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# Editorial

As 1977 draws to a close one looks forward to 1978. In so doing one is influenced by the events of recent years and in particular the current year. As Members know, from their Monthly Supplements, 1977 has been a year of discussions on changes required within the Institution to adapt to the reorganization of Corps central functions and to financial stringency whilst, at the same time, improving the future effectiveness of the Institution and maintaining its service to Members.

One of the studies has been concerned primarily with publications. Views have been requested on improvements to the *Journal* and more will be very welcome. Among the early opinions expressed it became clear that the RE *Journal*

is too technical—not technical enough
is very readable—not very readable
has too much history—not enough history
has too many WW1 & WW2 stories—not enough WW1 & WW2 stories
has too much "I was there"—not enough "I was there"
is too light in style—too heavy in style
has not enough speculation on the future—too much speculation
*and so on!*

With these views at the front of his mind it is with some trepidation that the Editor introduces the December *Journal*, hoping at the very least to please someone somewhere.

It is always dangerous to draw the attention of Members to a few of the articles as it might appear that the Editor considers some articles as being of greater worth than others. This is in fact true but it is not the object of the exercise! Most Members are busy people and there is a natural tendency to "skim" through any publication. Drawing attention to particular articles is merely an attempt to encourage Members not to do this and read articles which might suffer such a fate.

Sir W Kirby Laing, who served in the Corps during WW2 and is a Past President of the Institution of Civil Engineers, gave a most interesting lecture to the 1977 MES Conference on "Hover Barges". He was prevailed upon to develop the lecture into an article. The hover barge is a relatively unsophisticated means of transport which has military applications.

We welcome another article by Major Mike Gibson, particularly as the Reserve Army seem to be reluctant to write up their exercises and submit them for publication. In the article the "one Army" concept, referred to by the E in C in his talk at the Corps AGM, is shown to have worked well in the Hebrides.

We are extremely fortunate to have been given permission to publish the paper presented to the United Nations Water Conference held at Mar Del Plata, Argentina in March 1977. The paper, presented by one of our Members, deals with a particular form of disaster—cumulative drought. We have all read and heard of the problem and as military engineers we may well be called upon to help alleviate its attendant suffering. The paper, for the first time to our knowledge, distinguishes between the solution to the problem and the requirements for immediate relief. The author states that the provision, at very short notice, of an adequate wholesome water supply is routine practice for military engineers. He suggests an approach to the problem based on a sound appreciation.

The amusing article "The Way Ahead" is not meant seriously—or is it? It is a development of the old theme of the combination of two qualities and two attributes (*circa* Wellington) and as with all good humour there is some truth in it.

As we are on the subject of humour and Christmas is nearly upon us, a little fairy story which might amuse. *Once upon a time* at Christmas a Sapper officer presented a colleague with twelve shovels and told him to take his pick! Although the colleague found this confusing he countered with a pair of water skis, the recipient then spent the next year looking for a lake with a slope!!

# The Way Ahead

SAM

As the defence cuts bite ever harder the pyramid of promotion gets slimmer and it becomes all the more essential for every officer from a very early stage to know where his career will lead him.

The following reflections were prompted by the recent spate of advertisements in the National Press for officers for the Regular Army showing the promotion structure and ages of officers. You may remember the officer recruiting advertisement showing a pyramid whose base was ten 2nd Lieutenants becoming nine Lieutenants (aged 20½–26), eight Captains (25–33) and so through all the ranks via six Lieut Colonels (aged 37 onwards) who eventually become three Major Generals (at 49 onwards) topped off with one General at 56 onwards. All this advancement appears not to age the officer, who wears an unauthorized Sam Browne belt, by a single day. They do not even mention the "K" the General collects en route!

Since professional training has become a long and tedious business a subaltern has few opportunities to command those rare and much prized specimens—soldiers with a weapon. It is at this stage that a young officer should guard his command jealously since he will frequently be the victim of a Brigadier who will wish to command his soldiers for him—he himself having had few opportunities to exercise command. Alternatively he may give our young officer the benefit of his good advice without the responsibility of carrying it out in detail himself. Beware of this because our young officer may make a mess of things only to be told that he lacked the character to see the plan through.

