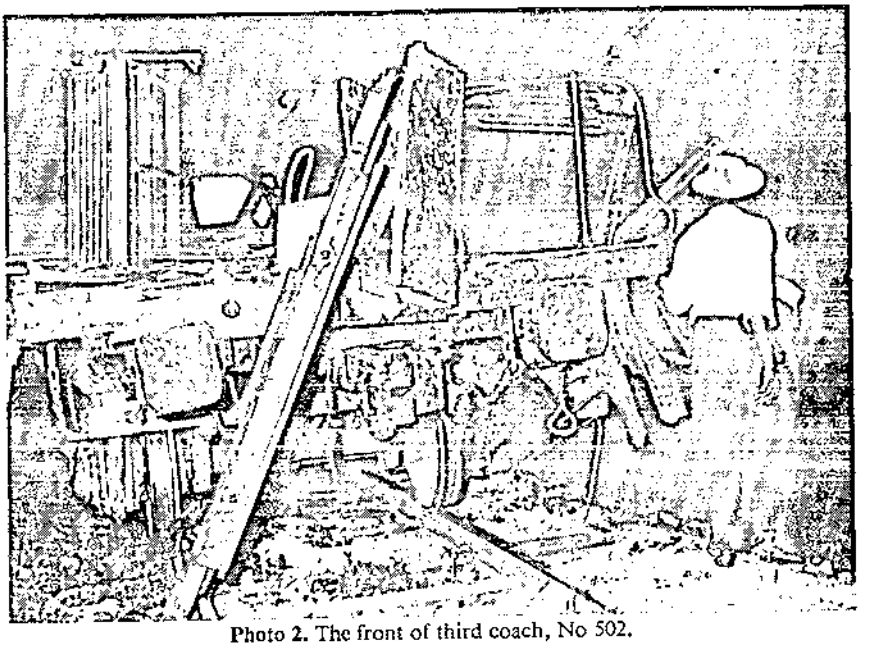


Photo 2. The front of third coach, No 502.

quarter of a mile before the automatic operation of the brakes stopped them. (Photo 1)

The rear bogie of the second coach remained poised in mid-air above the track long enough for it to sweep away the inner superstructure of the third coach with all its passengers. This coach ran forward, still on the rails, for 100 yards, its underframe stripped bare, and its sides hanging limply down. (Photo 2). By now, the shock of the deceleration was so great that the fourth coach disintegrated and was flung out in two parts. (Photo 3). The next five were wrecked in a narrow cutting, and the ninth coach was thrown on the hillside above the cutting and landed on its underframe but without its bogies. (Photo 4). The tenth coach ran into the wreckage, but the last two were only shaken. Wreckage and mangled bodies were strewn along the sides of the gulley and the exact number of fatalities was never ascertained; 163 bodies were recovered, of which sixty-nine remained unidentified. Mangled remains were estimated to correspond to another ten bodies, and nineteen more victims died in hospital, giving a death roll of 192. Over 1000 passengers were injured, many of them seriously.

Such was the disaster that shook Jamaica. It also shook the world. When I awoke on the Monday morning, I heard it on the BBC News, and on my way to London I saw it headlined in the newspapers. I was so distressed about this tragedy on a railway of such limited resources that on arrival in London I went straight to my chief Colonel Wilson, to discuss how we could help. Whilst I was talking to him, a call came from the Colonial Office asking whether we could spare an Inspecting Officer to act as Assessor to the Commission of Inquiry appointed by the Governor of Jamaica. I left by air on the following Saturday, and in the meantime found out all I could about the locomotives, rolling-stock and brake equipment in use on the Jamaican Railway.

I arrived at Kingston late on Sunday, and was met by the Chief Justice of the Island, who was Chairman of the Commission. The next morning I attended the Commission's first session which was held in open Court, with the Attorney General presenting the evidence and examining the witnesses. I asked for an adjournment to enable me to inspect the locomotives, the damaged stock and the scene of the

disaster. At that time no-one had a clue as to the cause of the accident, but rumours were rife. The driver was speeding dangerously; the engines had failed; the brakes had failed; passengers had interfered with the brakes; criminals had wrecked the train in order to rob the passengers. The railway authorities had made no attempt to investigate the accident, and had left everything to the Commission. Thus I started with a clean sheet.

Before describing my investigations, let me explain the working of the brakes which had such a bearing on this accident. The engine and coaches were equipped with the standard Westinghouse automatic air brake. With this system, compressed air from reservoirs on the engine and coaches operates the brake cylinders and pistons; these transfer power through rigging to the brake blocks on the wheels. The system is charged with air from the locomotive's compressor which pumps it through the train pipe to the valves and cylinders on the coaches; this air is controlled by valves on the locomotive operated by the driver. The brakes are applied by reducing, and are released by restoring, the air pressure in the train pipe. This is the standard "fail safe" principle. Thus, should the train pipe part as the result of a breakaway or accident, the brakes are immediately applied on the whole train. Standard hoses and couplings are used to connect train pipes together, and angle cocks at each end of the coaches enable this to be done without loss of air. These cocks are closed when the pipes are being coupled or uncoupled, but all of them, except the one at the end of the train, must be open when the train is in service. Each cock is provided with a self-locking catch handle with lugs that engage against stops on the main body of the cock, thus locking it either in the closed or open position. (Photo 5). Should any cock be left closed, the brake system behind it is isolated from the driver's control.

In the interests of safety, especially on a railway with such severe gradients, the brakes must be tested at the beginning of each journey, and before descending long inclines, so as to ensure that they are working correctly throughout the train. On the Jamaican Government Railway the driver and the guard have to sign a joint certificate whenever they carry out such a test, and, as will be seen later, one of these certificates featured dramatically in the investigation.

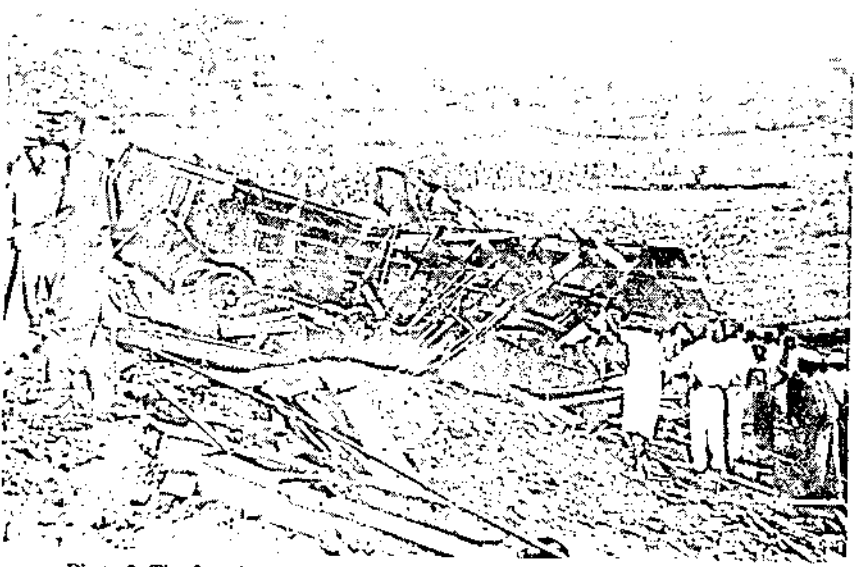


Photo 3. The fourth coach No 400 resting against the second coach No 500.

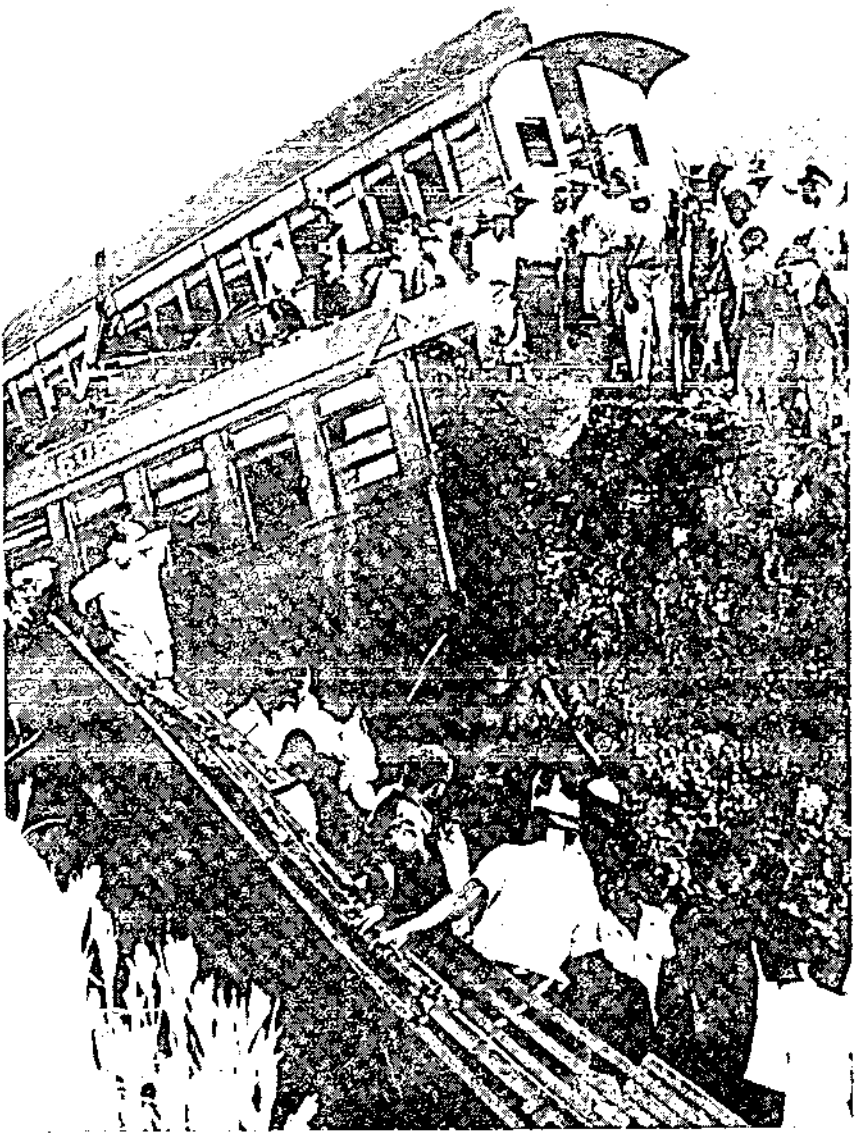


Photo 4. Wreckage in the cutting.

My first act was to inspect the two locomotives which had escaped so miraculously. They were quite undamaged, but the Chief Mechanical Engineer pointed out marks that he had found when he examined the engines shortly after the accident. On each of the left-hand wheels there was a series of light scorings around the rim of the flange, but there were no such marks on the right-hand wheels. These bright marks had clearly been made in the course of the journey, and we came to the conclusion that on rounding the left-hand curve where the train was derailed, the inner wheels had lifted, and when the engine reached the reverse curve immediately ahead, these wheels dropped back and their flanges caught the side of the check-rail.

Thus the locomotives must have been on the point of overturning as they rounded the curve.

Forthwith, I cabled to the manufacturers for the centre of gravity of the locomotive, and with this information calculated that its balancing speed on a 330 foot radius curve was 58 mph. There were no drawings of the coaches, but one of them was under repair in the shops and from this I had a drawing prepared and the centre of gravity calculated. After making allowance for the abnormal load of passengers, I estimated that the height of the centre of gravity above rail level was 62 inches, giving a balancing speed of 56 mph, only 2 mph less than that of the locomotives. This accounted for their miraculous escape, and enabled me to estimate with tolerable accuracy the speed of derailment. After making allowance for some sway as the coaches entered the first of the reverse curves, I calculated that the speed was not more than 55 mph. These deductions were invaluable in my later investigations.

On the next day I went up country to the scene of the accident to inspect the debris. I was particularly interested in the Westinghouse air brake equipment, because I suspected that an angle cock on the train might have been closed either accidentally or deliberately, thereby isolating the brakes beyond it from the driver's control. At Kendal Station I saw the third coach in a siding. The body had gone, but the underframe was intact. (Photo 2). The front headstock had received a heavy blow and the angle cock was badly bent with the handle in the fully-closed position. I thought at first that this closure was the result of a blow and not the cause of the accident, but I gave orders for it to be kept for later examination. (Photo 6).

Then, with the Members of the Commission, I walked up the line to where the wreckage lay spread out across the fields. Most of the angle cocks were missing or were so badly damaged that their condition provided inconclusive evidence, but in searching among some debris I found one cock fully closed and jammed tight. This seemed to be the clue for which I was looking because from its condition it could not have been closed during the derailment, and I concluded that it must have been closed some time before, probably by an inquisitive or ill-disposed passenger seated on the open platform where he could quite easily have reached down and turned the cock by hand, or he might even have closed it with his foot. From enquiries

Photo 5. Front view of a coach showing angle cock closed.

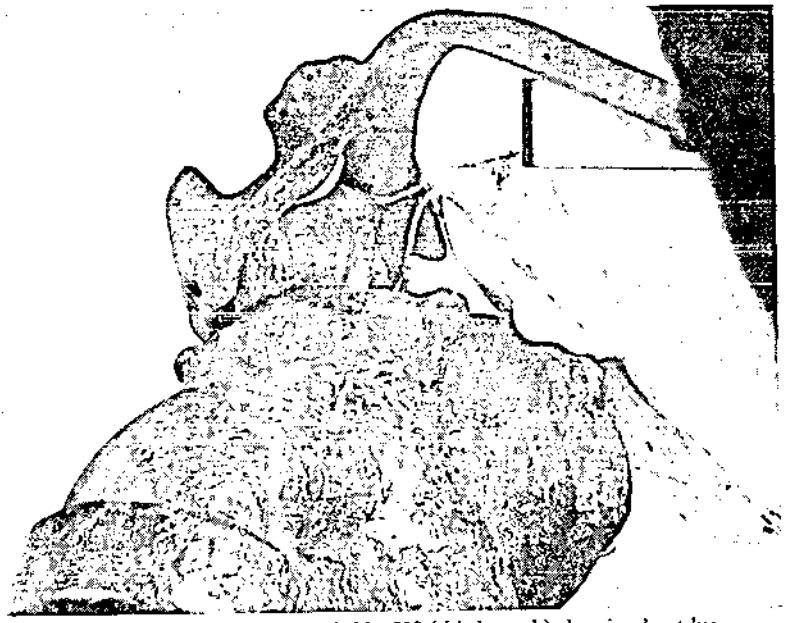


Photo 6. Worn angle cock from coach No 502 (third coach) showing bent lug.

among the railway staff who had cleared away the debris, I thought that the cock had come from the seventh coach—incidentally, newspaper reports suggested that a passenger had, in fact, closed the cock of that very coach. Naturally I felt very pleased with my two discoveries so soon after my arrival, and I began making the first of many braking-force calculations.

On the following morning I carried out trials with two engines hauling a load equivalent to that of the derailed train, and I tested a series of triple valves and brake cylinders. I was satisfied that the brakes, if fully applied, were capable of stopping the train from the highest speed it was ever likely to have attained.

The taking of evidence was resumed on the next day, and I confess I was somewhat shaken when an Inspector turned up with another angle cock closed exactly like the first one, and stated that he had found it buried at the bottom of the same pile of debris in which the first had been found. He thought that it must have come from the other end of the seventh coach, from which both angle cocks were missing. That one hooligan should close an angle cock was a feasible theory, but two, a coach apart, with the same idea, seemed to be stretching coincidence somewhat far. I was puzzled, but meanwhile the taking of evidence continued day by day. Witnesses told us of the scene at Kingston, the journey to Montego Bay and the fatal return. I heard about the detailed examination of the brakes at Kingston, the brake tests that were made en route, at Montego Bay, and finally at Greenvale, of which more later.

The driver, whose name, believe it or not, was Lurch, gave a clear and graphic description of the final stages of the journey. All went well, he told us, until they reached the descent to Kendal. Then, when he applied the brake, it failed to respond. He released and re-applied it without result. He tried the independent air brake and still the train gathered speed until he felt a severe lurch, after which the engines ran free and then slowed down and stopped. He admitted that he had exceeded the authorised speed in places, and his evidence showed that he was probably travelling at about 30 mph before he tried his brakes whilst running round a sharp reverse curve at the beginning of the last descent (the maximum permissible speed on this section of the line was 20 mph round curves and 30 mph on the straight).

The Management produced the brake certificates to show that the brakes had

been correctly tested at all the required places. Several of these were presented to us, but it was the last one, for the test at Greenvale, which attracted my attention. It had been signed by the driver and guard, but, unlike the others, it was clean and unsullied. By this time I had discovered that the method of filing was to fix papers on a sharp spike. All the brake certificates had a neat hole in the middle—all except the Greenvale certificate. I wondered why.

Meanwhile, I decided to reconstruct the accident as far as I could do so in safety. I arranged for a train of equivalent size and weight to be assembled at Greenvale on the following Sunday morning with two diesel engines to haul it. Before starting I enquired about the condition of the brakes and was told that they had been tested and found satisfactory. Having seen and heard something of these tests, I asked for a demonstration. I found that the brakes on six of the twelve vehicles were not working correctly, and even after adjustment the brakes on two vehicles still failed to function!

Despite the defective brakes, I considered that we had enough power for my test, so we set off for Kendal, where the Chief Justice awaited my coming. We ran the train to approximate to the driver's record, and allowed it to reach a speed of 30 mph on the falling gradient before we applied the brakes. Despite the loss of brake power on two of the twelve vehicles, we had no difficulty in controlling the train. This test satisfied me that the braking of passenger trains was adequate, even though their maintenance was not up to standard and the train was being run on the steepest gradient at speeds in excess of the maximum.

All the next week witnesses continued to tell dramatic stories of the fateful excursion, but none of this evidence had any significant bearing on my investigation. Thus I was still no nearer to solving the mystery of the closed angle cocks. I thought that they might possibly have been adjoining ones as I had heard that the train had been split at Montego Bay and placed in two sidings for stabling. The cocks at the ends of each rake would have been closed during shunting and on recoupling them the shunters might have failed to re-open the two centre cocks. I decided, therefore, to go to Montego Bay and reconstruct the scene, using a train of twelve coaches and the same train crew and shunters.

Accordingly, on the following Monday morning I set off with the Commission in a special Inspection Saloon, having sent our witnesses on ahead to await our arrival at Montego Bay. But first, at Greenvale, we decided to spring a surprise on the Stationmaster who up till then had not been called to give evidence. We therefore stopped at that station and questioned him about the brake tests and the certificate. By now I was immune to shocks, so when the Stationmaster emphatically denied all knowledge of a test or a certificate, I was not surprised.

This evidence led the Commission to recall the guard of the runaway train as soon as we reached Montego Bay. Then followed tense drama as the guard was made to take the Oath again and was subjected to a searching examination, sitting in the saloon facing the Chief Justice and flanked by the Attorney General and a press reporter. He recounted the incidents of the night of the disaster with variations. He was cross-examined about the Greenvale test, and finally, when faced with the Stationmaster's denial that any certificate had been handed in, the wretched guard broke down and confessed. Two days after the accident, he told us, he went to Kingston Station to collect some kit from his locker to send to an aunt who lived at a place called Maggoty. As he walked along the platform to the guards' cabin where he kept his kit, the Air Brake Inspector called him to his office and asked him to sign a certificate for the Greenvale brake test. This he did.

Driver Lurch was then re-called, but he denied signing this particular certificate, though he admitted that on occasions he had signed blank certificates to save time! We then adjourned for the night, and awaited the morning's papers before recalling the Inspector. Sure enough, the guard's confession came out in full and, on seeing it, the Inspector confessed to persuading the guard and driver to sign a fake certificate as, according to him, the original had been lost. At this stage we did not establish

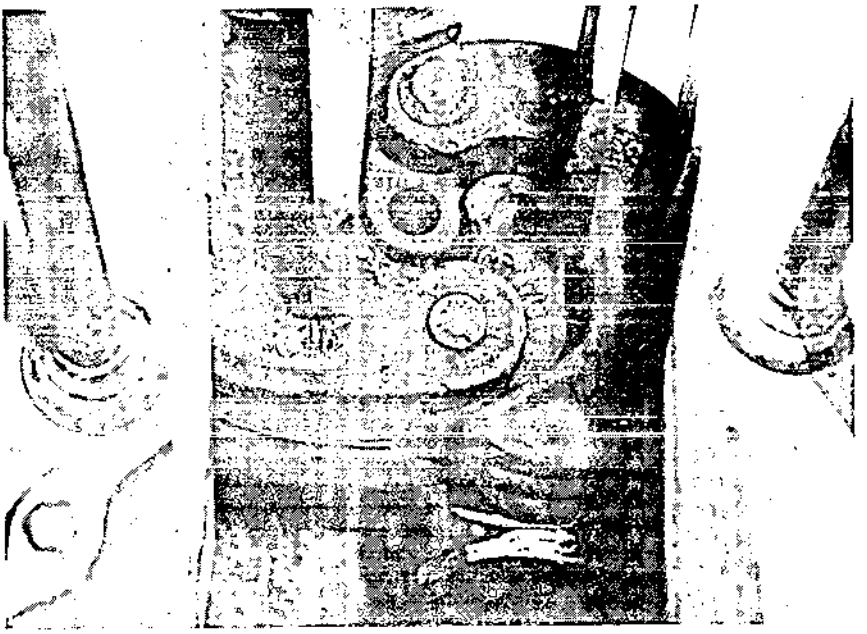


Photo 7. View of coupler on coach No 511 rubbing against the cock handle.

clearly who had initiated this deception.