It will be about now that our young officer will realize that there are only two sorts of officer in the army from Major onwards. The first is *clever but idle*, the second is *stupid but industrious*. Any who are *clever and industrious*, if not murdered by their friends in early service, must be seconded to another government department. The *industriously clever* senior officer could easily reduce an Army Corps to chaos and be exactly what the Government hatchet men were looking for. The *stupid and idle* will naturally retire as captains to manage their estates or make their fortunes in the City.

So now we have defined our aim to reach the rank of Major General by the age of forty-nine. You must be *idle but clever*—if you cannot honestly say to yourself that you are clever you must use the other channel which means you will never become a high flyer but will always be in support of a high flyer and may be fortunate enough to be carried along in his slip-stream.

You must make it quite clear that you are not interested in mundane earthy things like food, hygiene, supplies of all sorts, not because they are not important but because you have not the time to spend on the detail involved. You will be busy with tactics and spend hours on the radio and know all about antennae and can recognize the difference between a Harrier and a Mig early enough to prevent your soldiers shooting down anything in sight with their new SAGW. You will know all about ranges and beaten zones and argue the merits of tank killing from a helicopter flown in a tactical offensive role.

From commanding your troop you must not become a 2IC or Adjutant as you might reasonably suppose—you must command a squadron. In the enforced period between, you should teach at a recognized Army school—preferably not an engineer one but one at which you meet a large number of officers of other arms and services because you will need friends in high places if you are ever to reach the *TOP*.

You must then become a Brigade Major, these are key appointments where you can establish your grip on the promotion ladder and your ascendancy over the DAA&QMG who, poor chap has by now recognized that he is a worker and not a flyer.

It is at this stage that your AG Branch realizes that you are too hot to handle by themselves and MS are brought in to help. You acquire a separate file and immediately you impress on everyone the fact that Sandhurst or Camberley cannot fulfil their true functions without your assistance. Here you extend your contacts with other arms and services and practice the role on exercises of a Divisional Commander and above. You are introduced to the political concept and for all practical purposes are *GOD*.

You are now ready to emerge from your chrysalis and burst into full flight as a Regimental Commander taking care to pick a regiment in a Division commanded by one of your old friends. At about this time you become an expert on something, preferably a type of warfare (arctic, desert, mountain or just guerrilla). Whilst doing this you realize that out of the six Lieut Colonels, three of whom will become Major Generals, probably all are capable of commanding a division since the Army has an excess of talent from this point upwards. So you now have another opportunity to decide whether to continue in the Army or leave whilst you are young enough to earn your fortune in the City.

You may well skip the rank of Colonel, the haven of the stupid worker, for if you do not you will miss your appointed aim of being a Major General at forty-nine. However, if by mischance you have to remain in parking orbit you should take a Ministry of Defence appointment either in planning or weapon development so that you will not be surprized at anything the Army does in the next ten years.

But your way to the top is still not clear. It is at this stage that your civilian friends, dazzled by your rapid advancement in the Army begin to make you tempting offers of employment at a rate of pay much higher than you are now receiving. You should immediately go to MS and tell them, demanding immediate promotion or you will leave the Army—particularly if one of your contemporaries has just been promoted. You will be surprized to find MS quite unmoved by your threats, but you will have ensured that your file has been dusted off recently and the current officer dealing with your career recognizes you when your name comes up for consideration for promotion to One Star Rank (OSR). From now on it is a matter of luck since all the OSRs (now that we only have Field Forces we should not talk of Brigadiers) have arrived by the same route as yourself and there cannot possibly be enough appointments to go round at two star level. So you content yourself with commanding troops and platoons and offering subalterns good advice.

Now my young officer, if you think you can go through life simply enjoying your service in an unprogrammed haphazard manner I hope I have shown you the error of your ways. You too will have to take to your estates or accept an appointment in the City if you are to escape being a worker. I hope I have not depressed you too much to the extent that you decide to retire as a Captain. If you do the Army will fall apart since you have a scarcity value, they need you more than any other rank in the Army—indeed they cannot do without you—on the other hand there are always more than enough competent officers to promote to Major General.