I was more interested in the marshalling demonstration which followed, but this showed that the seventh coach was left in the middle of a rake instead of at one end, as I had expected. Consequently there was no need for anyone to shut either of its angle cocks, and I felt fairly sure that they had not been closed at Montego Bay.

The scent was getting somewhat cold by now. So I decided to make a fresh start and return to the first angle cock that I had seen, namely the damaged cock on the front of the third coach.

I had already watched the running of passenger coaches round sharp curves and I noted that at times the centre coupling came close to, though not actually in contact with, the brake pipe. On my return to Kingston, I carried out further tests with other coaches and on one I found that the coupler actually hit an angle cock when rounding a particularly sharp curve. (Photo 7). On this vehicle the bracket holding the pipe had been reversed in the course of repairs, and this brought the pipe and angle cock 3½ inches nearer the centre line than normal. The cock was badly worn and it had been damaged by frequent contact with the centre coupling. This discovery led me to speculate whether the pipe brackets of any of the leading coaches of he wrecked train had also been reversed.

I returned, therefore, to the scene of the accident at the first available opportunity to re-inspect the wreckage, with the intention of identifying all the underframes, establishing their position in the train, and of examining in detail all pipe brackets and angle cocks, in particular the one on the third coach, which I had suspected initially. I went at once to this coach and found that the pipe bracket had in fact been reversed and that the centre coupler could strike the cock, which was old and worn, and turned easily when the loose catch handle was lifted. With the aid of a magnifying glass I found marks on the coupler and the cock consistent with recent striking. (Photo 8). Accordingly, I removed this valuable piece of evidence and took it back to Kingston Workshops for testing. I placed the cock in a vice, then lifted the catch handle and gently tapped the side with a hammer. It began to close immediately, and after a few taps the valve was completely shut.

I noticed, too, that a lug on the handle had been bent recently, and I was able to demonstrate that this could *only* have been bent by a sharp blow with the handle at least half closed. (Photo 8). Such a blow must have come when this coach was swept under the second one during the derailment. Hence the handle must have been half closed *before* the accident. On stripping the cock, I found that with the handle in this position the valve itself was completely closed. None of the other pipe brackets was reversed, so this was the only one that could have been closed accidentally on this journey. A photograph of the leading end of the third coach, taken by a pressman on the night of the accident, (Photo 2), showed the damaged cock exactly as I had found it, and from the condition of the cock I was certain that no-one had tampered with it after the accident.

I concluded that the actual closure had probably taken place on the undulating line after leaving Greenvale. The speed over this section was higher than usual. The coaches were lurching round the curves, some of which were sufficiently sharp to cause the centre coupling of the third coach to strike the angle cock. The catch handle must have been thrown out of its seating by an extra heavy lurch just at the moment when the coupler struck it. This would have been sufficient to start the cock turning, and since the catch handle could no longer fall back into place, a series of further blows would be sufficient to close the cock completely. This must have happened by the time the train reached the last 1-in-30 gradient and hence it ran down this steep incline with the brakes on the last ten coaches cut off. Thus, when the driver made his first partial brake application, it had little effect and the train continued to accelerate, as I demonstrated by graphs showing the effect of different brake applications on this gradient at various speeds. Driver Lurch's predicament was acute. He attempted to save the situation by releasing and re-applying the Westinghouse brake, but without effect; then, thinking that this brake had failed, he released it again and tried the independent air brake that worked on the engine wheels only. This made matters worse, and the train hurtled to its destruction at ever-increasing speed.

Had he realized the situation and made a full emergency application immediately

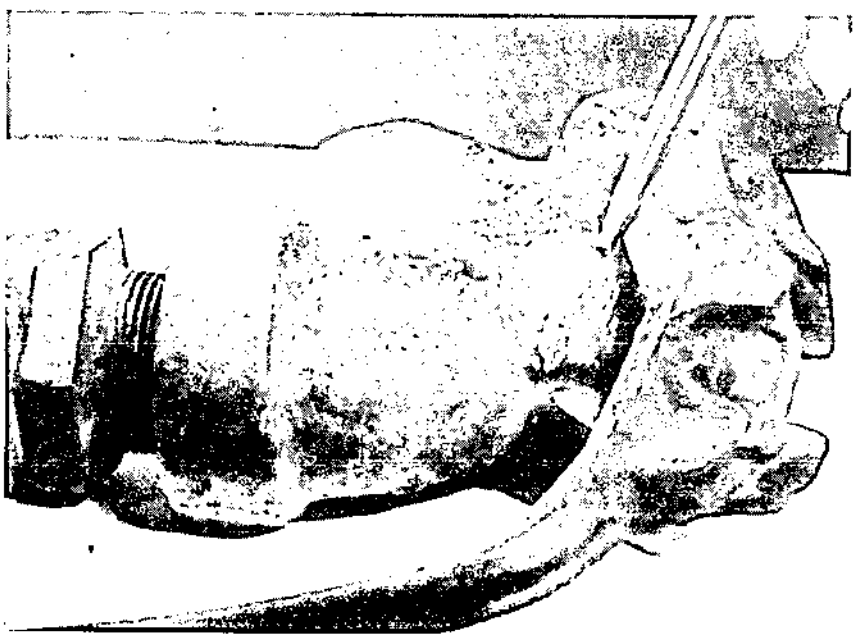


Photo 8. Worn angle cock from coach No 502 (third coach)

after the failure of his first attempt, Driver Lurch might have stopped the train or controlled its speed sufficiently to have avoided the derailment, but in view of all the circumstances I did not consider that he should be held responsible for the accident, though I criticized him for driving too fast round the sharp curves before trying to check the speed on the severe gradient.

Eventually I solved the mystery of the two closed cocks. After a long search through the debris, I found that the train pipe of the ninth coach had been burnt off with an oxy-acetylene cutter, and on cleaning the stub end of the pipe on one of the closed angle cocks I found marks of burning also. Then I remembered a press photograph of a coach on its side in the cutting with a group of men standing around it. One of them was wearing goggles and he was obviously the welder who had cut the pipes.

On checking back to the rescue operations, I found that the ninth coach had been lying for hours on the top of the cutting, surrounded by interested spectators, (Photo 4), but it was finally thrown into the narrow cutting where projecting pieces of undergear including the two angle-cocks were cut off to ease its passage through the cutting so that it could be dumped clear of the track. These pieces, with the two angle cocks, were left in the cutting amongst the debris of the seventh coach and so led me astray. As a result of this dénouement, I was convinced that the cocks had been closed by inquisititive spectators after the accident, and had got jammed when the coach was dropped into the cutting.

My technical investigation was now over, but we had not yet reached the last Act of the drama. A whisper had come to our ears about the author of the faked certificate deception. Accordingly, all the Chief Officers of the railway were called before the Commission to give further evidence – the General Manager, the Assistant General Manager, the Traffic Manager, the Civil Engineer, the Mechanical Engineer, and the Air Brake Inspector. Eventually, after two days' of revelations, confessions, disclaimers and excuses, I formed the impression that the Assistant General Manager had asked the Traffic Manager—whose name was Fidler—to arrange for the fake certificate to be prepared so that the General Manager could present it to the Court. The Commission, in their Report to the Governor of Jamaica, made scathing comments on the incompetence, lack of integrity and irresponsible conduct of these three senior officers.

Whilst the Chairman was engaged in drafting this Report, a final twist was given to this intriguing tale. One morning in November the Secretary to the Commission was shopping in Kingston Market when a railway Inspector whispered in his ear "The missing certificate is in the Greenvale Stationmaster's Office", and sure enough, there he found it! The Commission was promptly reassembled and the Greenvale Stationmaster was recalled. He blandly stated that a week after the accident he received a certificate by post, but as he though it was "phoney" he put it away and did not tell anyone, not even the Commission, about it. It was indeed "phoney". It had apparently been signed at Montego Bay for a test by another driver. Then Driver Lurch had written his name over the other signature, and the Guard had filled in the Greenvale details and left the certificate on the Stationmaster's table. By now the evidence of all the chief characters was so suspect that we never discovered the truth behind this latest intrigue, although the Stationmaster's actions were undoubtedly coloured by spite against his superiors and fear that his own ineptitude would be exposed.

As can be imagined, the publication of the Commission's Report was greeted by the local press with banner headlines, and extracts from the Commission's findings and my technical report filled many columns.

I had the task of finding a new General Manager, a new Traffic Manager, and two Senior Assistants for the Mechanical Engineer. The services of the Assistant General Manager were terminated, but he was not replaced.

The irony of the situation was that the final test at Greenvale had no bearing on the accident, because I proved eventually that the brake failure must have occurred

after the train had left there—the disaster was the result of a misadventure that might not have occurred in a million journeys.

As a tail-piece, I might add that when I visited the Island three years after the accident, I was faced with another serious derailment, this time of a freight train, but also from an unknown cause. I went to the scene where who should I meet but Driver Lurch of the ill-fated excursion train, in charge of the same two locomotives! On this occasion also, I was able to absolve the driver from blame and to prove that the derailment was due to a faulty tank wagon.

An Outrage at Quetta

MAJOR A I C GORDON, SCOTS GUARDS

THE history of Quetta as a cantonment town is not well known and there will be many who have not heard of a remarkable outrage, in which a Sapper officer lost his life, which was perpetrated during the construction of the military lines in 1877.

During the late afternoon of 26 July a drill parade was drawing to a close on the barrack square of the 4th Sikh Regiment. Three companies of the regiment, under the command of Captain Andrew Scott, had been on detached duty in Quetta throughout the winter of 1876 and summer of 1877, assisting in the barrack building programme. Nearby two officers of the Royal Engineers, Lieutenants Hewson and Kunhardt—who were attached to the Indian Public Works Department—were inspecting the building works in progress, unarmed, when they came across a dispute between a contractor and some coolies over some measurements. The summary dismissal of the coolies involved triggered off a furious response. Kunhardt was stabbed and narrowly escaped decapitation at the hands of a Pathan wielding a *talwar*. Hewson fought free of his assailants but not before he had suffered a serious leg wound. He stumbled and fell as he fled and was overwhelmed by his pursuers.

Captain Scott, realizing the gravity of this murderous assault, raced to the scene, exchanging his sword for the rifle and bayonet of one of his sepoys as he ran. It was too late to save Hewson but he was in time to rescue Kunhardt from a similar fate. Sepoy Rachpal Singh, who was armed only with a small axe, interposed himself between Kunhardt and the enraged coolies but was cut to pieces. Meanwhile Scott set to work with the bayonet. He accounted for two men before a third sliced off part of his helmet with a *talwar*, grazing the top of his head. Undeterred Scott seized this man by the throat and wrestled with him until he could be dispatched by a Sikh. The uproar was swiftly brought under control, four rioters were killed and seven wounded. An eye-witness observed that "the sepoy who attempted to help with Scott's regulation sword broke it at the first blow".

The subsequent enquiry into this attack established that it stemmed from an earlier dispute between a local tribe and the British authorities. Three camels stolen from the British had been traced to the village of the Banzai tribe of Kakar Pathans. According to the custom of the time the village headmen were held responsible and the Khan of Khelat ordered that the camels should be returned or, failing this, the sum of 300 rupees would be required in compensation. It transpired that the dismissed coolies came from this same tribe. Evidently their dismissal, added to the prospect of contributing to the fine, had so incensed them that they determined to wreak vengenance upon the nearest Englishmen.

On 18 January 1878 the London Gazette announced that the Queen had been "graciously pleased to confer the decoration of the Victoria Cross on Captain Scott for his gallant conduct at Quetta in the East Indies". General F S Roberts VC, CB, presenting the decoration at Dera Ismail Khan in April 1878 said ". . . there is no deed for which this Order can be more appropriately bestowed than when a soldier risks his own life to save that of a comrade . . . I think that the presence of mind displayed by you at Quetta on 26 July last compares favourably with any deed for which the Victoria Cross has hitherto been awarded".

Scott's subsequent career was sadly short. He was Brigade Major in the Second Brigade of the Kurram Field Force in 1878, and in 1880 he was commended in Brigade Orders following a successful recruiting tour on which 264 recruits were enlisted in one month. Shortly after becoming Second in Command he left his regiment in May 1882 "in very bad health" for six months sick leave in Kashmir, where he died at Srinagar in September, a bachelor of forty two.

Kunhardt continued to work in the Public Works Department after the outrage. It was he who designed and supervised the construction of the Residency at Quetta. He played an important role in the construction of the Punjab Northern State, Tirhoot and Rajputana Railways and he also passed the High Proficiency Examination in both Urdu and Hindi. In addition he qualified as a Russian interpreter. Apart from service in the Sudan Expedition in 1885 he continued to serve in India and Burma until his death while on furlough in Marseilles in November 1892. He was survived by his wife and two daughters.

As for Rachpal Singh, his widow Lachmi was admitted to the pension of the 3rd Class of the Indian Order of Merit from the date of her husband's decease.

The 4th Sikh Infantry was renamed the 54th Sikhs (Frontier Force) in 1903 and in 1922 it became the 4th Battalion of the 12th Frontier Force Regiment. After Partition it emerged as 6 FF in the new army of Pakistan. Today, 100 years after the outrage, a miniature replica of Scott's Victoria Cross is one of twenty six proudly displayed in the Piffer showcase in the Pakistan Staff College Mess.

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Kaafjord 1976

LIEUTENANT COLONEL G R OWENS RE

With acknowledgements to P J Cornish and N C Kelland

BACKGROUND

FOR a period of just over three weeks in July and August 1976 I took the Regimental Diving Team from 25 Engineer Regiment to Kaafjord in Arctic Norway linking up with, and forming part of, a civilian expedition from the British Sub Aqua Club to trace the location of *HM Submarine X5* and recover historic war material from what had been a major German fleet anchorage in World War II.

Like a number of previous enterprises it came about by several different factors "gelling" together to form the "whole". I had been fortunate in getting the larger part of the Regiment tasked for *Ex Northern Quest*—a construction task in Norway, from May till early August 1976. The CCRE, Brigadier Mike Matthews, had been encouraged by the Annual Diving Conference at the Kiel Training Centre, to declare 1976 to be "The Year of the Diver" in BAOR.

During one of the reconnaissances for *Northern Quest*, and with training for the diving team in mind, I visited the first operational base in Norway for the German battleship *Tirpitz*. This was located near one of our proposed work sites in an arm of Trondheim Fjord and I felt it might offer scope for a project. My Norwegian guide told me stories of British aircraft which had used the frozen lakes as airstrips in the battles of 1940 and had subsequently broken through the ice and sunk. One such aircraft, he told me, had been recovered intact in 1973, but he assured me there were several more left!!

My imagination "caught", I returned to BAOR and thence to UK to research the subject. This led via libraries, the Air Ministry Historical Section, the Public Record Office and the Cabinet Historical Section finally to the Imperial War

Museum. The story of the single aircraft proved true for in 1973 Mr Peter Cornish of the BSAC together with an RAF Sub Aqua Club Team had recovered a Halifax bomber from Hocklingen Lake. The plane had been damaged during an attack on *Tirpitz* and had made a forced landing on the ice before finally breaking through and sinking. After thirty one years it was still in an excellent state of preservation and, as the only surviving example of a Halifax, is now being restored by the RAF for their Museum. Alas, the stories of other aircraft waiting there to be salvaged proved to be false but the Imperial War Museum put me in touch with Peter Cornish, who was getting together a group of BSAC divers to search for an X-Craft lost in a later attack on *Tirpitz*, whilst at her northern anchorage at Kaafjord.

X-Craft were submarines developed and built during World War II and had won for their crews four VC's, two in Singapore Harbour against the Japanese Navy and two after the successful *Operation Source* attack on the German battleship *Tirpitz* in Kaafjord on the northern tip of Artic Norway. This latter attack by these

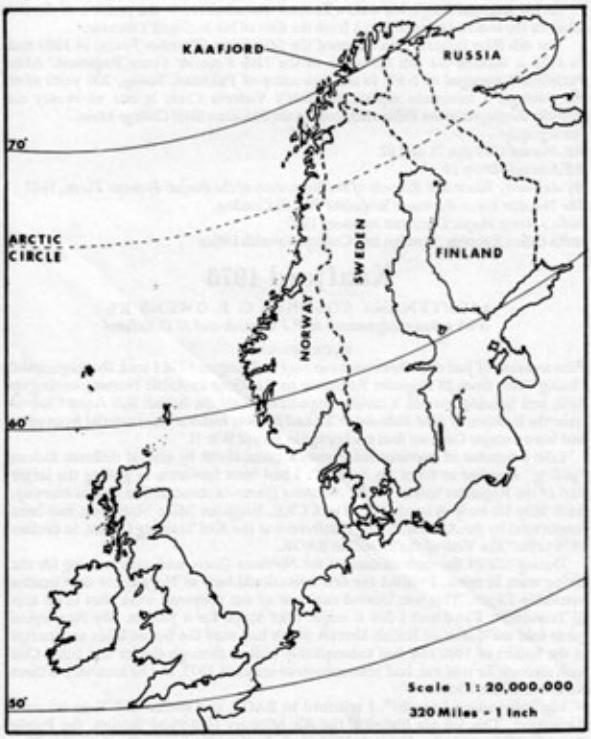


Photo 1. Location Map at Kaafjord.

Kaafjord 1976 (1)

Photo 2. A general view of Kaafjord looking seaward. The mooring positions are shown; A—Tirpitz, B—Scharnhorst, C—Lutzow.

Royal Navy X-Craft, was mounted on 22 September 1943.

The original plan had called for six submarines to penetrate the Northern Fleet anchorage, to attack primarily *Tirpitz* then *Scharnhorst* and *Lutzow* should they be present. Of the six only three succeeded in reaching the fjord, *HMS X5*, *X6* and *X7*.

HMS X6 and *X7* each with their four man crews, managed to pick their way through the coastal mine fields, penetrate the outer harbour defences and boom and the inner torpedo nets and lay their charges on the seabed below the keel of *Tirpitz*. The X-Craft were each armed with two two-ton saddle charges of Amatex and, when they exploded at 0812 hrs on that Sunday morning, lifted the 46,000 ton battleship, the pride of the German Navy, nearly two metres out of the water and gave her an immediate 15° list to port.

Following the laying of the charges the element of surprise was quickly lost. *X6* having experienced severe periscope difficulties on the way into her attack, was now virtually blind and was forced to surface on several occasions within the surrounding torpedo nets in an effort to determine her escape route. Each appearance on the surface was met with a furious barrage of small arms fire from the now fully alert crew of *Tirpitz* but fortunately due to her close proximity to the battleship none of the main armament of *Tirpitz* could be depressed enough to be brought to bear. In the knowledge that her charges and possibly those of other X-Craft, could explode at any moment, she surfaced and scuttled herself thirty metres off the port bow of *Tirpitz* and her four man crew were taken on board.

HMS X7 had also laid her charges but was hopelessly entangled in the torpedo nets about one hundred metres from the starboard side of *Tirpitz* at the moment of detonation of the charges. The explosion blew her clear of the nets, but despite having suffered major damage her crew, although shaken, were still alive. After assessing the damage, her Captain, Lieutenant B C G Place, attempted to scuttle the submarine which was now surfaced near a moored gunnery target. However, as he tried to get out the submarine sank below him and he managed to scramble aboard the target from which he was quickly picked up by a German launch. *HMS X7* hit the seabed at forty five metres but after thirty five minutes and subsequent depth charging only one of the three men left on board, the diver, managed to get

Kaafjord 1976 (2)

out by making a submarine escape. He later reported that due to the damage, the submarine had been slow to flood up and the two remaining crew men had been drowned before they could escape.

To this day very little is known of the last X-Craft—*HMS X5*. She was first sighted thirty one minutes after the explosion under *Tirpitz*. The battleship's log states that she suddenly surfaced on bearing 070° at seven hundred metres. The four man crew of *HMS X6* standing captive on the deck of *Tirpitz*, saw her erupt in a cloud of foam, as they estimated, at "five hundred and fifty yards" on the starboard beam. *X5*, for it could only have been her, lay on the surface and was repeatedly hit by the 105mm secondary armament of *Tirpitz* and quickly sank. A German destroyer *Z29*, then dropped fourteen patterns of five depth charges, the fifth pattern bringing up a lot of oil and personal effects. Both *Tirpitz* and *Z29* claimed in their log books that they had sunk her.

Considerable efforts were made by the German Navy to recover the wrecked vessels to evaluate the weapon system, whilst the six survivors were interrogated and eventually sent to German POW Camps. The wreckage of *HMS X6* was quickly located but had been utterly shattered by her own charges near which she had settled and she was judged to be of no consequence.

The Germans were unable to dive to the depths required but after three weeks, two ocean tugs *Arngast* and *Bardenfleth* snagged the sunken remains of *X7* near the original location of the gunnery target and managed to get the rear half ashore on the eastern side of the fjord. The entire front half of the submarine was found to be missing, presumably blown apart by the depth charging and, after a thorough examination the recovered parts were removed and reputedly sent to Kiel. The remains of the two drowned crew who were in this wreckage were buried with full military honours at Tromso. The Germans continued their search for *X5* but could not find her in the area where she was supposedly sunk and with the Arctic winter fast approaching, the search was eventually abandoned.

Had she in fact escaped or had the primitive German salvage efforts simply failed to locate her? Was it conceivable that she might still be lying there undetected

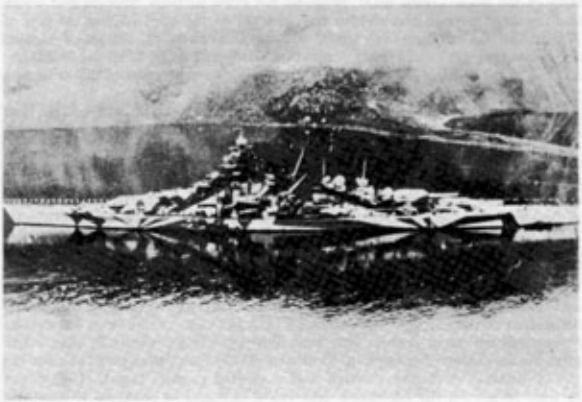


Photo 3. Tirpitz at her moorings in Kaafjord. Note the disruptive pattern camouflage. (Nominal displacement 42,900 tons, length 252 metres, beam 36.5 metres, speed 31.31 knots, crew 2,400, commissioned 25 January 1941)

Kaafjord 1976 (3)

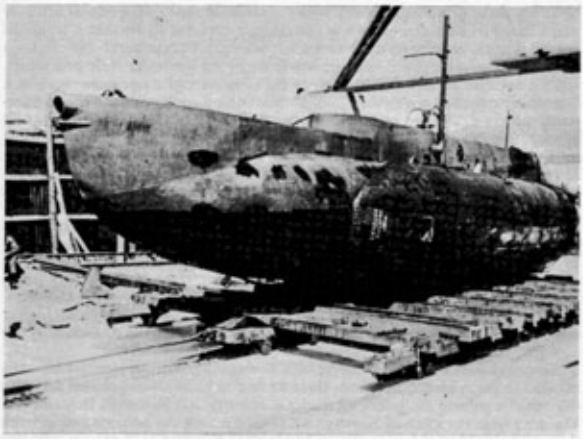


Photo 4. An X-Craft Midget Submarine. Note the amatex saddle charge.

after thirty one years?

After the war when the POW's were released and the full story became known the Captains of *X6* and *X7*, Lieutenants Cameron and Place were each awarded the Victoria Cross. Nobody could state with certainty what had happened to *X5* and her crew, or what she had achieved, and her Captain, Lieutenant Henty-Creer was Mentioned in Despatches. Many, particularly his family, felt that the rules for awards had acted harshly in his case and that of his crew, after all they had penetrated the minefields and the outer defences and given their lives in the attempt. It was felt that if only *X5* could be found and the saddle charges were no longer on her, then it would be reasonable to suppose that she too had penetrated the final nets around *Tirpitz* and was in fact on her way out when she surfaced and was attacked. There would then be strong grounds for pressing for commensurate awards to be made to Henty-Creer and his crew.

With backing and strong encouragement from members of Henty-Creer's family, Peter Cornish of the BSAC led the first full expedition to Kaafjord in 1974. His team of sixteen divers were selected from among the best sport divers in the country and included men and women with sufficient skills to approach the problem in a scientific manner. They surveyed a large proportion of the fjord and carried out a great deal of diving and found numerous wrecks and much war debris but they did not find *X5*. However in another area they did find the bow section of an X-Craft but were unable to positively identify it as *X5* or *X7*.

Kaafjord measures approximately 5 by 1¼km, which is an immense area to cover even with sophisticated equipment. Particularly when associated as it is with extreme depth and cold. At the end of their stay they had learnt a lot and found much but they could not categorically state that they had or had not found *X5* and so in an attempt to do this and to survey the whole area and recover historic war material, the 1976 Kaafjord Expedition was formed.

I met Cornish in London in early May and was at once impressed by his professional approach to the problem, his own obvious skill as a diver and his enthusiasm. He was obviously gathering around him a high powered team of like in-

dividuals, many of whom were very highly qualified in their own specialist fields for which they had been chosen. It was immediately apparent to me that it would be beneficial and interesting for us to work alongside them. For our part I offered a team of eight to twelve service divers who would arrive on site under their own steam, self-contained in all aspects, who had access to much useful equipment such as a "one man compression chamber", underwater cutting equipment and communications equipment, lifting gear, boats, vehicles etc. But we would have, from his point of view, the drawback of having to work to the more stringent Service diving regulations, of having to work on our own as a team rather than mix with his divers and to have widely differing experience and qualifications and therefore restrictions in the depth to which some men could dive. The net outcome of the meeting was that we were asked to join them as an integral part of the expedition and I accepted.

Many of the administrative problems are common to all such enterprises and I will only highlight those of particular interest. Fortunately our problems were eased by the fact that some of the Regiment would still be in Norway finishing off our construction tasks, at the start of diving operations. There is also a very useful paragraph in BR 2806—*The Admiralty and Joint Service Diving Regulations*,—which states a requirement for service divers to be given the opportunity for regular and interesting continuation training underwater and places the responsibility for arranging this firmly on the shoulders of the Commanding Officer!

Finnmark with its common border with Russia is a politically sensitive area and in order to get clearance to operate there we had to go in civilian clothes and with our vehicles painted the yellow of the local Forestry and Highways Departments. The drive from the south of Norway to Kaafjord is long and arduous and includes the use of a number of ferries, and we had to allow five days each way for this. For a variety of reasons I was unable to take the complete Regimental diving team and so to make up numbers we borrowed a diving supervisor and an advanced diver from 23 Engineer Regiment and a basic diver from 9 Independent Parachute Squadron.

The key to success of any diving operation is the welding together of the individual divers into a team and the working up and training of that team for a particular task. This is especially true for the cold and deep waters of the Arctic. I was not able to work up our team to my satisfaction before we deployed and this had a bearing on the tasks we were able to undertake. However all save one of the team were able to go to the Diving Wing at the Kiel Training Centre for a few days refresher training and make a chamber dive to in excess of 60m at a German Navy hospital, to ensure that everyone could reach the maximum depths in the area of operations in case of an emergency. The odd man out went to the diving school at Marchwood for similar training. Four of the team who were in Norway for *Ex Northern Quest* also carried out a reasonable amount of preparatory diving and were able to test and check out all the equipment, boats and outboard motors—an essential prerequisite.

We moved north in two parties by road and aircraft in the last week of July, an eleven man team of nine divers (three "diving officers", one "supervisor" one "advanced diver" and four "basic divers") plus a cook and a driver and linked up with the twenty seven strong civilian team at Kaafjord.

With any diving task a great deal of preliminary work has to be put in before diving can commence in earnest. This was no exception. Everyone helped with general camp administration and everyone was fitted into one of the specialist teams for the preparatory work.

SURVEY

One of the most pressing and important tasks was the underwater survey of the whole fjord and the plotting of every piece of wreckage or "sonar anomaly" so that diving time would not be wasted unnecessarily. This exacting work was under the direction of our Marine Geophysicist Nigel Kelland of BP Research, to whom acknowledgement is made for techniques and detail in the following paragraphs.

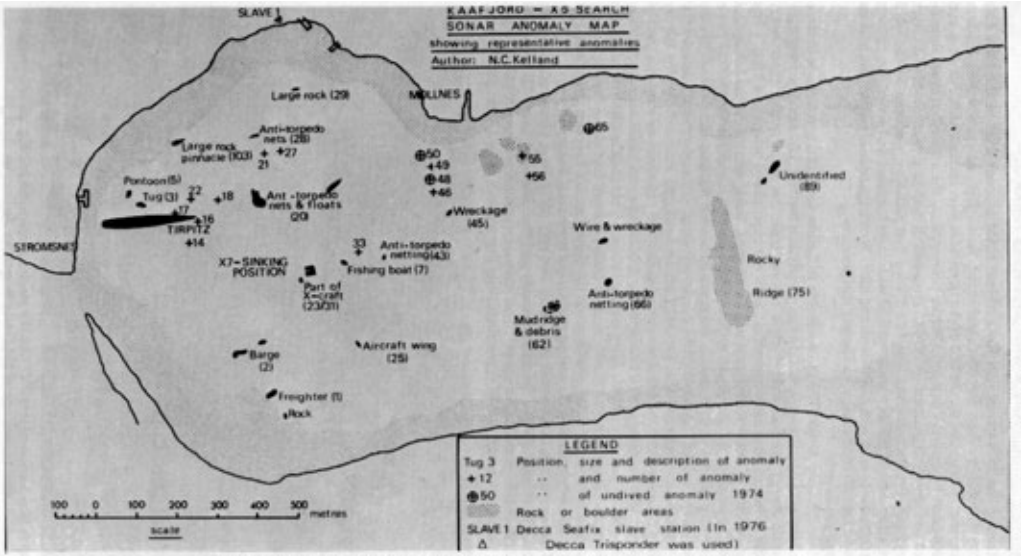


Photo 5. Kaafjord X5 Search Sonar Anomaly Map. Note area of rock walls and rock ridge.

Kaafjord 1976 (5)

During the 1974 expedition Kelland had made a sonar map of the fjord (see Photo 5) using modern shipborne surveying techniques. Any interesting features (anomalies) recognized on the bed of the fjord were then marked with shot lines and investigated by divers. Time in 1974 had prevented all the anomalies being investigated and so it was planned in 1976 to remake this map in greater detail and check everything. Previous observations had shown that although the sides of the fjord were steep, and in places almost vertical with huge boulders and rocks, the bottom was flat and covered with a silty sand and mud. Wreckage found lying on the bottom showed that siltation rates since the war had been low.

Search Techniques

Side Scanning Sonar. The most suitable technique for locating wreckage in these conditions is side scanning sonar. In this geophysical method pulses of high frequency acoustic energy are transmitted on a regular basis out from a transducer either rigidly mounted on a survey vessel or, as in our case, towed astern in a "fish". The beam widths of these transducers are fan-shaped, being narrow in the horizontal plane (approximately one degree to 3db points) but much wider in the vertical plane (up to fifty degrees to 3db points). Objects and seabed features which lie within the beam width "reflect" signals back to the survey vessel. These signals are detected by the transducer, processed and recorded on an analogue recorder. As the survey craft proceeds reflections from successive pulses are presented side by side on the recorder. The resulting side scanning sonar record thus represents an acoustic map of the seabed and any objects lying on the bottom. This map is distorted since the scale in the direction of the sonar sweep is different from that along the survey traverse and because the equipment records the slant distance between the transducer and a reflecting object on the seabed and not the horizontal distance.

Due to the relatively small size of an X-Craft or at least pieces of it, it was necessary to use high resolution equipment and that chosen was an "E G and G dual channel high resolution sonar". The equipment comprises a shipborne recorder, tow cable and sonar fish. It scans simultaneously to both sides of the survey track

Photo 6. Bow Section of HMS X7 with our marine geophysicist holding the underwater TV camera with one of the Decca Trisponder Stations on the right.

Kaafjord 1976 (6)

and operates at a frequency of 100 kHz. Its effective range resolution (measured in the direction of the sonar sweep) is 0.1m, whereas the resolution along the survey traverse is a function of range and towing speed over the ground. For our work the range was limited to 500ft and the towing speed to two to three knots.

The sonar method can only be used with any confidence for a search when the lost object has different backscatting or reflective properties from the general background. This would be the case if an X-Craft lay on a sand/silt bottom since a much stronger signal would arise from the submarine than from the seabed and would give rise to a distinct anomaly on the sonar record. However if it lay among rocks it would be virtually impossible to identify since signals from the rocks and submarine would be similar. Should a vessel wrecked on a rocky bottom be large then it can sometimes be identified on sonar records from its distinctive shape. However the X-Craft was small (15.5m) and probably broken up. Another situation which had to be considered during the survey was the effect of any side reflections. These arise when strong reflecting surfaces such as rock walls and jetties lie perpendicular to the sonar beam. If the reflected signals are sufficiently strong they are recorded from ranges in excess of the range setting on the recorder and will obscure weaker, nearer signals. Thus since the fjord sides were rocky and steep it was necessary to make the primary sonar traverses across the fjord. However as the best chance of locating a complete X-Craft would be to run traverses parallel to its length and thus ensure the largest sonar anomaly and as its position on the seabed was unknown, secondary sonar traverses were made at right angles, along the length of the fjord.

Anomalies of a size smaller than 1m were located on the seabed by this method.

Positional Control

Decca Trisponder. Any anomalies identified on the bottom of the fjord had to be mapped and buoyed to an accuracy better than the radius of an area which could be swept by two divers on a single dive. This was considered to be 20m. An accurate positional control for both the survey and for dropping marker buoys on to the anomalies, was achieved by using a Decca Trisponder on loan from Decca Survey Ltd. They very kindly calibrated the equipment before giving it to us.

Trisponder is a microwave pulse position system and in this case employed a range-range mode with a master station on the survey boat and two slave stations on the shore. In each case the ship lies somewhere along a circle of known radius (the equipment having a direct read out in metres) centred on the appropriate slave station. The location of the survey vessel is where the position circles from each slave station intersect. The accuracy of the fix is related not only to the distance measurement but also to the geometry, ie the angles of cut between the two position circles, and is best when they cut at 90 degrees. The slave stations were surveyed into position from a local large scale ordnance map to give the best possible readings over the whole area of interest.

Transit markers. The sonar was used at a range setting of 500ft which gave a sonar coverage of 1000ft from side to side (all measurements were in feet), and the primary survey traverses were run with a traverse spacing of 150m. This allowed a total overlap between adjacent traverses and meant that the area with the shortest slant range, ie beneath the sonar fish, was also looked at a second time at a greater slant range.

In order to ensure the accurate navigation of the boat along each traverse pegs were surveyed in along the shore so that each traverse line had a front and back marker. Large boards painted in red and yellow were then placed on these and used as leading marks. They were moved along as required by a shore party.

Interpretation

The interpretation of the sonar record is a skilled and exacting job and the position of each anomaly was calculated and plotted on a master chart. Allowances had to be made for variations in the ship's heading and tidal drift of the sonar fish and a mean position worked out between the overlap on adjacent traverses and when necessary between the primary and secondary traverses.

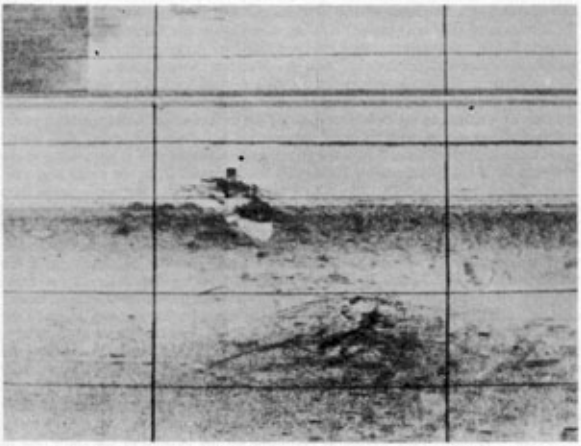


Photo 7. Part of the Sonar Trace of Kaafjord clearly showing a sunken freighter lying on the seabed.

Well over a hundred anomalies of different shapes and sizes were located, plotted, buoyed and subsequently dived upon. In most cases the object being investigated lay within 10m of the shot at the end of the buoy line and this clearly proved the complete system.

Results

Several hundred dives were undertaken and divers reported objects which included a 60m long two funnel tramp ship, a sea going support tug for *Tirpitz*, huge concrete pontoons and caisson's used during the subsequent repairs to *Tirpitz*, several fishing boats, depth charges, piles of torpedo netting and single net floats, aircraft wreckage, general debris of war and natural features such as large boulders.

As already mentioned the sonar could not differentiate between rocks and wreckage on the steep sides of the fjord or on the long rocky ridge (see Photo 5). These areas had not been investigated during 1974 and in 1976 required a great deal of painstaking effort and hard work to inspect and search them with divers.

DIVING

Military diving is most usually controlled by lifeline from the surface and tends to be at relatively shallow depths. Divers wear a "dry suit" which without modification can make it difficult to control buoyancy, particularly when surfacing from deep dives.

Sport diving is normally carried out swimming "free" in pairs and wearing "wet suits". Buoyancy is controlled by an inflatable life jacket which usually incorporates an automatic purge valve so that controlled ascents can be made without too much difficulty or skill on the divers part.

As Service divers we had to operate on the well proven Admiralty diving tables, whilst our civilian counterparts were able to use the newer RNPL tables adopted by the British Sub Aqua Club. This enabled them on the deep dives to dive more frequently in any given 24 hour period.

We were not able to mix the two systems of diving for safety reasons and so the

Kaafjord 1976 (7)

two teams worked separately, but of course towards the common purpose. Group tasks were allotted and adjusted daily as needed.

Rock Wall Searches

The greatest diving effort in terms of man-hours and time spent underwater, undoubtedly went in searching the steep rock walls that formed the sides of Kaafjord (see Photo 5). Looking at the flat waters of the fjord at the start, it was almost inconceivable that any wreckage could remain hanging so close to the edge, when the underwater profile showed banks as steep as 40–60 degrees. However a few dives soon dispelled this and we thought we were on to something. Huge rocks, some the size of a small house made up the steep jumble of the fjord sides and it was behind these that much wreckage was found wedged and perched. Within 20m of the waters edge on the surface and yet at depths of 35–40m we found a small freighter, concrete caissons, general wreckage and the one that gave us the most excitement of all—a 20m long fishing boat that at first sight was just the correct size and shape for an X-Craft. The total distance of rock wall to be searched was 4500m and for the reasons already discussed the service and civilian methods differed (see Photo 8).

We dropped a shot line from a boat some distance out on the flat bed of the fjord and from the shot led a jackstay or bottom line along the flat till we met the steep fjord wall and then up that to a marked station on land. A diver then descended the shot line and swam along the jackstay till he reached surface, searching as he went. The jackstay was then moved and the process repeated. This is very thorough but too painstaking for the size of the task.

Our civilian divers worked in teams of three joined by buddy lines. They swam down from the waters edge in a line abreast controlled by the centre men on a compass bearing. They reached the flat fjord bottom, swam out a short distance, swung round and came back up on an adjacent track on the reciprocal bearing. This method, although fast, seemed to me to be a bit too casual and to run the risk of overlooking small wreckage. Indeed the diver in charge also felt that after a few days, and tightened up his drills and re-swam the areas already covered.

The complete answer probably lay somewhere between the two methods and we evolved this for searching the rock ridge which proved to be the most difficult and demanding diving of all.

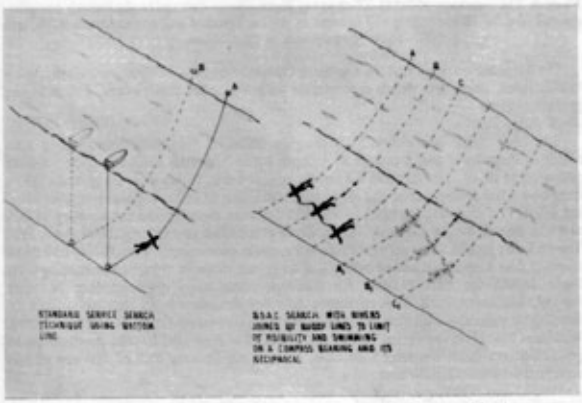


Photo 8. Diagrams illustrating the two basic search techniques used by divers.

Photo 9. The wreckage of HMS X7 showing depth charge damage to the battery compartment. Note the 10 ton lifting bag inflated in the background and the underwater TV and lighting equipment in the Gemini.

On the later searches our own team developed a system of contour swimming on buddy lines, using two depth metres and with the more experienced divers at the greater depths.

Rock Ridge Search

The rock ridge (see Photo 5) is roughly 300m by 50m with rocks up to 10m above bottom level and it occurs at a depth up to 55m (the limit at which we were prepared to dive). The method we finally adopted was to lay a jackstay some 400m long down the centre line of the ridge with a number of intermediate shot lines coming off it. The most experienced of the BSAC divers then carried out a sweep search at right angles to the jackstay—each diver connected to his neighbour by a line. The jackstay served as an accurate reference mark, particularly when a dive had to be aborted and also as an added safety aid to give a diver in trouble his bearings. At these depths the time penalty for recompression stops on ascending becomes critical, for example, a dive of fifteen minutes duration from leaving surface to starting to ascend—with due allowance for cold—requires stops of thirty minutes. Wet suits lose their insulating properties at depth and we had to take precautions to protect divers from the effects of cold, Service regulations restrict the use of wet suits in cold waters below 25m.

Anomalies and Wreckage Recovery

Diving on the anomalies was straighforward and proved the system being used.

Kaafjord 1976 (9)

Often the shot line dropped by the survey party was alongside the anomaly and always within reach of a 10m circular search. Anomalies nos 23 and 31 which had been found in 1974 were re-located and proved to be the bow and centre section of an X-Craft and permission was obtained to lift them. They were resting in 45m of water and partly covered by mud and took a team of divers, including part of our own Regimental team, a week and three attempts to raise them.

The method used was to pass heavy lifting chains around the wreckage and shackle on a number of lifting bags with either a 10 ton or 5 ton lifting capacity as required. As a safety measure we filled the bags from the surface using high pressure airlines. The centre section of the X-Craft gave us the greatest difficulty as it was not only filled with clay silt but also housed the battery compartment and weighed between 15 and 20 tons. Once raised, pieces of wreckage had nets wrapped around them to catch any artifacts and were towed to the shore where they were winched up the beach on wooden rollers by a Norwegian Army heavy recovery vehicle.

Each piece of wreckage was carefully searched and the finds wrapped in polythene to keep the moisture in them until they could be scientifically preserved. They have not all been fully evaluated yet but included clothing, a Sladen diving suit, three Luger pistols belonging to the crew, a pair of binoculars, a sextant and even a tin of "compo" margarine with the tin almost rusted away but the contents intact!

Among many other items we also raised the engine and several parts of a Grum-

Photo 10. Royal Engineer Diving Team. L to R: Captain Haywood-Broomfield, Lieut-Colonel Owens, Captain Lilleyman, Lance Corporal Spivey (front), Sapper Turner (rear), Lance Corporal Creasey, Corporal Barry, Sapper McMullen, Corporal Hillard.