Does that make you feel better?

# Early Days

MLC

THE Editor in the February 1877 *Journal* draws the special attention of members of the RE Cricket Club to an extract from Trevelyan's *Life of Macaulay*, in which the author comments on Lord Macaulay's defence of competitive exams, in a debate on the India Bill in 1853. Macaulay, it appears, in vindicating the principle of appointment by examination, alluded in passing to the theory that success in study is generally attended by physical weakness and dearth of courage. Mr Trevelyan goes on "as if a good place in an examination list was any worse test of a sound constitution than the possession of family or political interest. As if a young fellow who can concentrate his faculties over a paper must needs be less able to sit a horse or handle a bat. The Royal Engineers, the select of the select—every one of whom has run the gauntlet of an almost endless series of intellectual contests—for years together could turn out the best football eleven in the Kingdom."

He then reminds his readers of the "unprecedented success" of the RE over the I Zingari in 1875 (mentioned in a previous issue of these notes) when the RE made 720 in a two day match, and when (although Trevelyan does not mention it!) the IZ were not invited to bat.

One has the impression that the Editor printed the comment with his tongue in his cheek, and that he is gently suggesting to the cricket team that they have been lucky to have got into the Corps. But one may be wrong here—the *Journal* of those days was very far from having a light touch!

In the next issue appeared an extract from *The World*, which starts by taking the junior officers of the Corps to task for being too self sufficient, too self asserting, too ready to give themselves airs, too proud of their special education and their capabilities. "No wonder the whole Corps was not popular with the Army at large". The article (which is essentially sympathetic) then goes on to vindicate, if not to excuse, these attitudes by detailing some of the achievements of the Corps as a whole, and those of individuals who had obtained distinction both in their military and civilian careers; "for instance in the hands of such men as Gordon the reputation of the Corps, of which he is an ornament, is certain to be preserved safe and undimmed".

But all was not sweetness and light in the more junior elements. At the Summer Royal Military Academy passing off parade and commissioning ceremonies, the Commandant was pained to report that the conduct of the cadets had not been up to standard. "There had been slackness and the heads of the establishment had not received that support to which they were entitled". No sword of honour was to be awarded. He was followed by the Duke of Cambridge, who expressed his regret that the conduct of the Seniors had not been such as to receive the usual praise. He reminded them (apparently at some length) that the strict observance of discipline was the first essential quality of an officer. "If they failed at the Academy, how could he expect it of them when they joined the ranks . . . etc etc." Quite so! The cadets were also reminded (*pace* Trevelyan) that those who had the happy knack of combining study and recreation, "without becoming book worms" were often the most useful men in their profession. History does not relate whether this particular batch of YOs produced, in due course, an above average cricket team!

This impression of discipline at the Shop contrasts rather sadly with an account (in the December 1877 issue) of a similar ceremony at the RMC Kingston, when the Governor General expressed much pleasure in congratulating the cadets on the "healthy, manly and soldierlike spirit by which they were animated. A finer set of young men it would be difficult to find in any country . . .". There was more in this vein, and clearly the RMC had fully earned the Governor General's "warm appreciation of everything that I saw". RMA please copy!

Another interesting side light on discipline is to be found in the address of the Inspecting Officer (Lord Napier of Magdala) at the 1877 Annual Inspection of RE Gibraltar. After congratulating the troops on their smartness on parade, "notwithstanding the men being so constantly employed on the works", the General also had to regret the loss of some good conduct badges because of drink. "If once a man takes to drink he is too often a lost man, for the habit, when once confirmed, is scarcely ever broken off". This despite, as the General also remarks, the best efforts, care and good example of the NCOs. One would imagine that the very best "care" would not have removed this particular source of ill discipline from the British (or any other) Army of those days.