Kaafjord 1976 (10)

Photo 11. Two 10 ton lifting bags, with underwater TV and video recording equipment in operation from the Gemini alongside.

man Hellcat aircraft of the Fleet Air Arm. Three of these from 1840 Squadron were lost, one on 22 August 1944 during *Operation Goodwood* I and II and two on 24 August 1944 during *Goodwood* III. It would appear that the plane we found belonged to a New Zealand pilot who was killed when he was shot down, and is buried in the military cemetery at Tromso. The propeller from this aircraft is being presented by the Regiment to the Fleet Air Arm Museum at Yeovilton.

Photo 12. The sextant, two Luger pistols and the binoculars from HMS X7.

Kaafjord 1976 (11 & 12)

Equipment

Underwater Television. A small portable television camera was used in conjunction with videorecording equipment and underwater lighting. Power was supplied from a generator mounted in a Gemini inflatable. It was particularly useful in recovery tasks to brief divers exactly where to attach lifting strops etc: I do not think we utilized the full potential of this equipment and believe that a development of it would be useful to diving work within the Corps. It should be possible, by using winches mounted on the inflatable to control the integrated camera and lights from the surface and study objects and work being carried out at depths.

Compressors. Between us we used two civilian compressors made in Austria and two service issue ones provided by the Regiment. They were in use almost continuously for up to eighteen hours a day; all gave trouble and required constant maintenance. Without our help and the use of a Norwegian Army workshop to mend them, diving would have had to stop on several occasions. As it was we just managed to keep going.

Surface Demand Diving Equipment. Service air tanks are of small capacity and for deeper dives of longer duration we rely on SDDE equipment. In the Corps we use parts of the RN system modified to suit our Heinke equipment and in my view this is not satisfactory for deep or difficult diving. Despite quite extensive pre-dive training we had two small incidents with our SDDE and I discontinued its use. Where necessary for deeper dives we borrowed civilian tanks of larger capacity and in future I would always do this or use the full RN system without any army modifications.

Safety

Diving medicine is very much a specialist skill and few doctors are aware of all the problems involved. We were most fortunate in having with us a lady anaesthetist from a London hospital who was not only a first class doctor but also a top rate diver. She brought with her a very comprehensive list of drugs and equipment. The nearest large hospital was at Tromso, six to eight hours journey by road and the nearest X-ray facility at Hammerfest three to four hours in the opposite direction.

I took with us a Drager one-man compression chamber from REDU Kiel. The nearest Norwegian one was at the Navy Base at Tromso and was fortunately of the same make, so that we were able if needed to transfer a patient under pressure from our chamber to their larger one. With so much diving and difficult conditions all emergency kit was on immediate standby and our chamber was fitted in the rear of an 4-ton truck and always available on site with sufficient air supplies in large cylinders on board.

Our first and most serious accident occurred to one of the civilian divers on the second day and underlined the necessity of working up a team before an operation. He was using one of the new "unisuits" and was not fully used to it and his demand valve was possibly carelessly serviced. He was at a depth of about 36m and had difficulty in breathing which led to a build up of carbon dioxide and a partial blackout. Either because of this or because he was not used to his equipment he surfaced too rapidly despite the efforts of his companion to hold him down and control his ascent. He arrived at the surface frothing blood from his mouth, caused by ruptured lungs. Instant reaction by Dr Joan Lamb undoubtedly saved his life and the local Norwegian Red Cross proved their efficiency and flew him at low level by amphibious plane to Tromso. He made a quick recovery and although still on the sick list spent the last few days back at Kaafjord.

A similar incident happened to one of our service divers who wrongly inflated his suit at depth. He made an uncontrolled ascent and broke the surface like a Polaris missile. However he remembered his correct drills and breathed out during the ascent thus avoiding injury to himself. This occurred mainly through inexperience and highlights yet again the need for continuous training for divers.

The last incident of note was when one of the BSAC divers developed overnight an inexplicable limp and pains in the ankle. On checking his diving log we found

Photo 13. The one-man compression chamber in the back of a "four tonner" on site and ready.

that he was just within the requirements of the RNPL tables he was using. Allowing for cold water and hard work he had had 15 minutes too little recompression in the last 24 hours according to the Admiralty tables we were using. The dilemma was whether to treat it as a bend and commit him to a period of almost 7 hours in the very cramped one-man compression chamber, try to treat it medically or accept that he had only twisted his ankle and leave it in the hope it would get better. The Service Diving Manual makes provision for advice to be available in difficult cases from the Superintendent of Naval Diving *HMS Vernon*. Dr Lamb and I decided to avail ourselves of this and I wish to express thanks here to the efficient way the Naval system operated. We used a NATO phone line from the local Territorial Army unit and were through on a Sunday morning to the Duty Officer of *HMS Vernon* within five minutes. Within twenty minutes a specialist medical officer from the Royal Navy Physiological Laboratory was on the phone and was able to discuss the case with our own doctor. In the event it was diagnosed as a minor bend and treated accordingly.

One interesting way we used our compression chamber was to calibrate all the divers individual depth gauges. Sport divers rely on the accuracy of these to calculate their stops during an ascent. We found a horrific discrepancy in some of the guages in use and this will probably be the subject of an article in the BSAC Journal *Triton* in due course.

SUMMARY

As a result of diving in Kaafjord we learnt a great deal more of the attacks on *Tirpitz* and the brave men who made them.

The forward half of *X7*—as it proved to be—has been handed over to The Imperial War Museum, together with other material, to form the centre of a new display.

We can catagorically say that *X5* was not sunk, as claimed, in Kaafjord and does not lie there. That solves one mystery only to pose another which will probably never be solved.

We have proved the mutual value of diving alongside a civilian team and as a Sapper team have probably undertaken deeper diving under more difficult conditions than has been tackled by the Corps for a number of years.

We have been involved in the use of the most up-to-date and sophisticated equipment and have learnt a great deal from Peter Cornish and his colleagues on the possibilities that such equipment opens up.

From a military point of view the most worthwhile aspect was the high degree of skill and experience acquired by a Regimental Diving Team after only a few weeks of concentrated diving.

HMS X5 "SPECIFICATION"

Built:	Vickers-Armstrong Ltd. Barrow-in-Furness
Launched:	31 December 1942 at Faslane
Displacement:	35 tons
Overall length:	15.5 metres
Pressure Hull diameter:	1.8 metres
Armament:	2 detachable saddle charges, each containing two tons of amatex fitted with a thirty six hour delay action fuse
Engines:	Gardiner diesel engines and heavy duty batteries
Complement:	4 men
Captain:	Lieutenant H Henty-Creer, RNVR
Crew:	Sub Lieutenant D J Malcolm, RNVR Sub Lieutenant T J Nelson, RNVR ERA 4 R J Mortiboys
History:	Reported sunk 0843 hrs, 22 September 1943

Three Weeks to La Panne
A Diary of 1940—Part 2

LIEUT-COLONEL R L CLARKE, MA, C ENG, FI MECH E, FIEE, FI PROD E, MIWM, M INST MC

PART 1 of this diary took the reader from 9 May to the moment on 17 May 1940 when the news came through that 4 Div, who had moved up to Brussels, were to fall back.

Friday 17 May (continued)

The news is that we are to fall back behind the line of the Dendre now held by 3 Div. The doctor and Sauervein are to set off at once with the advanced party for Resseghem, while I get some sleep and bring on the section with the HQ Div convoy after dark. We have to be across the River Dendre by first light. The Adjutant and CRE are together in the Humber Snipe elsewhere so I am to take the shooting brake. The RSM, the CSM and the Sergeant Clerk ride in 15cwts. A tracing has been issued showing the route which avoids both Alost and Ninove. I have a torch to look at the map but the shooting brake is not blacked out so have to be careful. We are allowed no lights.

I start badly by taking the wrong road out of the village. Rather than face turning each truck round in the dark, I drive into a field of roots, take a wide sweep and drive out again and back; successful, but have now lost the convoy ahead. Take my direction from the flashes in the eastern sky. On the main road Graham comes alongside on his motorcycle. "Sir, Hodder has broken down". "How long?" He went back to find out and eight shadows behind me slushed to a standstill. "No verra bad; ten minutes". Suppressing the feeling that we are well in the rear of the

whole British Army I decided to wait. Twenty minutes later we start. There should be a left turn soon. . . . Can hardly see the road, let alone landmarks. Turner is not much help, being so shortsighted that I have to tell him how far is he away from the edge of the road. This could be the place, but there is no going back if it is wrong. Leeming shepherds the convoy round. Next there should be a right turn; but I only have seven trucks instead of eight. "Foster has gone back to look for Gregory", says Cpl Wilkinson alongside, "He must have gone straight on at the last turning". I start off again. From here according to the map a beautiful wide road leads to our destination, but instead it is getting narrower and narrower. I am climbing a hill, and I feel the tyres ploughing through sand! I come to a fork. The gunfire has stopped, there is no moon and I have no idea which way I am pointing. The lanes are too narrow to turn. There is a cottage, pitch dark because it is after midnight. I knock on the door until a man emerges, his wife behind. They do not speak French. I go in and spread out the map on their table. They are excited because they have never seen a map before. I cut them short and ask the way to Resseghem but they do not seem to have heard of it. I take the right hand lane. Half a mile later it ends at a gate.

Repeating my previous performance I drive into the field and do a wide circle but this time the Humber sinks down to the axles in the soft ground. I tell the other trucks to turn round as they can, and Goddard backs over Leemings motorcycle. The moon is now up and a mist is rising. It is 2.00 am. We load up the motorcycle and offload the Humber. At last it comes free with a lot of pushing and the convoy sets off back down the lane. The other fork leads downhill between steep banks. A dark figure looms in front. "Where does this road lead?" "Dunno sir, but its blocked by ammunition lorries up ahead". We'll see about that. I squeeze past the first lorry, and turn to see the others squeezing past too; then two more, and then I come to the last, I rouse the driver and make him pull over. We cross a stream by a grove of poplars. Up a little hill there is a hurricane lamp with the welcome sign HQRE. Inside I surprise Dick Walker, Adjutant RE 3 Div and lately of 7 Fd Coy who puts me on the right road.

The doctors anxious face is a cheering sight at the rendezvous where we are well overdue. Foster like a good despatch rider has already arrived, taking the sensible route by instinct. Gregory turns up later in the morning having followed an RASC convoy along the main road.

Saturday 18th May

No time even to set up the office truck. I am to leave at once as the next advanced party with Sauervein. Div HQ is to move to Waregem behind the River Escaut today so there is no time to lose.

The main road is a mass of traffic of all formations moving west with no attempt at spacing or discipline, ambulances, three-ton lorries, Belgian horse drawn artillery. One horse has a flap of flesh hanging off its rump. As we draw near the Audenarde bridge traffic becomes two then four abreast, mounting the verges in attempts to gain position. This would be a holiday for the Luftwaffe, but there is not a single aircraft in sight. A II Corps Staff car draws up alongside me and there is Major G G S Clarke. "About that last pillbox return of yours," he begins. . . . The jam is caused by sappers of 44 Div, a welcome sight, preparing the bridge over the Escaut for demolition. After Audenarde, the road to the north west is deserted. I stop in Kruishouten and we buy cold sausage and cheese. Waregem is a pleasant little village with a chateau. The road with the chateau is allotted to "gunners and sappers". We move like lightening. While I hang the RE sign on the wrought iron gates to keep out the gunners, Sauervein marches up the front steps and bawls out a surprised Belgian family having lunch. In future they will be permitted to use the kitchen and one back bedroom. By the time he has allotted the other bedrooms, with a suite for the CRE, his interest begins to wane. But when Madame at the house next door shows reluctance to accommodating the section, he perks up. "Salle femme! This is war you must understand. . . . Do you not hear the cannon?

Boom, Boom!" Then he goes to sleep on the lawn while I proceed to find a billet for the RSM. The CRE would be pleased; he is partial to chateaux, and I have to be firm with Monkey Hill who is having second thoughts about a place for "A" Mess. Finding the key of an empty house takes me out of the village, but I get back at five o'clock in plenty of time to meet the main convoy. Sauervein is frantic. "I have been looking for you everywhere! Everybody has gone away. The location has been changed to Sweveghem". I said I have to return the key, but Sauervein said that it would be a ridiculous waste of time. We creep shamefacedly into Sweveghem behind the convoy, but the doctor has done wonders in the short time he was given, finding us an office in one corner of a large classroom in the school. I balance my Intelligence Box on two desks and make out my reports.

Things at the RE Mess are not too happy. The doctor has found an empty blue-tiled shop in the main street but it is too narrow to park a truck there so the equipment has had to be carried which makes the dinner late. The CRE has arrived tired and cross, and Paul Hodgson is lecturing people on the sole purpose of HQRE, ie, to administer to the CRE's comfort. I entirely agree but lack of sleep has overtaken me and I am not a bit hungry. I retire with Geoffrey to the loft allotted to officers and collapse on the wooden floor.

Sunday 19th May

Aroused by a Bren carrier clattering past. As the noise dies away a muttering shuffling remains. The window is level with the loft floor so without getting out of bed I look out to see the refugees. Later there are church bells and as I go to breakfast the townspeople in their best clothes are going to church.

Take my map board to Div HQ. They have got the chateau this time and no mistake, taking it over from the Belgian Corps HQ. They had to push antique furniture aside to set up their "tables 6ft" and install telephones.

We are to stand on the Escaut which is a relief, with 44 Div on our left and 3 Div on our right. The maps are hopeless so the first task for us is to be a complete road survey. Geoffrey and I divide the Div sector between us and set out on reconnaissance. Eastward from Sweveghem the road undulates for a mile or two and then sweeps down to the river. Beyond, tree covered hills rise to dominate our whole forward area; but as yet there is no sign of life. The four bridges in our sector are manned by 44 Div RE. Across the northerly one the refugees are pouring, shepherded by the CMP onto side-roads. They are very orderly with carts, perambulators, cars topped with mattresses, household utensils suspended, donkeys behind and dogs underneath. They wave as I drive past. Everywhere troops are digging-in guns making use of every bit of cover. Every minute or so a ranging shot comes flip-flopping overhead. Our right hand boundary is the Bossuyt Canal which rises by a series of locks to the watershed. Crossing the bridge at one of these locks I see to my horror that it is prepared for demolition with the detonators in position and no one on guard. In a nearby house I find the NCO who has knocked off his party for a smoke. Take him outside. . . .

Monday 20th May

A dung cart goes past the window with a shovel stuck in the top. Business as usual, but not today on the forward slope. There is no going down to the river. The Germans have got across during the night on the 44 Div front and their shells are ranging on various landmarks, farms and crossroads, throwing up a cloud of pale brown dust every few minutes. Some dead animals in the fields. Nobody stirring, not even refugees.

Back to lunch having completed my reconnaissance. Sauervein plunged in gloom at the news that General Giraud has been captured. Go to Div HQ afterwards for the latest news. The map is covered with blue marks and question marks. There are fifth column scares—we shall be glad to get away from Flemish speakers who sound like Germans. Brigadier Anderson has been shot at. As I come out through the garden a padre is being marched in between two military police. Behaving in a very odd way and refusing to give his name, but is obviously British and hear later

that he comes to his senses under John Stevens' steely influence. The French have closed the frontier so the streets are now milling with refugees. No civil administration in evidence. Get talking to a girl in a blue dress and advise her not to try to get into France.

Enemy aircraft reappear in the afternoon flying high with attendant puffs. They remind Div HQ that their chateau is too obvious and we are warned that we might have to move out of our school to make way for them. The doctor goes to prospect alternative accommodation while I finish my road report. Despatch tracings to HQ Div and Brigades.

Tuesday 21st May

Gus Galloway rings up to say that a carrier pigeon has been launched from near the 59 Fd Coy office in the outskirts of Sweveghem. I take Sauervein and meet him on site where he points out the suspect house, guarded by a few sappers. As we watch another carrier pigeon flies out from the roof. I draw my revolver and fling open the front door. Inside an elderly Belgian couple are cowering. A policeman appears from nowhere. "Pigeons monsieur? But here all the world has pigeons". I am conducted upstairs to the pigeon loft. The anticlimax is too much for the policeman. Struck by a happy thought he says "Where is your licence?". The old man produces a dirty screw of paper. It is out of date. He is put under arrest. Many words are spoken by all Belgians present, simultaneously. Outside the guard is getting restive as pigeons fly out from all over the place. A crowd begins to gather and the policeman is on his mettle. Up the street he dashes into house after house, coming back proudly leading a little group of criminals. What did I want him to do with them? Something bold is expected of me, but summary execution seems inappropriate. To play for time I bundle them into the back of my truck and drive off to the Field Security Office. I go in and ask Basil Bartlett if he is collecting pigeon fanciers. As his answer leaves no room for doubt I turn them loose hoping that the walk will teach them a lesson. Continue on a tour of companies. 18 Fd Park is settled in a barbed wire factory. Glorious afternoon with the fields hard as iron. A thick column of dust rises from a group of houses half a mile away, then another and another. Harassing fire.

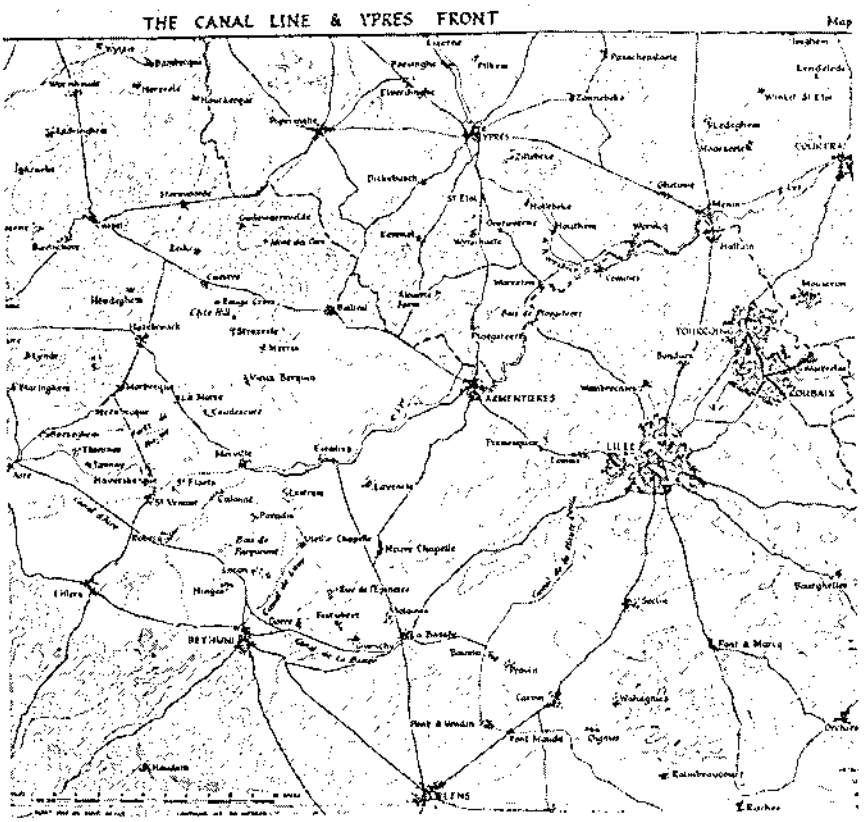
I get back to the office to find a panic. The Adjutant has been looking for me for hours. We are to fall back to behind the French frontier, occupying as luck has it, not our old sector but one to the left; so we take over 5 Div sector and 3 Div moves into ours. I am to leave immediately for HQ 3 Div and show them where all the engineer work is, especially the pillboxes. We have handed all our records over but I carry them in my head. Hewitt is standing by with my truck. I am not allowed to take Sedgewick because he has become too useful as Mess Steward, but he has packed and loaded my kit. I shall have to rough it with a batman/driver.

HQRE 3 Div are near Aalbeke and I arrive in plenty of time for dinner. They are old friends, and are interested in my account of the 4 Div war so far. They are to move next day, so Lieut-Colonel Desmond Harrison suggests that I should go round to G(Ops) after dinner to report. Pat Ronaldson takes me round and introduces me to the GSO1. He has received a pillbox tracing but it does not seem to be quite right. I am shown a table where I sit down and mark up their map. They do not think that 4 Div has done very much work at all. They wish they were in their old sector where they have dug a continuous fire trench from end to end as well as building twice our number of pillboxes. It is getting dark and the lighting set has not been switched on. A voice snaps "Who are you and what are you doing?" A little man with a face like a weasel has come into the room, his jacket undone. I am surprised to see red tabs under his jerkin. I stand up and explain. "All right, carry on". He turns away. It is Montgomery, the Divisional Commander.

Back at HQRE Hewitt has laid out my kit on a couch in the passage.

Wednesday 22nd May

With nothing to get up for next morning I am pleased to see the others hurrying away. The doctor of 3 Div RE cooks me an excellent breakfast. There is nothing



I can do because everybody is packing up, so I walk round the village keeping close in case a call comes through. The place seems deserted. I suppose the people are all in the cellars.

Orders come that 3 Div HQ is to move to Bondue, (see map), that night. I leave with the advanced party after lunch. It seems like coming home, zigzagging round the frontier barricades into France and our old sector. Visit the Citadel to call on the officers of the Secteur Defensive de Lille with whom we have laid out many happy switch lines. They are sitting mournfully in a basement by candle light. Shake some very limp hands and feel embarrassingly hearty. At La Madeleine I see the Fd Park Coy has arrived and call in to see if they have found our dumps. Winkfield has not missed anything. The windows of my old billet are shuttered; the Rouzets I am glad to see have left for Aix-en-Provence. Tourcoing is still crowded with children playing around the pillboxes. There are enemy recce aircraft about but no attacks. Every tree has a vehicle under it with a unit sign every few yards. I am hailed at one unit to advise on whether the roof of the place they have chosen as an office is strong enough. Reassure them. They have opened the frontier again at Roubaix because a column of refugees is moving west, diverted towards Mouvaux off the main road.

When I get back to HQRE 3 Div I find that Desmond Harrison is planning a private-enterprise scorched earth operation for the following morning. As a guest I am of course invited to join the fun. He has spotted a weaving mill in Mouscron on the Belgian side of the frontier. Being disappointed by the amount of material falling into German hands, and having plenty of spare energy he has decided to burn it down before breakfast.

Thursday 23rd May

The whole of the HQRE staff take part in the operation, just filling one truck. We cross the frontier with explosives and cans of petrol as dawn glimmers ahead.

This is now the front line because our rearguard has fallen back from the Escaut during the night, but according to the picket there are no reports of the enemy. To be on the safe side we drop off a sentry at our right-turn off the main road with instructions to fire two shots if an enemy patrol appears. We have guncotton ready to blow the gates but they are standing ajar. We drive up to the black mass of the factory and tumble out. Dick Walker has explored the sprinkler system by daylight and sets to work to lay the explosives to cut it. The rest of us disperse to various buildings. The store house allotted to me is stacked with milky white reels of thread piled twenty feet high into the gloom. I pull down pile after pile onto the floor and spread shavings around. Then comes a whistle warning us to muster by the main gate while the sprinkler charges are blown, a shattering noise in the early morning peace. Now we must work fast. I slosh petrol around, open all the doors and windows; strike a match. There is a roar of flames followed by dense choking smoke. I run back to the yard where the CRE is dealing with the oil store. I never realized that oil is so difficult to set alight. I follow him into the next shed, piles of reels and criss-cross passages. The smoke gets thicker. Will he never come out? I go further down after him and meet him halfway back with the flames leaping behind him Suddenly there is a click, a rushing noise and we are both drenched. The sprinklers have won after all! Outside thick black oil smoke is curling up. There is a noise of tracks, a carrier going fast down the main road; probably one of our patrols coming in. "Better get going. Everybody here?" Dick Walker is missing. It is already light. Somebody runs back, and a long half minute passes. Then they both come running and jump on behind the truck. As we drive back through the zig-zag we hear the clanging of a fire engine's bell.

After breakfast I set off on my tour of brigades. There is an impressive display of energy; everywhere weapon pits are being dug and culverts prepared for demolition. My reception at brigades confirm my favourable impression. In every case I am received by the brigadier with the utmost courtesy. Brigadier Woolner (late RE) invites me to a drink but I have to hurry on. In general they have had no difficulty in finding our pillboxes but do not think much of their siting. But our efforts will be useful in diverting enemy attention away from the fieldworks they are building for themselves.

A summons arrives for me to report immediately to HQRE 4 Div at Wervicq Sud in the former 5 Div sector. When I arrive I find I am in hot water again. The Chief Clerk packed the spare maps in the back of my truck without my knowledge. Sedgewick has been made an unpaid lance corporal and I have lost him for good. So nobody had kept a place for me and Hewitt has to rig up a bed in the corner of the mess where it has to be taken down to eat. The doctor and Foster are wearing beautiful new sheepskin jackets. "If I don't take them the Germans will" he says. Paul Hodgson says something about getting down to a job of work after my prolonged holiday.

I set off for 7 Fd Coy to plan a wiring operation near Halluin for the following night. The night is very dark and it takes me two hours to travel the four or so miles, and then only finding Company HQ by the aid of the flares the enemy are now dropping. The atmosphere there is rather strained; Vaughan Williams has sent the French Liaison Officer upstairs to get properly shaved.

Friday 24th May

Div HQ has settled in a large white house overlooking the River Lys valley and visible for miles. Straubenzee and Stevens are in a little room behind. A Bren gun is mounted on the window ledge with which Straubenzee takes a pot shot at aircraft from time to time. The news is stimulating. The enemy has reached the coast and we are to stand here and fight it out. We certainly have plenty to fight with. I have never seen such a concentration of formations as yesterday, the white triangles of 1 Div

and the crossed keys of 2 Div as well as the TA divisions. I go down to the Lys and look across the bridge to Menin, occupied by the Belgian Corps on our left. The bridge is under guard and prepared for demolition. Shells are falling occasionally on Menin. A mother is doing her washing on the river bank, a child playing beside her.

A shell lands in the 18 Fd Park Coy. Arthur Nixon brings a piece to show us. When I take it round to G(Ops) with my first "Shelrep" there is nobody in the office so I sit down to read the latest summary. "Excuse me". A padre has come in. I say I am a visitor like him but he does not seem to hear me. "My colonel has sent me to find a parking place for our transport. Can you advise me what to do?" I suggest he sits down and relaxes. "But you do not understand; it is a gunner unit and it is essential that I find some place for the transport at once". Then he gets abusive. "You staff officers are all alike; none of them will help me". He wanders off down the passage wailing "What am I to do; will nobody help me?"

Drive to 18 Fd Park Coy for the wiring lorries after dark and bring them forward to a rendezvous with the 7 Fd Coy section doing the wiring. I know the roads having traversed them in the days when 5 Div had the sector. Things fairly quiet and the operation passes without incident.

Saturday 25th May

There is a noise of AA fire over Wervicq followed by two dull thuds. A pane of glass breaks. "They are bombing the bridge; go down and get it blown at once" Liaison with the Belgians has broken down and if the charges are displaced the enemy might capture it intact. I spring on my motor cycle and ride for the town, above which the smoke is rising. The streets are full of broken glass. At the bend before the bridge the ADC is standing in the middle of the road, and a sapper is paying out electric cable. He tells me that he has passed on the order to blow. There is a mighty roar and bits fall around. I go forward to check that the demolition is successful.

Geoffrey Pawle is sent off to cross the Lys lower down and recce the canal from Comines to Ypres as a defensive position. I am to recce the Lys itself, west from Halluin, making sure that the Middlesex who have joined us to guard it do not leave any barges unsunk.

My first quarry is a group of barges near Halluin which the Middlesex are attending to. As I watch them at it I am conscious of a hostile presence. Behind me a group of very tough-looking bargees are staring at me. I walk nonchalantly to my motor cycle and ride off to the next point. At Bousbeque there is another section of Middlesex, the corporal is worried because one barge is still occupied. He points out a houseboat with a smoking chimney. I walk across the field towards it, and up the gang plank. There are lace curtains and china ornaments and an elderly couple very frightened. I give them ten minutes to pack their belongings and get out. They ask me where they are to go, and I cannot help them. The river here loops away from the road so I continue across fields, the towpath being the opposite side. There are steep banks making barge-finding difficult. Behind me black smoke curls up from the burning houseboat.

At Wervicq the river is deserted. Shells are falling near the church tower on the far bank, probably ranging. A column of transport comes shuffling across the bridge at Comines and a French officer leans out of the leading car, asking me the way to Lens. He comes from the Leger Division Motorise and is moving south to rejoin the main French army. I ask him what is happening to the north and he says that all is confusion.

When I get back I find all confusion at HQRE too. The Belgian defence has collapsed. Paul Hodgson says he would not have sent me along the Lys if he had known there was nothing the other side. Div HQ is exposed and has to move quickly to Linselles a few miles to the south west. The doctor has done the billeting with his usual efficiency and we have a nice terrace house with clean sheets for all. Unfortunately a medium regiment has set up across the road and fires most of the night.

Sunday 26th May

Geoffrey arrives in the small hours very cross having fallen into a ditch.

Our office is established in the stables of Div HQ's new chateau, and we should be very comfortable. But by the afternoon the flap is really on. We are apparently about to be attacked by two German corps, and one officer and one other rank from each unit has to get back to England to "tell the tale". Geoffrey Pawle has rested, and is sent off with Foster for Dunkirk with the Div HQ party.

We are to withdraw from the Lille salient tonight, but there is no mention of embarkation. I am to lead the HQRE section and rendezvous with the HQ sections of the companies led by the seconds-in-command at Beveren, the II Corps Report Centre, travelling by Nieukerke and Poperinghe. This time I take the Humber Snipe driven by Smith, together with the section transport and Doctor, Sauervein, RSM, CSM, Staff Sergeant, office staff, cooks and despatch riders but without an advanced party. We start soon after sunset. Ahead a heavy streak of smoke lies across the horizon. Gun flashes are no guide this time because they are all round us.

The CMP Traffic Section have marked the first part of the route with a gala of glow-worm lamps, but they give out when the going gets difficult. To avoid other divisional routes we move by a mixture of road and lane to Armentieres and without lights the going is slow. The moon is rising when we reach Nieukerke. A line of black shapes is standing ahead and glass lies thickly near the cross roads. We inch our way past the heavy lorries. There is a smell of death and a pile of tangled equipment. We turn right beyond the town onto a concrete surface and proceed at speed, but soon close up behind some medium gunner Scammell tractors. From now on it is stop-go.

Monday 27th May

By the time we see Poperinghe ahead it is daylight. A solid line of transport is waiting to get through the town. Every minute a shell crashes down into the main square and a cloud of dust rises. Bang-Crash. The queue shifts forward a hundred yards and stops. Bang-Crash. Ambulances, staff cars, matadors, all mixed up as at Audenarde. Must keep our convoy together. Bang-Crash. Something ahead comes loose and we all move forward, into the square and away.

To the left there is distant thunder, and tiny black dots are weaving in the cloudless sky. An hour later more black smoke rises ahead and Stukas can be seen screaming down through it. This looks like Beveren. Stop the convoy on the side of the road and drive on into the town with Graham on his motor cycle as soon as things are quiet. Find Bradfer-Lawrence of 18 Fd Park Coy who congratulates me on not having arrived a few minutes earlier when I could have shared a slit trench with him and watched his transport disintegrating. Drive on searching for the II Corps Report Centre without success until I find myself beyond the town. Here is a track leading away from the road along a hedge offering some air cover to a field with a few poplar trees. This seems a good place for the section to rest. Leaving Graham to reserve the area I drive back to bring up the convoy.

We park under cover and the cooks serve breakfast. I post Bourner, our toughest despatch rider, as air sentry with the mounted Bren gun. The doctor sets off to Beveren to buy some fresh bread which he finds essential. The rumble of traffic on the road lulls us to sleep in the hot morning sun. Suddenly there is a scream like splitting silk and a Messerchmidt 109 shoots over our heads a few feet above the poplars followed by another and another; a sharp turn, round and over us again. Bourner lets them have it with the Bren gun and the rest of the section falls flat. After a long minute everything is peaceful again. There are no casualties so perhaps they were firing at the traffic and not at us. The doctor returns without any bread, pink and angry having spent some displeasing moments in the 18 Fd Park Coy slit trench.

I set off again to look for the Report Centre and find the 59 Fd Coy sign outside a farmhouse. Gus Galloway is sitting on the verandah having breakfast. He asks me whether I am scared. He has no news. I also find Bill Hedley of 225 Fd Coy. He

has no news either and we discuss what to do if we cannot make contact with anybody before the enemy arrives. I drive on to prospect an area where we can make a stand and find some convenient barbed wire defences across the fields to the west indicating the frontier.

Aircraft still active as never before, but the section have not been disturbed again. They seem to knock off at meal times. Time to think about accommodation for the night, so the doctor sets off one way while I take Sauervein the other. We stop by a likely-looking asbestos barn. A Heinkel is flying about and two Belgian soldiers of the Chasseur Regiment are lying in the ditch. "Quesque vous chassez sous les arbres?" says Sauervein. The barn is full of manure, but the doctor has found something, I go back with him to have a look. It is a farmhouse with a red brick path leading up to the low door; the neat kitchen will do very well as an office. As the doctor steps outside again a Junkers 88 roars over the roof a few feet up. He lifts his arms and curses like Balaam.

Back at the section news has come via a despatch rider from the CRE. We are given the map reference of II Corps HQ where we are to report to the BGS. I pick up Gus Galloway and drive to Corps where we find none other than Brigadier Pepper, our late tactics instructor from the SME Chatham, so we are on our mettle.

Bytown—Ottawa 1826–1976

BRIGADIER HWL BROWNE, OBE, MA, CEng, MICE, MBIM

"*OTTAWA, CANADA*—On the 26th of September 1826, Colonel By, Royal Engineers, in selecting the northern point of departure for the Rideau Canal inaugurated the contruction of the Canal and set in motion the founding of By Town—now Ottawa. This year, 150 years later on Sunday, September 26, the City of Ottawa, in conjunction with the Canadian Armed Forces, will commemorate Colonel By's action by naming and dedicating as Colonel By Valley the area lying between Parliament Hill and the Chateau Laurier and containing the impressive flight of locks by which the Canal leaves the Ottawa River.

"More than 150 members of the Armed Forces will take part in the Dedication Ceremony, all in full uniform and formation. They are part of the Head Quarters Ottawa Militia District, the 30th Field Regiment RC Artillery, the Third Field Engineers Squadron, the Governor General's Foot Guards Band, the Cameron Highlanders (Ottawa) Pipes and Drums Band, the 28th Ottawa Service Battalion Ambulance Detachment, the First Field Engineers Squadron, and the 53rd Field Squadron Royal Engineers from Great Britain.

"*Officials:* City of Ottawa, Deputy Mayor Marion Dewar
Master of Ceremonies, Alderman Georges Bedard (Chairman, Sesquicentennial C.)
Major-General Ashton, Armed Forces
Colonel By, Royal Engineers"

So ran the City of Ottawa official press release, which announced that the 150th anniversary of the founding of the city by Lieut-Colonel John By RE would be signified by dedicating a valley in the heart of the city to his name.

Colonel By has long been remembered in Ottawa, and indeed his name is already enshrined in Colonel By Drive, Bytown Bridges, Byward Market, but the desire to record his exploits and honour his name has grown in recent years in a way which is most heart warming and encouraging, especially to visiting members of Colonel By's Corps. It is only five years ago that a statue of By was unveiled in the city and an excellent article, by Lieut-Colonel P A Camp, describing that occasion and telling the story of By's work on the Rideau Waterway appeared in the December 1971 issue of this Journal. It is of interest to note that the idea for the statue was con-

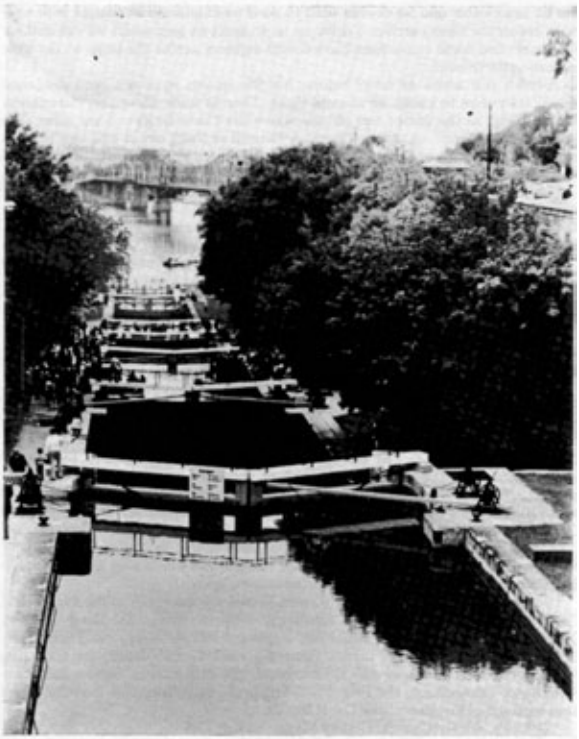


Photo 1. The site of the foundation of the City of Ottawa on 26 September 1826. John By's first flight of locks from the Ottawa River (in the background).

ceived at the turn of the century, the block of white granite on which it stands was unveiled in 1926 but the enthusiasm to build the statue itself took forty years to generate.

As Colonel Camp has stolen the thunder, this article will do no more than describe the ceremony briefly and then enlarge on some aspects of the By saga which seem relevant to the work facing many of his successors today; though sadly, such work is now of a much smaller nature.

The dedication ceremony took the form of a small military floating convoy consisting of a 9pdr gun and detachment on an airportable raft, ten men of 53 Field Squadron (Airfields) in period scarlet uniform on an improvised raft of oil drums and logs (propelled somewhat incongruously by two outboard motors), shepherded through the canal and down the locks to the dedication site by a "Rotork" tug

Bytown-ottowa 1826-1976 (1)

manned by RCE. The remainder of 53 Squadron dressed in service dress marched to the site and had the honour of being the major contingent on parade.

The principle speech was given by the Madame Deputy Mayor who spoke most fluently in French and English without a note. The purpose of her speech was the pride Canadians felt in their city and in the memory of Colonel By, whose vision and ability in town planning laid the foundations for the broad avenues it enjoys today; and whose wisdom and staunch character were the example which the early settlers in Bytown followed. She expressed great pleasure at having so many members of the Royal Engineers present and ended by reminding everyone of the importance of building on the past and respecting the ideas and work of men like By.

Other speakers were Major-General RE (Dick) Ashton, the Senior Canadian Military Engineer, and "Colonel By" himself. The latter is self appointed, a citizen of Ottawa who has played the part to perfection for a number of years. As Colonel By he is always dressed in immaculate period uniform and *is* the Colonel. Children accept him without question; the quote from the press release shows that cognoscenti among adults do too. It is in the worst of taste to ask him who he is in real life and he is never happier than when an ingenuous adult says to him "You look so much younger than I expected you to".

The speeches were followed by a *feu-de-joie* by 53 Squadron, songs by the Ottawa Welsh Choir, a 3-salvo salute by the 9pdr, presentation of a special illuminated picture by the Historical Society of Ottawa to 53 Squadron, and the presentation of a most handsome silver medallion, specially struck for the ocasion by the City of Ottawa Coin Club, to the Corps of Royal Engineers, which has been placed in the Corps Museum at Chatham.

By would thoroughly approve of the choice of the new area to bear his name, not only does it contain the start of the canal system and the biggest flight of locks, but his house and the earliest buildings stood on the heights either side. Moreover, in the last few years the railway lines which ran beside the canal and the main terminal station which stood in the centre of the city near the head of the locks have all been cleared away and the whole area landscaped most attractively. In winter many

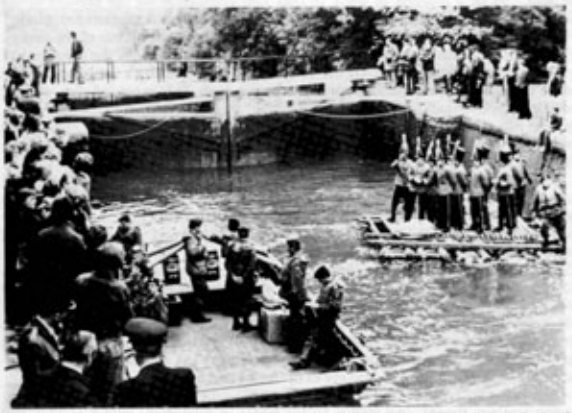


Photo 2. Members of 53 Field Squadron (Airfields) in "period order" on improvised raft navigating the canal. The "Rotork" tug in the foreground is manned by RCE. Is the Sapper in the "Rotork" reading a comic or the instruction manual?!

Bytown-ottowa 1826-1976 (2)

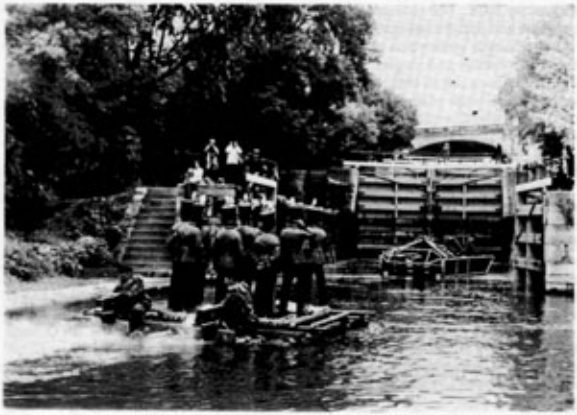


Photo 3. Steady boys! Steady!!

commuters skate five miles or more along the canal to work in the MOD, whose buildings, like the old station, stand near the head of the valley. History does not relate what summer commuters and non-skaters feel about it all!

The Canal was never used for its original military purpose but By on his own initiative designed it to be suitable for commercial traffic as well. He looked upon it he said, "to be a mistress of trade to that vast population on the borders of the Great Lakes which would serve so many outlets for British manufactured goods." He thus insisted on locks big enough to handle the larger steamboats of the period. For fifteen years until the St Lawrence Seaway was opened in 1847 the canal was of vital commercial importance. In the early 1840s a normal day's freight would be seven or eight steamers pulling up to ten barges each. It is recorded that, on one occasion exceptionally, the steamer "Hunter" pulled twenty-four barges. As a general rule the barges were "locked through" in pairs. In 1842, 44,374 immigrants entered British North America of whom 30,000 passed through the canal system on their way to Canada's West.

Had the British Government wished they could have made the canal pay its way and also have recovered the capital cost of the building construction; but the immigrant traffic was carried free and the commercial passage dues were only set at sufficient to cover operating and maintenance costs. By the turn of the century few boats other than luxury pleasure steamers used the waterway; the last of these sailed in 1935. Nowadays the canal has come to life again and, thronged each summer with smaller pleasure boats, is again thriving. It is particularly pleasing to note that the locks have been completely renovated and restored to their original state. A few years ago there was a scheme to modernize the lock machinery and some gates were fitted with electric operating gear. Such was the outcry that this new machinery was removed. Canal users are encouraged to take pleasure in operating the gates themselves by hand under the watchful eye of the lock keepers.