In August 1877 the Queen held an investiture at Osborne, at which the Commandant of the SME, Colonel John Stokes, received the KCB. Stokes was then 52. In his early days he had had his measure of active service in South Africa, where he not only distinguished himself as a Sapper, but also was reported on in most glowing terms as a staff officer. He was "ordered home", together with another RE officer, from his post as DAQMG Second Division, by the Horse Guards because the Duke of Cambridge "disapproved of officers of the Royal Engineers being appointed to the General Staff". This action by "His Grace the Commander in Chief" was not well received by the C in C South Africa who, it seems, could see no sense in it. Well may the Corps have resented the very restricted number of vacancies available to RE officers at the Staff College, and the fact that an officer had to leave the Corps Regimental List, and cease to be eligible for promotion and employment in the Corps, as such, before he was available for the Staff.

Stokes returned for a short time to Corps duties (as an assistant instructor in Survey) before becoming Chief Engineer of the Turkish Contingent during the Crimea War. Thereafter, from 1856 until 1875 he was mostly employed under the Foreign Office, and was concerned with the international use of navigation for both the Danube and the Suez Canal. In 1875 he became Commandant of the SME. While he was Commandant, his services were still much in demand by the Foreign Office over Suez Canal questions and, indeed, as regards the Panama Canal, which was then being planned as a feasible proposition by both European States and the USA. Stokes was one of those many RE officers of the latter half of the 19th century, who distinguished himself both inside and outside the Corps.

Those were the days when an officer could go on the Reserve List if employed (by the Government) in a civilian capacity, and had the right to return to the Corps if not away from military duties for more than ten years. During his absence, and if he kept himself efficient and up to date, he was promoted on a sort of "shadow roster" so that he returned to the Corps, having kept his relative seniority.

The regulations about retirement were drastically changed by a Royal Warrant published in August 1877 and which, as might be expected, received many column inches in the *Journal*. The minutiae of these rules were long and complicated and are of little interest now. Since promotion occurred according to establishment and vacancy (caused maybe by death or unforeseen retirement) and length of service in the Corps, the big decision to be faced, by say a fairly junior Lieutenant Colonel, was whether to retire from the Corps on temporary half pay—that is to look for no more employment in the Corps and to hope that employment—and promotion—within the Army as a Staff officer (as briefly mentioned above) would arise in the course of perhaps the next ten years or so. The alternative was to retire completely but on a higher rate of pay, since the pay for a fully retired officer was higher than "half pay" (which seemed to have been a phrase describing an individual's status rather than his actual pay). The choice was a nice one. It very much applied to Brevet Colonels hoping for promotion to Major General (there being no such rank as Brigadier or Brigadier General). Incidentally, under this new Warrant a Major General did not retire until he was 70. As stated above, the system was all very complicated, and the whole business of promotion, establishment, retirement, redundancy pay etc seems to have been much in the melting pot in the latter part of the last century. One of the complications in, for instance, 1877 was that there were still a considerable number of "Line" officers who had purchased their commissions, and they had to be compensated for the abolition of that system.

Since "100 Years Ago" type articles were first published in the 1970 *Journal*, they have often been somewhat critical of the seeming want of interest of the *Journals* of those days. Those *Journals* too often just did not seem to reflect the thriving business the Corps then was, and the tremendous opportunities it offered to both units and individuals. It is, perhaps, salutary to take a glance at the *Journal* of, say, 1976 and to imagine what someone in 2076 (or even 1876) would think of them. It is, of course, an Editor's job to think along these lines, but it is certainly not necessarily his fault if the answer is not satisfactory. He cannot force people to contribute!

One would hazard the guess that the reviewer in 1876 would wonder at the paucity of "professionally qualified" articles, would applaud the fact that the *RE List* in all its details is no longer published without fail month after month, and would probably approve of the publication being quarterly and not monthly. It seems certain that he would find it very readable and very worth while. To the correspondence columns, disappointing as they may be, he is likely to give more than a passing glance as they are at least more interesting than he would have been used to!

As for the reviewer in 2076. The odds are that he would admire the publication for its interest and standard of presentation, as would our friend in 1876. He might even be as envious of the opportunity and type of life the Corps offered in 1977, as we can be of the Corps in 1877. For he might by then find himself in some less closely knit "Military Engineer" organization with the *RE Journal*, as such, no longer being published. A good reason to ensure that we keep up our present standards, for it is surely the duty of every generation to ensure that its successors have some reason to look back on the "good old days"!

# The Development of Water Resources in Disaster Situations

PETER H STERN, MA, C Eng, FICE, MIWE

THIS paper was presented by Mr Stern, Surface Water Development Adviser, Ethiopian Water Resources Authority, on behalf of the Government of Ethiopia, to the United Nations Water Conference, Mar Del Plata, Argentina in March 1977. Permission to publish has been given by both the Water Resources Authority and the Secretary General of the UN Conference to both of whom we are grateful.

ABSTRACT

The paper divides disasters into two groups, instantaneous and cumulative, and examines the situations resulting from the major cumulative drought disaster which occurred in Ethiopia in 1973–1974. The nature of the world response to the Ethiopian disaster is discussed, with particular reference to the problems of water supply and sanitation. The technology of improving water supplies is reviewed, again in the light of the Ethiopian situation, with referenceto the various sources available in the country, which include surface water, springs and shallow ground water, and the extent to which emergency measures were taken to develop these sources. The merits of capital-intensive and labour-intensive techniques, and the opportunities for the use of modern synthetic materials are discussed in the light of both water supply development and the protection of health through sanitation and waste disposal. Finally comments are offered on the need for proper co-ordinated surveys and investigations of a disaster situation, so that the true needs may be understood and appreciated and so that mobilized assistance can be used to the best advantage.

## INTRODUCTION

Disaster situations can be divided broadly into two groups—instantaneous and cumulative. Disasters in both groups may result either from natural causes, or from human activity, or from a combination of both. Examples of instantaneous disasters are the havoc and devastation caused by earthquakes, typhoons, hurricanes, floods and other mainly natural manifestations. Cumulative disasters are those which occur as a result of a succession of adverse conditions whose cumulative effect creates disaster conditions. The most common example of the latter is starvation and death following a succession of years of poor rainfall and bad harvests, or the progressive damage caused by pests, resulting eventually in complete crop failure. Another cause of cumulative human disasters is progressive population growth, giving rise to undue pressure on land, over-crowding, soil erosion and bad husbandry, all accelerating the exhaustion of available natural resources.

Whatever the causes of a disaster, the immediate basic needs to sustain human life are food, water, shelter, clothing, medical care and health control. The order of priorities of these needs will vary with geographical location and climatic conditions. In temperate regions, during winter months, or in exposed situations at high altitudes, shelter and warm clothing may be the most important need. In hot, arid, desert conditions water will probably be the most important requirement for survival.

It is a well-known fact that water and health are closely related, and that many communicable diseases are transmitted through water. Disaster situations may often result in the complete breakdown of an existing service, such as a pure water supply, and if alternative polluted sources of water exist, these will be used; if these are seriously polluted, epidemic diseases will quickly appear. If there are no available sources of water at all, then acute distress will result very quickly under tropical conditions, and will lead to dehydration and death in a comparatively short time.

This paper examines the water problems which arose from the drought situation in Ethiopia, which first reached disaster proportions in 1973 and which continued in some parts of the south-east of the country well into 1976.