Sadly, for By himself, as described in the 1971 article, the story does not have a happy ending; though one visitor to his home in retirement spoke of "his still possessing the confidence of the Government" and "possessing a stout frame and physique of a thoroughly English type." Very likely he was sad not to receive the

Bytown-ottowa 1826-1976 (3)

honours he deserved, but one doubts that such a stalwart character would have allowed self pity and disappointment to undermine his wish to live; as is the popular view of the cause of his death.

The trouble all began, as so many such stories do, because to begin with, the original estimate, based on a survey conducted by Samuel Clowes in 1824, was ridiculously low. Clowes predicted the canal would cost 230,875 pounds sterling. Evidently this estimate was made deliberately low so the British government would be convinced to go ahead with the project. Before the work began in 1876 the Chief of Works, John MacTaggart, after surveying the route, came up with a revised cost of 486,000 pounds sterling. Not only had Clowe's original estimate been low, but Colonel By made a number of changes. The lock walls were built of stone rather than wood, and the size of the forty-four locks was increased from 100 feet by 22 feet, to 134 feet by 33 feet. The British Government, alarmed at MacTaggart's estimate, appointed a commission led by Lieut-General James Kempt, of Nova Scotia, to investigate the situation. The commission approved a cost of 558,000 pounds sterling for the project. By 1831, the cost of building the waterway had risen to 776,023 pounds sterling. Colonel By had run into problems. The landowners along the route wanted high prices for their land, and the dam at Hog's Back had collapsed just as it was nearing completion.

So, not only were the Government conned into launching into a job which was subsequently, at the detailed reconnaissance stage, estimated to cost more than twice the original estimate but the final price was almost as much as these two estimates added together. It was not that By had a free hand to spend money without check or audit at the time. Money to pay the workers had to be sent from England to Montreal, where it was loaded into birch bark canoes and paddled to Ottawa. Colonel By had to submit all his requisitions, even for minor items of stationery, in triplicate and written by hand, to Quebec. It was just that politically the time was not ripe for large expenditure on a colony which was so far away, especially when the reason for the expenditure when it was authorized—threat of invasion by the USA—had long since evaporated. Besides there was rumour of graft and corruption.

By came through all enquiries and examinations with a completely clear sheet but with no thanks, let alone honour or reward.

The moral is the age old one for sappers, that we allow ourselves to be committed to a job without taking time and trouble over reconnaissance, planning, preparation and costing at our peril. And even then we need to take active steps to see that our political and other masters are as much as possible with us in spirit and backing us up as the work progresses. By had not the excellent means of communication that we have today and was at a severe disadvantage in consequence. He can be accused of nothing worse than bad luck; and the citizens of Ottawa are justly proud of him.

Joint Professional Meeting

The Construction of the Roll On Roll Off Jetty at Akrotiri

LIEUT-COLONEL B R RAWLINGS RE, C Eng, MICE, FI Plant E with Major J N Leivers RE, B Sc, C Eng, MICE and Major A D Jolley RE, B Sc presented a paper to a Joint Meeting of the Institution of Royal Engineers and Institution of Civil Engineers at Princes Hall, Aldershot on 24 February 1977.

The paper has been edited slightly to make it more suitable for "page" as opposed to "platform". No attempt has been made to indicate change of, or to identify, the speakers.

Lieut-Colonel Rawlings introduced the evening by giving an outline of the

CYPRUS

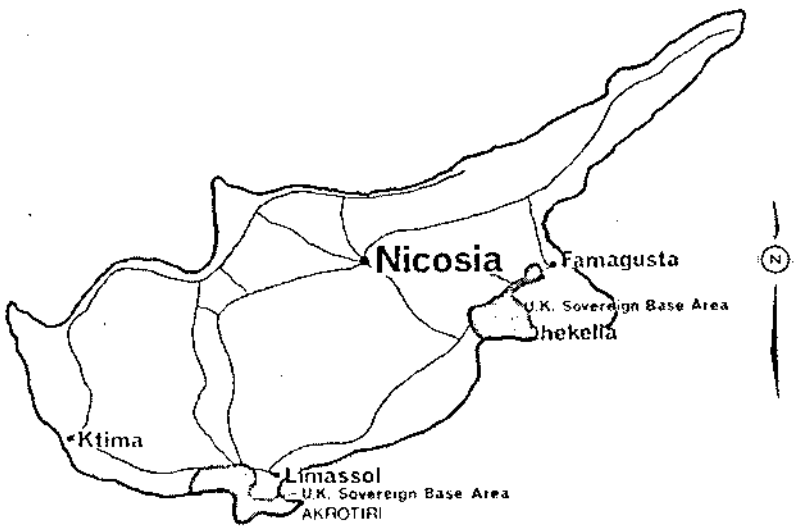


Figure 1. Map of Cyprus showing main locations.

contents of the presentation. To assist the civilian members of the Institution of Civil Engineers present he then briefly described Royal Engineer Unit organization, the analogy of the contractor and client in the relationship between the Quartering Staff, the Property Services Agency and the Royal Engineers and the standard project planning sequence used by the Royal Engineers.

THE BACKGROUND

Prior to the intercommunal fighting in 1974 the main logistic base for the British Forces in Cyprus was the Eastern Sovereign Base Area (SBA) and Famagusta Civil Port was the main sea supply entry port. (See Figure 1). A jetty at Dhekelia was and is still available when sea conditions moderate in the summer. The main airfield is Akrotiri in the Western SBA and in February 1974 the Royal Engineers completed the reconstruction of a Mole to form a small lighterage harbour as an essential element of the contingency plans for the emegency resupply of the Western SBA.

During the intercommunal fighting all civil ports were denied to the British Forces and the Royal Corps of Transport Port Unit moved from Famagusta to Akrotiri. The facilities available for sea supply were thus:

(a) By Landing Ship Logistics (LSL) to Dhekelia Jetty

(b) By LSL or other RFA ship to moorings off Akrotiri Mole to be off loaded by MEXEFLOTE rafts and Ramp Powered Lighters

Following the cessation of fighting these facilities were augmented by civil shipping into Limassol civil port but obviously this alternative was not always available and depended very much on the political situation.

In January and February 1975 the Staff of Headquarters Near East Land Forces looked at the possibility of constructing an LSL "RoRo" Jetty at Akrotiri in conjunction with the Regional PSA/DOE. By this time the projected move of the Logistic Base to the Western SBA as a result of the Defence Review had become a further factor. In March 1975 Headquarters Royal Engineers Near East Land Forces asked the Ministry of Defence to make available an officer to carry out initial

reconnaissance. On the 9 April I arrived in Cyprus accompanied by Captain Jack Ditchburn who was at that time the Chief Marine Superintendent (Designate) of the Royal Fleet Auxillary.

THE REQUIREMENT

The requirement was for an LSL berth at Akrotiri with a Cl 30 roll on/roll off jetty.

The Landing Ship Logistic's vital statistics are:

Length overall	412ft
Beam overall	60ft
Waterline to upper deck	26ft
Tonnage: Laden displacement	5674 tons
Draft: Laden maximum	16ft
Bow ramp supported	class 60

When discharging over the bow ramp the distance from the waterline to the top of the quay should not exceed 6ft

The ship is classified as a Board of Trade Class I Passenger Ship Lloyds Register +100A1.

Once the principal parameters of the ship had been established possible berth sites were investigated taking into consideration hydrographic information, prevailing winds and ship handling considerations. In particular three sites were investigated in the vicinity of Akrotiri Mole and one selected as the recommended berth with an estimated fair weather availability of 300 days per year.

THE DESIGN

The site having been established my thoughts turned to the type of structure to be designed. We had been given a design life of ten years in view of the probable limited future of the base, therefore costs would have to be kept down if the expense was to be justified. A further consideration was the need to construct the jetty in a limited period using a field unit, therefore the design should be as simple as possible and not involve cofferdams or major underwater excavation or concreting. The presence of a set of Heavy Girder Bridge in Cyprus which was probably surplus to Service require-

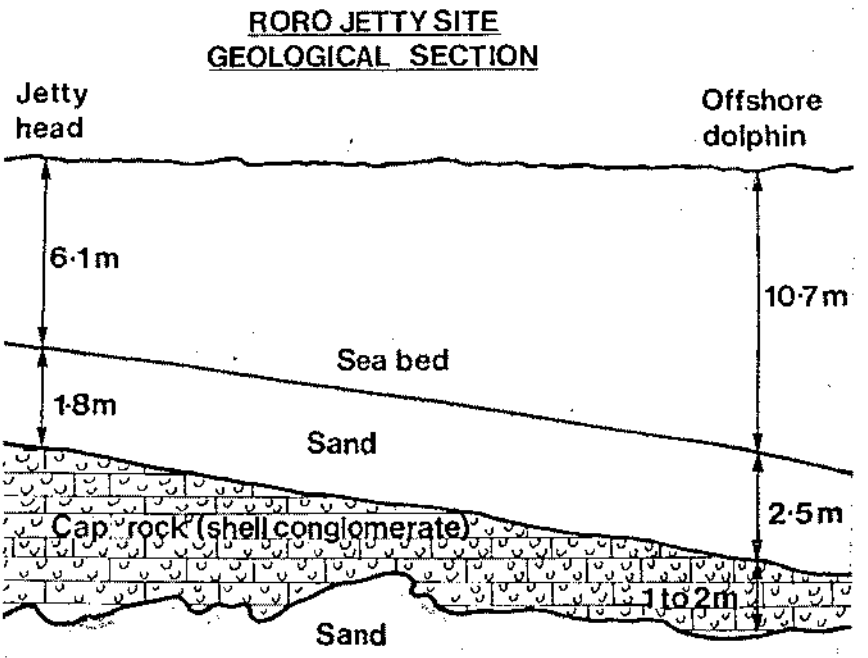


Figure 2. Geological Section at RoRo Jetty Site.

ments had considerable influence on the design in terms of the potential saving to the works vote and the ability to get into deep water with a fairly long span. However the major consideration was the foundation conditions. These were abstracted from a report made in 1970 by Dr F Moseley then a TAVR Major in the Specialist Pool.

Observations during the subsequent construction of the Mole and probings made during the initial recce tended to confirm his findings which were that: "The sea bed consists of 2.5m of sand overlaying 1 to 2m of hard caprock and shell conglomerate which is underlain by soft unconsolidated shell sand, fine grained and silty in places and 8 to 9m thick." (See Figure 2). Also I noted that the slope of the mole consisted of 4 to 5 ton armouring rock and was unsuitable for mass concrete wall foundations or piling. I concluded that the sea bed was unsuitable for a conventional piled structure and that the bearing pressure should be kept as low as possible.

My outline calculations for the stability of the proposed structures assumed:—

(a) Wave forces produced by a 4.9m unbroken wave
(b) Mooring forces due to a 33 knot easterly wind
and (c) The berthing forces produced by the ship striking the dolphin at 10° whilst moving at 0.15m/sec

The Initial Reconnaissance Report published on 30 April 1975 concluded that the construction of a fair weather LSL roll on/roll off berth at Akrotiri Mole was feasible and that the construction should take the form of a jetty head and two dolphins in cellular form; the jetty head to be linked to the mole by a Heavy Girder Bridge span. The cells would be formed using Frodingham straight web section piles with granular fill and capped with concrete.

Several months of staff negotiations followed and in late September, 62 CRE were tasked with undertaking a Detailed Reconnaissance and publishing a report by 19 December 1975 with a view to construction being undertaken in 1976. The Detailed Reconnaissance was carried out in October by a team led by Captain Bob Barlow, 2IC 524 STRE (Const).

During the detailed design of the facility it was necessary to reach agreement on the design and specification of the structures with both the Regional PSA/DOE Civil Engineer in Cyprus and with the Directorate of Civil Engineering Development

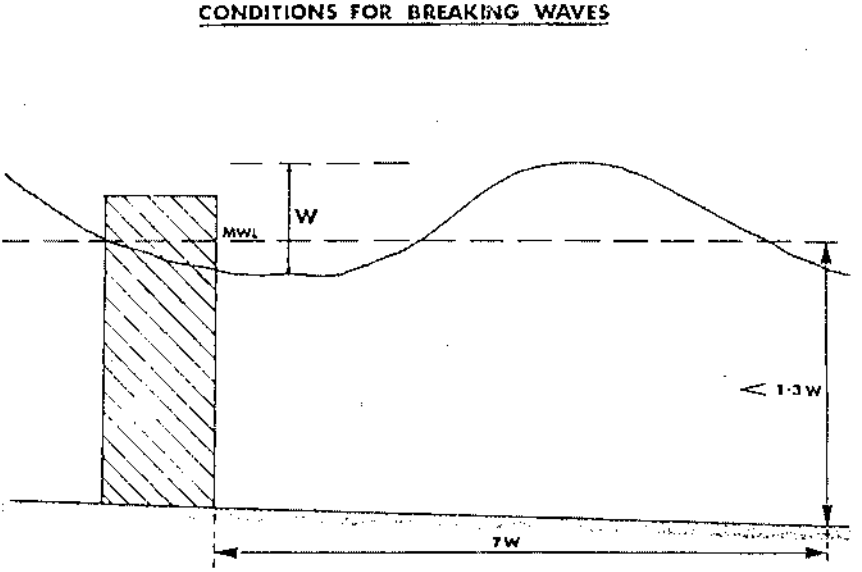


Figure 3. Conditions for Breaking Waves.

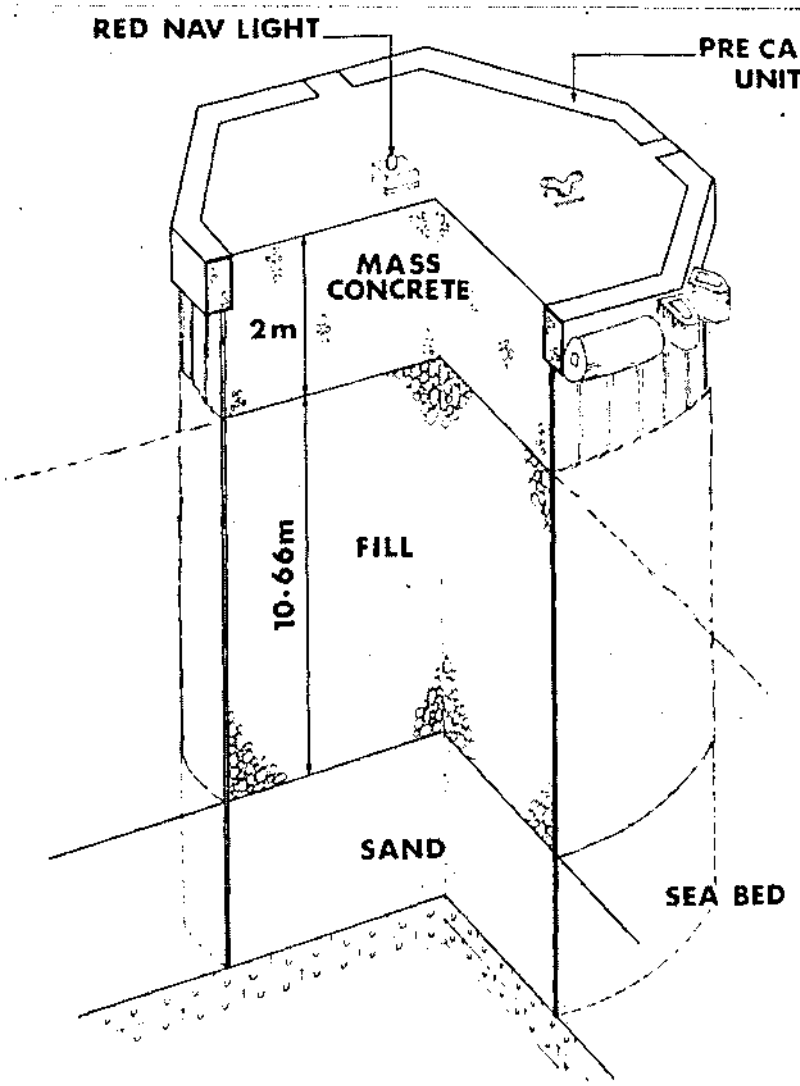


Figure 4. The Outer Dolphin.

PSA/DOE Maritime Branch at Croydon.

The Detailed Planning was in most respects a straightforward process and I will only deal with the technical design considerations and the resulting design. First, a detailed analysis of the forces acting on the structures showed that:—

(a) as far as berthing forces were concerned the displacement tonnage of 5674 tons produced a force of 50 tonne after allowing the fender system to absorb 34 kilo newton metres of energy.

(b) the question of wave forces is not an exact science. A structure subject to breaking waves must withstand greater forces than if the waves do not break. The most generally accepted theory is that waves are caused to break when the depth of water a distance of seven times the wave height to the seaward of the structure is less

than 1.3 times the wave height. In our case we found the structure would not be subject to a breaking wave and that waves greater than about 3.6m from trough to crest would flow over the structure and further reduce the pressure tending to overturn it. (See Figure 3) The design factor of safety for the offshore dolphin was 1.6.

(c) It should be noted that in view of the fair weather nature of the berth the major wave and berthing forces were not considered to act together and that no account was taken of the penetration of the piles when considering the stability of the structures.

The outer dolphin is shown in Figure 4 and is representative of the other structures.

British Steel produce two sizes of straight web piles suitable for cellular construction; the lighter section type SW1 was selected as the estimated corrosion life in sea water of 40 years was considered more than adequate and hard driving conditions were not expected.

The selection of fill material was the most difficult problem. A material, rock or sand was required of a grading which would produce a dense filling when allowed to self-compact underwater to minimize future settlement and maximize resistance to over-turning. In view of the position of the structures the material was required to be pumpable when suspended in water. The source selected by the Detailed Reconnaissance team was beach pebble from which particles over 50mm would have been removed by screening. The source was subsequently changed due to ownership problems to another producing similar material.

Precast concrete units were selected to form the facing and in-situ shuttering for the capping concrete on the dophins and jetty head. This had several advantages; it improved surface finish to concrete faces, the placing of fixings for fender bolts was made easier, and by allowing concurrent work and the use of spare labour a significant time saving could be achieved. Grade 40 concrete was specified for precast units as it gave high early strength for lifting and is the minimum grade specified in CP 110 for marine environment. The infill mass concrete was specified as grade 30.

Each dolphin was provided with two 30 ton cruciform type bollards, a ladder on the lee side, 375mm cylindrical, hollow fenders in 3m lengths and flashing warning lights. The jetty head was provided with four bollards and the concrete surface recessed for the ships ramp and bridge bearings and ramp.

The temporary works were a significant part of the design load and steel piling towers and whaling frames standing on adjustable legs were proposed to be manufactured in the Central Engineer Park (CEP) before shipping to Cyprus. (See Photo 1).

The cost of the project was estimated to be £59,000 and the cost effectiveness was one of the principle factors which led to the decision to proceed with construction. The total civil estimate for the project was approximately £250,000.

THE PLAN

The Initial Cascade Diagram in the Detailed Reconnaissance and Planning Report envisaged a three month project. I subsequently revised this to four months. Figure 5A shows the outline of this plan. The reasons for the change were as follows:—

(a) The initial plan anticipated all the setting out to be done during the advance party phase. This was not considered practical.

(b) The time allowed for piling was considered to be too little due to the inexperience of the Royal Engineers in this technique.

(c) The pumping of the gravel to fill the sheet pile cells was based on a gross pump capacity of $4m^3$/min with 25% solids in suspension. The pump manufacturers recommended a rate of only $3m^3$/min with 15% solids.

FILL MATERIAL

As you have already heard, attempts by the reconnaissance team to find suitable fill material were unsuccessful. The HQ of the Royal Engineers in Cyprus had to solve this problem. The final solution was to set up an old Goliath secondary crusher unit in the "Kouris" river bed, ten miles from site. The crusher was modified in order to use it screens only, thus producing 40mm down, rounded river gravel.

PLANNING CHARTS

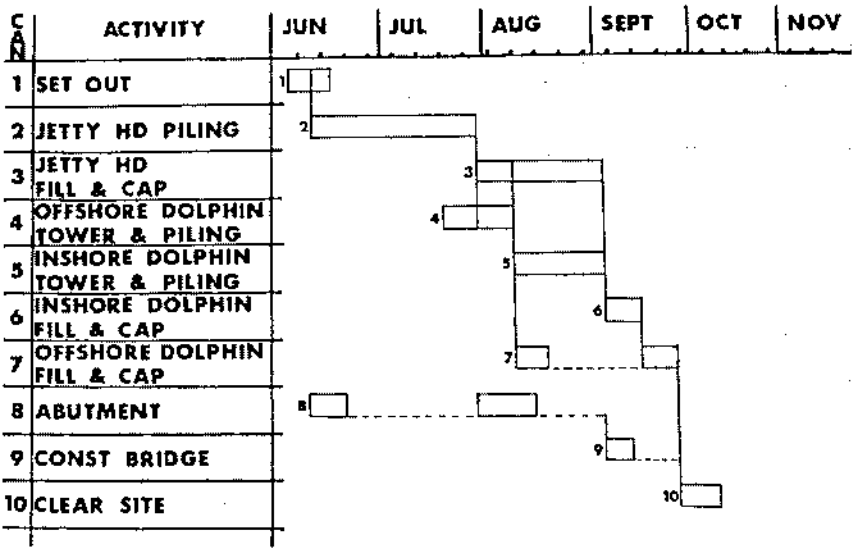


Figure 5A. The Outline Plan.