## THE ETHIOPIAN DROUGHT DISASTER

*The Climatic Factor in the Ethiopian Drought*

Although the causes of drought conditions are complex, droughts are a fairly

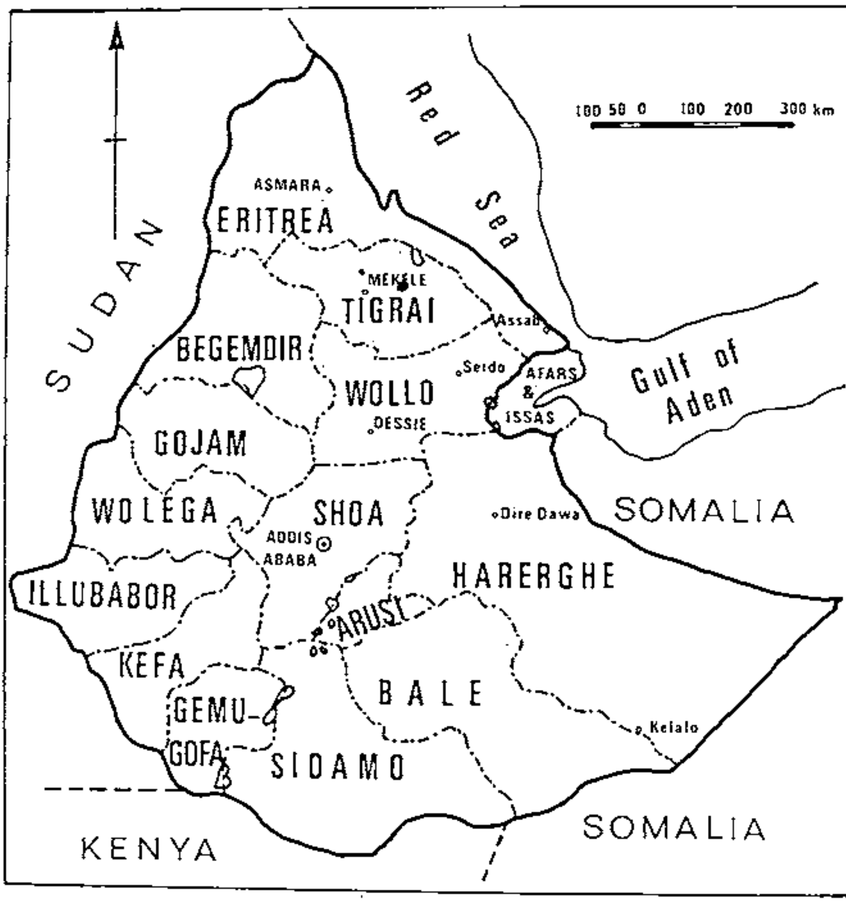


FIGURE I – MAP OF ETHIOPIA

common feature of the world climatic pattern. Since the recent drought first struck the whole of the Sahel belt of Africa and extended eastwards across Ethiopia and Somalia, meteorologists and other scientific workers have been studying this phenomenon. Opinions as to its causes differ: D Winstanley (1) has detected a long-term trend in rainfall patterns which currently shows an increase in the winter rains in the Mediterranean zone of north Africa and a corresponding decrease in the monsoon rains of Africa south of the Sahara, and forecasts a continuing downward trend with increasing frequency of droughts in these areas, extending to the year 2030. H E Landsberg (2), with a different approach, claims "there is no need to invoke climatic change as a cause each time drought occurs. Quite the contrary is evident; drought is an integral, if irregular, component of climate as it exists now".

It is, however, undisputed, that the years 1970–1973 saw a pronounced reduction in overall rainfall throughout the drought-affected areas of Africa, and this can be verified from a study of annual rainfall for selected stations in Ethiopia. As is generally accepted, particularly in tropical and sub-tropical regions, interpretations from the rainfall records of single observation stations can be very misleading, since they are not representative. This creates a problem for Ethiopia, because, although the country has a large number of rainfall stations, very few have complete records for more than a few years. The records for Addis Ababa, which are the longest in Ethiopia and probably the most reliable, are not, however, typical of the country's drought-affected areas. Four stations in the drier eastern part of the country (see Fig I) which have continuous records for a number of years are Asmara, Mekele, Dire Dawa and Kelafo. The mean annual rainfall for Addis Ababa and for these four stations, and individual annual amounts from 1969 to 1975 are given in Table 1. The annual figures which are less than the mean are underlined.

The records from these five stations have been plotted as percentage variations of three-year rolling means from the long-term means, and these are shown in Fig II. The downward trends in recent years are clearly evident. Had this diagram been plotted early in 1973 the trends would have already been visible. It will also be seen that while Addis Ababa has followed a similar pattern to the others since 1970, it is not a reliable indicator of conditions at the other stations.

*Table I—Annual rainfall at selected stations in Ethiopia (in mm).*

| Station | Years mean | Mean mm | 1969 | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 |
|---|---|---|---|---|---|---|---|---|---|
| Addis Ababa | 29 | 1191 | 1308 | 1432 | 1175 | 937 | 1271 | 1120 | 954 |
| Asmara | 28 | 488 | 202 | — | — | 381 | 368 | 363 | 642 |
| Mekele | 16 | 567 | 623 | 647 | 442 | 565 | 473 | 348 | 800 |
| Dire Dawa | 23 | 614 | 589 | 667 | 406 | 474 | 390 | 441 | 676 |
| Kelafo | 13 | 174 | 250 | 219 | 104 | 348 | 92 | 86 | 48 |

*The Disaster in Ethiopia*

The occurrence of drought in Ethiopia in 1973 was not a new phenomenon. Droughts are known to have occurred in the past as far back as 1540, and in the present century in 1913–14, 1921, 1953, 1958–59, 1961, and 1964.(3). It is believed, however, that the drought of 1973–74 was more severe than any other in the present century. The almost complete failure of the early rains in 1973 in the north-eastern highlands (Tigrai, Wollo and northern Shoa) resulted in a widespread failure of the early food crop. This produced a serious food shortage, which reached disaster proportions later the same year when the long rains also failed. In the period from June to September 1973 the famine occurred and over 100,000 people and an enormous number of animals died. By June 1973 it was reported (4) that the nomadic people in the Danakil plains of Wollo and Tigrai had lost up to 90% of their cattle and 30% of their sheep. A year later, and after good rains in 1974, conditions in these regions were greatly improved, harvests were good, grazing recovered, and,

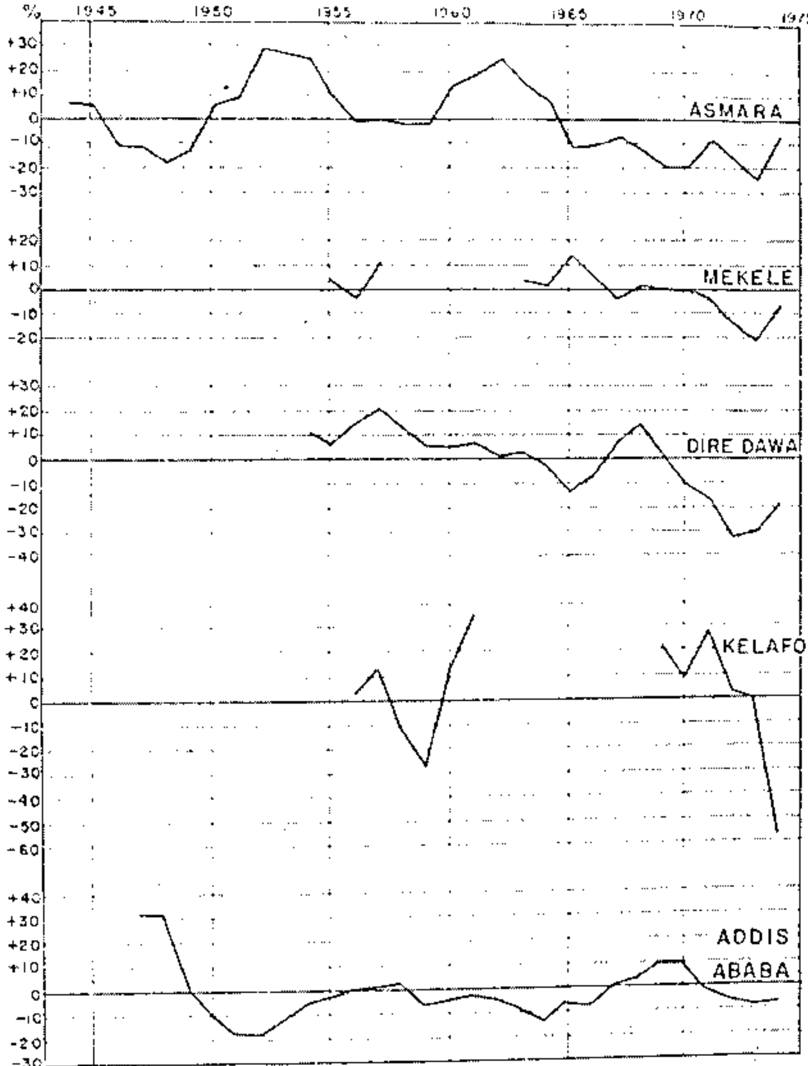


FIGURE II - RAINFALL AT 5 SELECTED STATIONS EXPRESSED AS PERCENTAGE VARIATIONS OF 3-YEAR ROLLING MEANS FROM THE LONGTERM MEANS