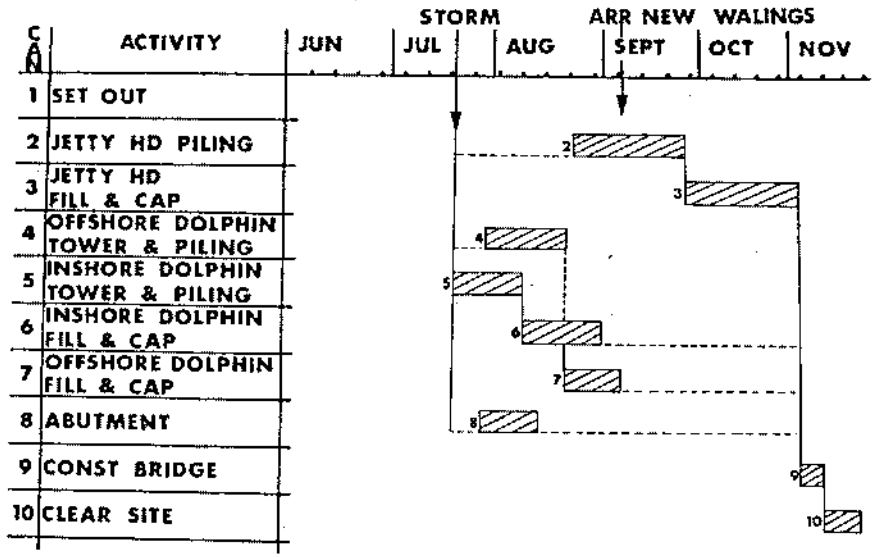


Figure 5B. The Revised Outline Plan after the set back of 20 July.

The slow rate of production required stockpiling to begin before the deployment of the tasked unit. 62 Cyprus Sp Sqn undertook this task and had stockpiled 850m³, of the total requirement of 3,300, on site prior to the arrival of 60 Fd Sqn.

TRAINING AND PREPARATION IN UK

On 19 February 1976, 60 Fd Sqn RE received a signal tasking the squadron for a four month unaccompanied tour in Cyprus starting in June 1976. The thought of a

summer in the sun was very attractive.

The Squadron planning was divided into three phases:

(a) Reconnaissance 17 March–22 March
(b) Training 29 March–28 May
(c) Deployment 31 May–6 June

Prior to the reconnaissance in Cyprus we had read the detailed report issued by 62 CRE Construction and had spent many hours going over the drawings. Major Leivers appointment as Resident Engineer was a considerable advantage as he had already been involved for many months and was stationed in Cyprus. We were therefore able to concentrate our attentions on problems that he had already identified.

The training programme before embarking on the project, covered Heavy Girder Bridge construction, pile driving and artisan training for the carpenters and concretors. This training was considered necessary because the squadron had been involved mainly in Combat Engineering tasks, and many of the soldiers had recently served in Northern Ireland. Our artisan tradesmen were therefore a little rusty.

During the training period, we deployed a troop to Central Engineer Park (CEP) Long Marston to construct the girder towers that were to be used in Cyprus. The value of a trial build is immense—a number of fabrication problems were overcome and construction techniques were resolved. It also gave CEP an understanding of our packing and marking requirements for ease of construction which was to pay dividends later.

Squadron Organization

A Field Squadron is organized for its war role and in this respect the command structure is undoubtedly very different from that found in any civilian construction firm. We are interested in training people to command as well as improving their ability in construction work. This project allowed the basic military structure to be retained. The outline organization is shown in Figure 6.

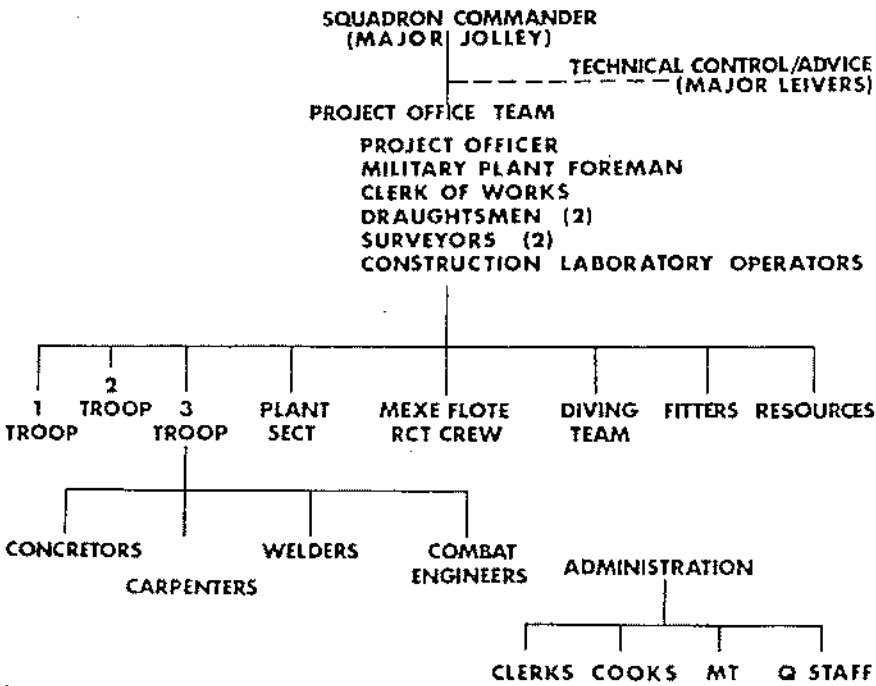


Figure 6. The Outline Organisation.

The Military Plant Foreman was in charge of the piling, all other plant work being controlled by the Squadron Plant Sergeant. The Clerk of Works exercised technical control over the carpenters and concretors. Those parts of the project needing strong artisan sections were the responsibility of 3 Troop, the specialist sections being increased in strength when necessary by attaching soldiers from other troops for short periods.

Deployment

The deployment of stores from UK to Cyprus should have been completed prior to the deployment of the Squadron. The vagaries of civil shipping caused delays, though the forecast arrival dates meant that the construction could remain on schedule. The advance party of thirty men set off on 31 May and the main body of ninety five men, followed on 7 June. The first working day of the project was 10 June though the advance party had carried out some preliminary survey work on land by this date.

CONSTRUCTION

Setting Out

How do you set out underwater, in this case at a depth of 5.5m in the area of the jetty head 11m, in the area of the offshore dolphin? Our solution was to use a ranging rod with two divers buoys fitted to it, the line to a peg in the sea bed being tensioned, so that the buoys were just below surface level.

By surveying at first light, when the sea was calm, a centre line for the jetty head was set out on the sea bed, the location being found by intersection onto the rod float from a measured base line on land. The positions of the footing boxes were set out from the sea bed centre line pegs by divers, using measured lengths of wire and locally produced templates.

The accuracy of the surveying was estimated at no more than ± 100mm, however, the final setting out of the abutment could be adjusted to this variation once the first pile of the jetty head was in position.

The same method was used later for setting out the dolphin centre line and boxes.

Footing Boxes

The divers positioned wooden footing boxes and dug them half a metre into the sand using an air lift pump. The boxes were levelled by eye and boning rod and were then filled by placing dry mix concrete in sand bags. Metal bearing plates were placed on the surface of the concrete to complete the construction of the footings for the girder towers.

Tower Construction

On land 1 Troop were busy building the girder towers that had been manufactured at CEP Long Marston. (See Photo 1). The original plan was to construct the basic tower on land, position it at sea on the footing boxes and then build the waling rings in position, underwater. This would have been no easy task for the divers, particularly as the sections making up the waling rings had to be adjusted within elongated bolt holes to achieve the same shape for the upper and lower rings. During the Squadron recce it was discovered that a 25 ton Smiths crane could be made available and that it had the capacity to lift the basic tower and lower waling ring as one structure.

We decided, therefore, to complete as much as possible of the temporary works on land. In Photo 1 you can see the basic tower with both waling rings in position.

The design of the jetty head waling rings was modified on site, additional struts being welded in position to reduce flexing when being lifted. Lindapter clamps provided for securing the ring to the bearer beams were also found to be unsatisfactory when subjected to flexing and therefore all joints were welded. In fact welding became a major task and throughout the tower construction phase we had two teams of three working in shifts.

The completed upper waling ring was placed on the tower and the two rings checked for shape and position, the lower ring then being welded in position on the tower. The straight edges of the upper and lower walings are for the diaphragm—a

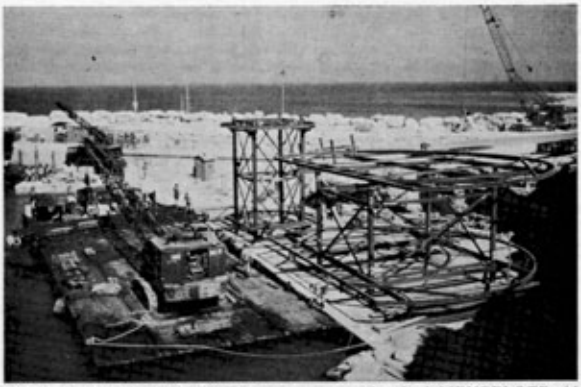


Photo 1. Jetty Head and Dolphin Towers pre-constructed on land. MEXEFLOTE with NCK loading pile.

similar tower being used for the other half of the jetty head construction.

In the background of Photo 1 is the structure for the inshore dolphin. In this case the weight limitation did not apply and therefore the tower and waling rings could be built as one structure. The offshore dolphin tower was a duplicate but sitting on extension legs of 2.1 metres.

Photo 1 also shows the MEXEFLOTE in harbour with the NCK crane on board.

Tower Positioning

A jetty head tower was too large to be carried on the deck of the MEXEFLOTE,

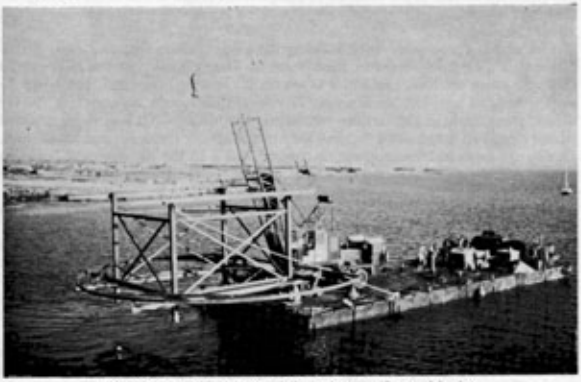


Photo 2. Jetty Head Tower being taken out for positioning.

consequently it was with some trepidation that we "set sail" with the first tower (See Photo 2). The MEXEFLOTE, due to the confined space, leaving harbour in reverse.

The MEXEFLOTE was moored to concrete blocks on the sea bed and by adjusting tirfor winches could be positioned accurately. The tower was then lowered and positioned on the footing boxes, many adjustments being made until the surveyors were satisfied that it was positioned accurately.

The upper waling was placed on the tower, plumbed over the lower waling and then secured with Lindapter clamps.

Piling

With the jetty head (North) tower in position we were ready to begin piling. At each end of the diaphragm was a Y pile forming the junction with the curved sections. The inshore Y pile was bolted to the waling, the remainder of the diaphragm then being pitched and driven to bed rock about 1.8m into the sand. Pitching piles was made easier by the use of a guide device for aligning the knuckles. This allowed work to continue in fairly strong winds.

The diaphragm wall should have been 60mm longer than the straight edge of the waling but in fact there was virtually no tolerance. At the time this did not appear to have any special significance though it was in fact the first clue to our subsequent problems.

Work then started on the first cell, piles being pitched round the curve, starting from both Y piles leaving the last pile to be pitched at the point furthest from the diaphragm. The piles were held against the upper and lower walings by steel wire rope, wedges being used to provide space between the wire and the waling for the next pile. All piles were pitched against the waling so that the tolerance on the circumference would be available in the closure area. In theory the last few piles were to be wedged away from the waling in order that the gap for the last pile could be increased to the correct size. The final gap was also expected to be wedge shaped as it is impossible to achieve a perfectly vertical, parallel sided gap. Again in theory the last pile is slotted at the top and lowered until it sticks. A small fillet that had been slotted to set the gap to the correct size is then removed by the welder. How do you get the last pile down to the sea bed?

During a visit to a construction site near Bristol in March, Major Leivers had watched a technique for pitching the last pile. The technique was developed after they had a caisson burst open when filled with sand—the last pile having been weakened at the knuckles by being driven into position. In essence once the last pile is slotted it is lowered until it sticks. The adjacent pile is then lifted to the same height as the first slotted pile using the second rope on the crane. The tension on both ropes is released and the piles allowed to slide down. Piles are lifted on alternate sides of the closure point. (Photo 3 shows five piles in the air). It just remains to persevere with this technique and eventually all the piles will be in position on the sea bed.

Using this technique in the worst case we had nine piles at maximum height in the air and in the best case only three.

But to return to our first attempt at closure. It was at this stage in the project that we had a major problem.

Problems of Closure

Our first problem with the N Cell of the Jetty head came at the time when the diaphragm was driven and 2/3 of the remaining piles were pitched. High winds one night caused flapping of the diaphragm wall, which sheared the straight section of the upper waling in two places. This was repaired by insitu welding and strengthened the following day. Pitching continued. However when we tried to make closure, it was found that although it was possible to slot in the closure pile at the top, the gap on the sea bed was 200mm too wide. We hoped our closure procedure would solve this.

By pulling alternate piles we lifted a total of eight, which did eventually descend, but in doing so they caused an inward kink and fouled on the bottom waling. At this

Photo 3. Closure technique in progress showing five piles withdrawn.

point I thought that the problem had been caused by the earlier damage to the top waling which may have been distorted and knocked out of plumb with the lower one, thus using up the designed slack which should have been available between piles and walings. The bottom waling had to be reduced to size. It was cut and Tirfor jacked back to allow the piles to descend.

The piles now locked solid and refused to move up or down. We even tried the pile driver on them.

By partially withdrawing some piles further round the cell we were eventually able to pitch the piles then by applying our closure technique again to this new sector we thought success was ours; for with nine piles partially withdrawn they suddenly all descended as one. But again the piles had kinked inwards on descent and five of them hit and badly bent the bottom waling. One pile went inside the waling!!

It was intended to lift these piles and cut away more of the bottom waling on the 20 July. However that morning the 15 knot wind swung round to the NE giving an onshore wind. This caused a heavy swell. By 7 am, the swell had already caused the piles, left high resting on the bottom waling, to descend further bending the bottom waling into the sea bed.

The scene at about 9 am is shown in Photo 4. The sea was calmer. The damage done. The cell has twisted anticlockwise causing the pitched but undriven piles of the curved portion to distort and lean. However the driven diaphragm piles were still vertical and apparently unaffected.

Later that day the sea was back to its normal calm self, and we attempted to

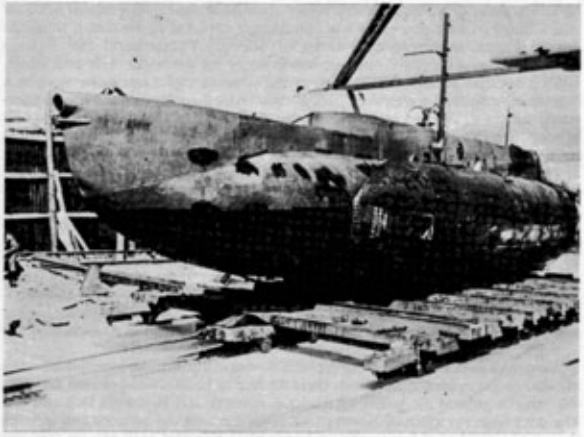


Photo 4. An X-Craft Midget Submarine. Note the amatex saddle charge.

after thirty one years?

After the war when the POW's were released and the full story became known the Captains of *X6* and *X7*, Lieutenants Cameron and Place were each awarded the Victoria Cross. Nobody could state with certainty what had happened to *X5* and her crew, or what she had achieved, and her Captain, Lieutenant Henty-Creer was Mentioned in Despatches. Many, particularly his family, felt that the rules for awards had acted harshly in his case and that of his crew, after all they had penetrated the minefields and the outer defences and given their lives in the attempt. It was felt that if only *X5* could be found and the saddle charges were no longer on her, then it would be reasonable to suppose that she too had penetrated the final nets around *Tirpitz* and was in fact on her way out when she surfaced and was attacked. There would then be strong grounds for pressing for commensurate awards to be made to Henty-Creer and his crew.

With backing and strong encouragement from members of Henty-Creer's family, Peter Cornish of the BSAC led the first full expedition to Kaafjord in 1974. His team of sixteen divers were selected from among the best sport divers in the country and included men and women with sufficient skills to approach the problem in a scientific manner. They surveyed a large proportion of the fjord and carried out a great deal of diving and found numerous wrecks and much war debris but they did not find *X5*. However in another area they did find the bow section of an X-Craft but were unable to positively identify it as *X5* or *X7*.

Kaafjord measures approximately 5 by 1½km, which is an immense area to cover even with sophisticated equipment. Particularly when associated as it is with extreme depth and cold. At the end of their stay they had learnt a lot and found much but they could not categorically state that they had or had not found *X5* and so in an attempt to do this and to survey the whole area and recover historic war material, the 1976 Kaafjord Expedition was formed.

I met Cornish in London in early May and was at once impressed by his professional approach to the problem, his own obvious skill as a diver and his enthusiasm. He was obviously gathering around him a high powered team of like in-

Photo 5. Tower and damaged waling being brought back inside the mole. LSL in the background.

being started first.

(c) This gave a new completion date of 22 November. In fact the new waling arrived on 26 August, gaining us eight working days. A further ten days were gained by going into double shift work 5 am–7 pm. These two facts, along with the squadron's rapidly improving piling and concreting techniques enabled the "RoRo" to be finally opened on 4 November eighteen days ahead of the revised schedule.

If anything, the set back increased the squadron's determination and they started work on the new plan without delay.

The Dolphins

During the recovery of the jetty head the setting out and concreting of the inshore dolphin footing boxes was completed. The dolphin walings were reduced to the minimum possible radius by butting the curved sections together (The gaps were due to manufacturers error, thank goodness!). This increased the tolerance between the circumference of the waling and the inside circumference of the piles from 70mm to 225mm. As a check we coupled forty-eight small pile "offcuts" together to prove that the piles would fit. It also showed that in the case of the dolphin, which is the smallest radius that can be built using Frodingham straight web piles, wedging away from the waling in the area of the closure point is not sufficient. Wedging had to start at the halfway point round the circle if the last pile was to be slotted successfully.

The tower was loaded and moved to sea, lowered into position on the footing boxes and adjusted until the surveyors were satisfied that it was on the dolphin centre line.

Pile pitching and closure were both successful. The piles were then driven to cap rock, about 2m into the sand, using a McKiernan Terry 600N air hammer.

Since the beginning of the project, the Squadron had taken over the production of fill material from the Couris river. Two shifts worked the daylight hours as it was always a race against time to produce the quantity needed, some 2,400m³ in addition to the 850m³ already stockpiled for us by 62 Cyprus Support Squadron.

A Sykes UVC6 pump was used to pump the aggregate, suspended in sea water, from a Braithwaite stilling basin to the dolphin. A second Sykes pump provided the

water to the tank. The pump site was at the end of the mole and a MEXEFLOTE causeway had been constructed out to the dolphin to carry the pipeline. (See Photo 6)

When the aggregate was high enough to provide a working platform for the welders the piles were cut to the final level. The aggregate inside the dolphin develops high circumferential tensile forces in the piling and for the first time during the project we had a solid structure safe from damage by the sea. The aggregate was raised to the final level and then capped with blinding concrete.

In the car park of 10 Port Sqn RCT we had established a pre-cast concrete yard where we made two small and one large pre-cast beams for each of the dolphins and one large straight beam for the jetty head. The NCK crane on the MEXEFLOTE was used to position the beams on the dolphin. Brackets had been welded, at intervals, to the inside of the piles to support the beams. The concretors fixed the reinforcing and bollard cages ready for the concrete pour inside the pre cast beams which acted as permanent formwork for the dolphin caps. The final lift of concrete, (grade 30) was pumped from the mole, levelled, and cured for seven days. The inshore dolphin now only needed the finishing touches.

From the moment that piling on the inshore dolphin had been completed, the MEXEFLOTE and crane was free to begin work on the offshore dolphin. During the setting out we adjusted the position of each of the footing boxes 200mm closer to the centre point. The footing boxes of the inshore dolphin had fouled the circle of the waling rings and clearance had only been achieved by cutting the flanged lip of the boxes at the corners. By the evening of the 9 August we had the offshore dolphin tower in position and nineteen piles pitched. The next day would probably see the remaining piles pitched, and driven.

At 0830 the next morning I was in the Squadron office when I received a phone call to say that I was needed on site urgently! The caller did not say what was wrong but with a feeling of alarm off I rushed. I met Major Leivers on the outer dolphin where he explained the problem. During the night one of the footing boxes had tilted in the sand, the tower and piles no longer being vertical. The options were to attempt to correct the situation by jacking or to recover the lot and start again.

The relationship between the Military Resident Engineer (PQE project officer) and the Squadron Commander cannot be better illustrated than in this situation.

Photo 6. Pumping aggregate and water from the Braithwaite tank to the piled cells using a Sykes UVC6 pump.

Joint Professional Meeting (6)

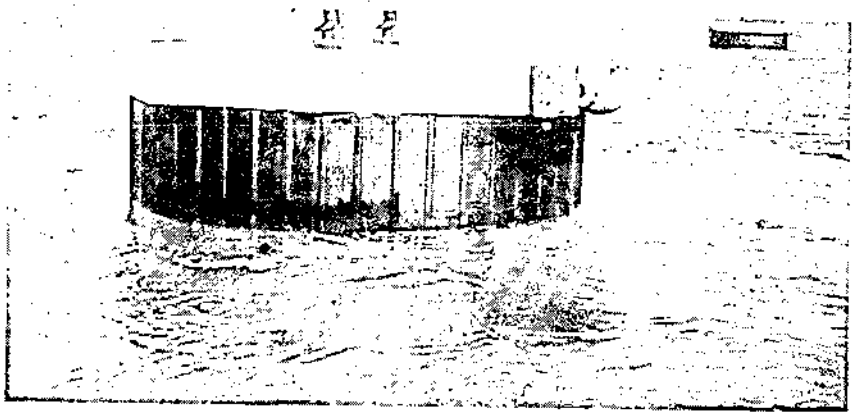


Photo 7. Completed Dolphins.

The PQE officer is responsible for the technical control standard of the finished work and acts as adviser on technical problems. The responsibility for the course of action taken is that of the Squadron Commander. In this case both courses had their merits and their risks.

Everything, including the footing boxes, were recovered and a fresh start was made the next day. Five days later we had completed the piling of the outer dolphin. Fill with aggregate, cap with concrete, add the finishing touches and we had two completed dolphins. (Photo 7)

We had proved that the techniques worked. It was now a race against time to complete the jetty head, as sea conditions normally deteriorate at the end of September. The cascade plan showed that pumping fill to the jetty head would have started by then, but that the structure would not have sufficient strength to withstand a rough sea. So, with piling of the outer dolphin completed work started again on the jetty head.

Construction of the Jetty Head

Determined to avoid the closure problems encountered on our first attempt on the Jetty Head, the following precautions were taken:—

(a) The circumferences of the new walings from UK were to be made over 100mm smaller than the original design.

(b) The second, unused original pair of walings were also reduced in size on site.

(c) Greater care was taken to ensure that the upper waling was not distorted and was plumbed in accurately over the bottom one. This was done on land first; to check all was well.

Once again we set out to construct the Jetty Head. The squadron piling experience was now considerable. Techniques had improved beyond all recognition. For example, during the first attempt of the North Cell the average pile pitching rate was two piles per hour. This meant working eight hours per day it took five days to pitch one cell. This rate was now doubled, enabling up to pitch the piles for one Jetty Head cell in two days working fourteen hours per day.

It was not long before we were once again at our closure point—And guess what? The walings were still too large. Yet again closure was impossible. This time we knew the drill. Both top and bottom walings were cut insitu and reduced in size by pulling back with Tifor Jacks. The top waling being rewelded again to preserve

its rigidity. This took an extra day with the cell in its most vulnerable condition. But this time the weather behaved itself and we got away with it. Closure was made and the piles driven.

Now the question; WHY? Let us go back to the diaphragm wall. When we placed the tower and walings we had considerable trouble fitting the straight waling against the diaphragm. The designer had allowed for 60mm slack. Where was it? The diaphragm wall was measured and found to be 60mm shorter than the drawing showed. This meant that the average width of one pile was 411mm not 413mm as shown in the BSP handbook. A measurement of the curved piles once driven confirmed the smaller pile width. This meant that the actual pile circumference for the seventy piles in the curved portion of the cell, was 150mm less than that shown on the drawings and explained why we had been unable to close the cells.

Armed with this knowledge, the new walings for the last cell were reduced in size yet again. When we came to closure we had 100mm slack and were able to complete this final closure in fifty-five minutes. This cell was driven to bed rock and the piles trimmed to the correct level. We were now ready to fill and cap.

Jetty Head Fill

Filling the dolphins with aggregate had given us proven data on which we could base our plans for filling the jetty head.

Pumped Gravel

	Volume	*Rate*
Inshore Dolphin	267m³	95m³/day
Offshore Dolphin	306m³	134m³/day
Jetty Head	2180m³	?

The rates achieved allow for an average of eight hours down time per day due to blockage and repairs. For the longer task of filling the jetty head we used a planning figure of 100m³ per day; this meant that the operation would take eighteen days instead of the planned ten days. Two more pumps and additional hose were requested from UK and two pump sites were established.

In June, as a medical precaution, we had requested an analysis of the dust from the rock crusher. In August a report from Cardiff University arrived in Cyprus. The sample contained asbestos dust. Work could continue provided that everyone

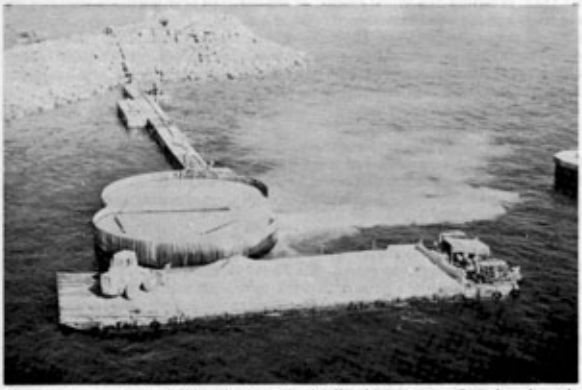


Photo 8. Two methods of filling the Jetty Head cells with aggregate. Pumping along the causeway and using the MEXEFLOTE.

Photo 9. Pre-cast beam being placed on the jetty head. The fill already shaped for the blinding concrete.

likely to inhale the dust was wearing an industrial face mask. The source of the contamination was the asbestos mines in the Troodos Mountains many miles away.

Pumping started from two sites, one at the entrance of the mole and the other on the original site at the end of the mole. The day was divided into three shifts, a competitive rivalry soon developing over quantities shifted. We had been concerned that the reinforced PVC pipes would quickly wear out though the only damage suffered so far had been caused by external wear, the pipe rubbing on the MEXE-FLOTE causeway due to the motion of the sea. The pipe junctions were laid on sandbags and the pipes were turned twice in each shift. Despite our fears the pipes survived the whole operation. The main wear was in the Sykes pump. The impeller blades were worn down and finally snapped off, after pumping between 600–700m³ of aggregate. After four days we were only able to maintain two pumps in operation and so the pump site at the entrance to the mole was shut down.

Crusher production was behind schedule due to breakdowns and in the end 650m³ of fill was purchased.

In the final stages we also placed fill with the MEXEFLOTE, the deck having been covered with tarpaulins and small retaining walls built along the sides. (See Photo 8) Only a limited quantity could be placed in this way as the bucket loader could only just reach inside the piles and mounds formed caused aggregate segregation and uneven loading of the cell walls.

The Jetty Head Cap

The jetty head fill was shaped by hand and the piles were trimmed to the final level. The pre-cast beam was placed. (See Photo 9). Blinding concrete was laid and the jetty head divided into a series of bays for the final lift of concrete.

Throughout the project concrete was pumped to the dolphins and jetty head by a Wibau Challenge lorry mounted pump through a 100mm steel pipe. The contractor had never carried out such an operation before over the distance involved. We had a number of blockages, rescued his pipes when he left them full of concrete at the end of pumping, and dumped several loads of concrete in the sea when he panicked and added water. One lesson that we did learn was to watch the contractor at all stages in order to prevent the concrete supplied being even worse. The contractor was

responsible for the mix design and despite a lot of pressure from PSA (and others!) never met the specification required.

The jetty head ramp was shaped to accept the ramp of the Landing Ship Logistic. Bollard cages were prepositioned, the wooden template being used to ensure that the bolts would fit into the bollard later. With the reinforcing in position concrete was laid flush with the top of the piles. Whilst the concreting was in progress the MEXEFLOTE was again at work. This time the NCK was fitted with a grab and was placing two ton rocks around the base of the jetty head and dolphins as a protective measure against scour. The rocks had been produced by the Squadron in a nearby quarry.

With the concreting completed the jetty head was now ready.

The Abutment

Since the beginning of the project work had been carried out at various stages to prepare the Bridge abutment on the mole, the bridge bankseat being concreted once the first pile of the diaphragm was in position and the surveying checked. The rear wall of the abutment could not be built until the bridge was in position.

The Bridge

Construction of a Heavy Girder Bridge should be a matter of routine! This was an interesting build for several reasons. The grillage layout was wider than the roadway of the mole and therefore construction plinths for the roller set up were built on the inside of the mole. A restricted site was overcome by prestacking the stores in the right sequence on the wharf inside the mole. It was a downhill launch of 1 in 35. The nose had to be removed by the bridging crane on the MEXEFLOTE in the seaward side of the Jetty Head as the bridge was boomed across.

With the bridge in position the rear wall of the abutment was poured. A channel made up from a damaged pile was set in the concrete as a bankseat for the toe of the bridge ramp.

The mole was reinstated to its original condition. The bollards and wearing baulks fitted to the jetty head.

Construction was completed on the 28 October and the jetty was opened by the Commander British Forces Cyprus on the 4 November. (Photo 10)

CONCLUSIONS

Project Planning Time. Time from Initial Recce to the start of the project was the

Photo 10. Akrotiri RoRo completed.

minimum required—fourteen months. But the allocation of this time to the different phases was far from ideal. You can see in Figure 7 that the staff decision to proceed used up far too much time at the expense of the design phase. Hurried designs with not enough time for research and checking can cause expensive delays and even failures. With this project we were lucky. The unit chosen to undertake a project, should be tasked as early as possible. This enables them to plan, set up and achieve the often much needed pre-project training required.

Costs. The breakdown of the final bill and estimated savings is shown below. The initial estimate did not allow for civil shipping costs or inflation.

COST SUMMARY

Initial Estimated Construction Cost	£59,000
Final Construction Cost	£68,500
Civilian Shipping Costs	£30,000
Total Cost	£98,500

ESTIMATED SAVING

LSL Costs £3,000 per day
Turnaround Reduced from 5 to 2 days
Estimated 4 Trips/Year
Saving per year £36,000
Cost recovered in 3 years

The project provided excellent management and trade training at all levels. The problems encountered were all overcome but it must be emphasized that this was not within the capability of the Squadron on its own, a tremendous amount of help being given by PSA, the staff and other units in both UK and Cyprus. We hope this with other projects, will be continuing proof of the Corps capability to undertake major construction tasks.

The reason we succeeded was that the soldier worked willingly and happily for very long hours with no reward other than pride in himself, his unit and a task completed professionally.

THE DISCUSSION

The discussion in the main covered site investigation, design, meteorology, sheet piling, concrete quality and costings.

The site investigation for the adjacent mole had been carried out by a Reserve Army geologist and this was confirmed by further probing as necessary to establish depths of water and the extent of the rock and sand. This was more than adequate for the project.

The decision to exclude breaking waves from the design considerations was raised and it was further explained. The key was that the water was of sufficient depth to ensure that waves would not break.

Meteorological reports are always useful as background information but the importance of them is related to their reliability. Before the project began the reports were studied and used in the design stage; during the actual work the reports were found to be too unreliable to be of great value: it must be remembered that only winds from the East could create real problems, except for this the weather was not really a problem.

On sheet piling it was stated that the clutches were not inspected before filling the structures and that no trouble had been experienced. In fact the clutches were so good that as the structures were filled the water, instead of leaking out, came over the top of the structures. In the discussion on the "lightness" of the structures it was stated that in the initial design stages the idea of driving four "king" piles had been considered. It was decided however that they would not be necessary in that environment.

The failure of the concrete to reach specification in quality was difficult to pin point but there were three possible reasons:—

(a) The aggregate used was rounded river gravel

(b) No check was made of the mix previous to its delivery to site, that is to say

the contract let by PSA did not require trial mixes and cube testing to prove the contractors design mix

(c) The language barrier contributed to poor results

It was also suggested that poor concrete is met all over the world and arises largely because we try to impose British Standards in areas where they are not known. A further problem in Cyprus is that the limestone ridge in the north of the island is now denied to the south and one is compelled to use poor aggregates.

Some surprise was expressed at the very low costings. A single dolphin similar to that described in the paper but built in Portsmouth Harbour cost £67,000. It was explained that the costings given were costs to the military and did not include military fuel, plant and equipment or the soldiers pay and allowances for example.

The facility would be used in earnest for the first time in March 1977.

The meeting closed and the vast majority of those attending retired to the RE Mess at Minley to continue discussion and partake of buffet supper. On one point there was no dissension, it had been an excellent evening.

Memoirs

LIEUT-COLONEL J E (ALEC) SOUTH

Born 16 February 1916, died 12 February 1977, aged 59

ALEC SOUTH was known to most Members of the Institution. In this Memoir we have concentrated on three areas of his life, with 32 Assault Regiment, with AG7 and with the Institution of Royal Engineers, not because they were the most important but because they best reflect his true worth. RAB writes:

"I knew Alec South in his early days as a Quartermaster. 32 Assault Regiment, as it then was, placed a heavy burden on him, born of its considerable man-power aggravated by the turbulence of National Service, its involved roles and equipment, and its innumerable extra activities (the annual Corps demonstration), and such added complications as the Lynmouth floods, the East Coast floods and every other chore that could be foisted on to the only Sapper unit on Salisbury Plain. Alec handled everything with unfailing charm and quiet efficiency and contributed more than his fair share to the official choice of the Regiment as the best, administratively, on the Plain. The Regiment, and I in particular, were very lucky in our Quartermaster and his wife, Connie; both in the "office" and socially."

JHF writes:

"By the time I arrived in March 1964 he was the cornerstone of AG7. He had been there several years and knew his way round every corner of manning, postings and officers careers. He had all the rules at his fingertips as well as the ways round them. He had an unrivalled knowledge of the officers of the Corps and in particular of his Quartermasters whom he dealt with in detail. The latter had a great respect for him and he took a lot of trouble in fitting round pegs in round holes. He had helped a series of new DAAGs and Staff Captains to find their feet in a complicated business—we all leaned on him heavily and he always came up with the answer. He was a cheerful companion and was one of those people who took a genuine interest in others and their families. He had a delightful sense of fun lurking behind a slightly serious manner and you were never quite sure when he was pulling your leg. He was an ardent follower of cricket, particularly the interests of Kent."

AGCJ writes:

"I knew him mainly through AG7, where his enormous experience and wise advice were of the greatest value to an impulsive new DAAG (0) trying to put the world to rights in five minutes! Alec knew very nearly all the answers, and on the rare occasions when he was not absolutely in the picture, you could always rely on him to find out, in very quick time indeed. In his own quiet way he was a very

shrewd judge indeed of people, and the Corps owe him a great debt. In particular, I cannot think of any body of men who were better cared for than Sapper Quartermasters. He took enormous trouble to place them where they wanted to be, and through all his years at AG7 I never heard any Quartermaster complain about the way his postings had been managed."

JFMG writes:

"I had the privilege to work closely with Alec South during the last two and a half years. His untimely death has robbed the Corps of a devoted Sapper and an outstanding Librarian. His deep interest in and wide knowledge of our affairs, past and present, were acknowledged by all who came in contact with him. No query, great or small, failed to have his detailed and urgent attention. His Library was a friendly place, where all were welcome.

"No mention of Alec would be complete without recalling how he and Connie gave full support to the social side of our HQ Mess. Their presence was always a tonic.

"He will be sorely missed."

EEP writes:

"I knew Alec for nearly twenty years and worked with him closely for the last four in the Institution. As Head Librarian his deep interest and wide knowledge was very evident but his real strength was that these attributes were accompanied by almost instant recall. For example, in the "Peter Simple" Column of the Daily Telegraph of 1 December 1976 there was a plea for information on the builders of the road which runs on the general alignment of, and sometimes on, Hadrians Wall. By 9.30am that day Alec had sent the answer to Peter Simple who published it commenting on the commendable speed of reaction.

"His quiet humour and kindness have already been referred to. He was superb at helping the many small boys who wrote on the lines "Please Sir, I am doing a project on the Royal Engineers, will you please send me copies of all you have on them."

"Above all he was a true and steadfast friend who would do anything for the good of the Institution.

"To his wife Connie and his two sons we offer our sympathy."

COLONEL J R H ROBERTSON CBE, BA, C Eng, FI Mech E, FCIT, FIRSE

Born 18 November 1912, died 20 February 1977, aged 64

JOHN RICHARD HUGH ROBERTSON was Chief Inspecting Officer of Railways in the Ministry of Transport and the Department of the Environment from 1 January 1969 to 31 December 1973, having been an Inspecting Officer of Railways for the preceding ten years. He was educated at Wellington College (Head of School), at the Royal Military Academy, Woolwich, (entered as a Prize Cadet, won Cadet and Army Scholarships and the Sword of Honour), and at Trinity Hall, Cambridge, (Honours Degree in Mechanical Sciences Tripos). His prowess at Rugby, Boxing, Athletics, Pentathlon, and Swimming was legendary during these years.

He was commissioned into the Corps in 1932 and following general military engineering training became a student at the Railway Training Centre, Longmoor and later Assistant Adjutant until the outbreak of WWII. From 1939 he served in various railway units in France, Norway and the UK before attending the Staff College in Camberley in 1941/42. His war-time service was with Engineering, Transportation and the Movements sides of Combined Operations, including a period as SORE 1 in the Directorate of Combined Operations, India; he finished the war as Commander (Colonel) of 46 Indian Beach Group in the landings in Malaya. He then served as Movement Liaison Officer in HQ SACSEA and was secretary to a special team headed by the Minister of War Transport, to arrange

the distribution of rice throughout the Far East, accompanying the team to Bangkok, Saigon, Hong Kong and Batavia. Siam was then the only country which, not having been involved in the war, had sufficient food.

On his return home in 1946 he became Chief Instructor of the Transportation Centre RE before going on to the Joint Services Staff College. His later appointments included three years in charge of the Discipline Branch of the War Office (after which he was awarded OBE); Chief Instructor of the Greek Staff College at Salonika; Commanding Officer of the Middle East Transportation Regiment RE running the Canal Zone Railways, Inland Water Transport and Military Ports, in the period following Egypt's abrogation of the Treaty; and Chief Instructor in the SME in which he had been a student twenty one years earlier. One who served under him in the Middle East remembers him as a keen sportsman, wearing his Wellington boater and playing an excellent game of cricket. No man had a fairer CO.

He was serving as Colonel in charge of the War Office Manpower Planning Co-ordination Branch when, in June 1958, the opportunity of joining the Railway Inspectorate occurred and he became an Inspecting Officer of Railways on 1 January 1959, continuing a long line of succession within the Corps. In his later working life he suffered increasingly from arthritis which restricted his fly fishing which he had come to enjoy. He underwent two major hip operations; but he continued to be a fighter to the end. Those with whom he worked remember him sitting in a chair, specially fixed to the roof of a work's train, inspecting the electrification over Shap Fell in a bitingly cold wind, or being carried in a makeshift sedan chair along the "ces" to the scene of an accident. He never gave up.

His recommendations following one of the accidents into which he inquired, that of the derailment, at high speed, of the "Aberdonian" on the Morpeth curve, led to the introduction, for the first time on British Railways, of the use of the automatic warning system with an illuminated notice board at the appropriate braking distance, as a warning of the approach to a major permanent speed restriction; this has come to be known as a Morpeth Control. On his retirement on 31 December 1973, when he was appointed CBE in the New Year's Honours List, he joined Freeman Fox and Partners as a consultant to advise on the safety aspects of the Hong Kong Mass Transit Railway, on which work began in 1975.

He leaves a widow and two married sons, Michael a Major in the Royal Green Jackets who won the MC in Sarawak in 1966, and Timothy a Major in the Royal Engineers. To them we offer our sympathy in their sad loss.

AGT-R

COLONEL H A BAKER, OBE, MC

Born 26 August 1896, died 11 September 1976, aged 80

HUGH ARTHUR BAKER was commissioned into the Corps from RMA Woolwich on 22 April 1915. Within a few months he was in France with 7 Field Company in 50th (Northumbrian) Division and served with them throughout the War, winning his MC in 1917. His service career followed a fairly normal pattern including service, in Jamaica, Tientsin, West Africa, BAOR, Palestine and Transjordan. He retired in 1948. He was efficient, well liked and respected.

Unusually he really made his "name" as an individual after he had retired from the Active List.

ETLB writes:

"On retirement he went to South Africa to visit his sister and decided to settle there at Rondebosch, Cape Town. Being a very energetic person he amused himself with long walks into the mountains of the Cape Peninsula, the Hottentot Hollands, and further afield. Having for years been interested in flowers he found much to interest him and was brought into touch with other botanists. When the British Museum asked the Director of the Kirstenbosch Botanical Gardens if their herbarium of the *Ericas* could be replaced Hugh was persuaded to undertake the work.

"Over the next twenty years or so he covered most of Southern Africa and built up an index and description of all he found and which other people brought to him for identification. The magnitude of the undertaking is revealed by the fact that known *Erica* number over 600. For his work he received great encouragement from Professor Ryecroft and the Director of the Kirstenbosch Botanical Gardens and Captain Salter RN. In the long run he found all previously identified *Ericas*. In addition he found several not previously known, one of which was named after him as the finder. In the course of this work he exercised meticulous care and in some cases re-classified more accurately a number of known species. He invented a new "key" involving the use of a set of cards bearing species data together with a sorting system depending on cards having 168 numbered holes whereby the most important key characters of specimens are determined.

"Parallel with this work he collected data for a book which was to set out the order of the species, himself writing most of the contents with the collaboration of Mr E G Oliver, a professional botanist, who was able to give much help in composition and its publication. The book was eventually published in 1967 and has since become the master book of reference under the title *Ericas in Southern Africa*.

"In 1967 he had the great honour of being presented with the Harry Bolus Medal by the Botanical Society of South Africa for his outstanding services, as an amateur, to botany. Harry Bolus himself was an accountant who went to Cape Town and became so interested in botany that he became a leading figure in that science.

"A few years before his death he handed all his records, some 1,100 pages, to be placed in the Bolus Herbarium at the Kirstenbosch Botanical Gardens for the benefit of both present and future workers in this fascinating field."

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