apart from an acute shortage of livestock, life for many who had survived the disaster was quickly returning to normal.

However, this was not the end of the trouble for Ethiopia, because soon after the news broke out of the disaster situation in Wollo and Tigrai, disturbing reports began to come in of similar, if not worse conditions in the lowland pastoral areas of Hareghe, Bale, Sidamo, and Genu-Gofa regions in south-east Ethiopia. (5). Very large numbers of the animals belonging to the nomadic people in these lands perished from lack of grazing and water, and estimated losses were 80% of cattle, 50% of sheep, and 30% of camels and goats. This reduced about a million nomadic people to famine conditions.

## RELIEF ACTIVITIES

*Emergency Action*

In April 1973 the Government of Ethiopia set up a National Emergency Relief Committee, which started borrowing grain stocks from the Ethiopian Grain Corporation and International Agencies, and during that year 14,000 tons of grain were distributed. (5). The people initially most affected by this disaster inhabited country lying mainly to the east of the north-south main road in northern Shoa, Wollo and Tigrai. These areas on the eastern edge of the highlands and spreading over the rift valley escarpment hills, are areas of low agricultural productivity, with poor soils, and limited water resources; they are therefore more vulnerable to rain failure. So the only hope for the people who had become destitute by losing, first their crops, and then their possessions (by selling them for food), was to move westwards to the more fertile and prosperous highlands in search of help. It was thus that these people collected in hundreds and then in thousands, at the towns and administrative centres along or near the main road, during the latter half of 1973. The knowledge that relief food was being distributed at such centres, provided an additional incentive to this migration. Shelters were hastily put up by local authorities to provide temporary accommodation. Because of overcrowding, poor sanitation and inadequate and polluted water supplies, these shelters became centres of epidemic disease, and many of the people who had come to the shelters for help died there.

In March 1974 the Relief and Rehabilitation Commission (RRC) replaced the Emergency Relief Committee, and undertook the purchase and distribution of food relief. During 1974 food assistance was brought to some 2½ million people through selective feeding programmes. At the same time extensive programmes of medical assistance were started, mainly financed by outside donor agencies. By the end of 1974 the relief operations in the highlands were giving way to longer-term rehabilitation programmes, and the emphasis on relief work had moved into the nomadic lowland areas. Here too the main efforts were directed towards food and medical assistance, but some attention was also given to the very acute problems of drinking water.

*Water Problems*

It may seem surprising that in this disaster the question of water supplies did not command immediate attention. In fact it was not until towards the end of 1973, when reports started coming back from the drought-affected areas in Wollo and Tigrai by doctors, medical teams, nutrition experts and other relief workers, both in Government and in the voluntary agencies, that the Government became aware that there were water problems, particularly in the emergency relief shelters. In all these centres where relief workers were operating the problems arose from the sudden increase of population caused by the influx of drought victims overloading an existing primitive, inadequate and insanitary water supply. Thus between October 1973 and March 1974 when there were over 10,000 victims in relief shelters in Wollo, each shelter was a health hazard not only to its inmates but also to the resident community within which it was situated, and the health of perhaps a quarter of a million people in all was at risk. By January 1975 all the shelters except one (at Dessie) had been closed, and at this one there were only 750 inmates.

In the drier areas further to the east, the water resources situation is very different from that in the wet highlands. On the escarpment hills of the Rift Valley and in the Danakil plains, even in years of good rainfall, freely available water is a scarce commodity. With the succession of dry years, previously reliable sources dried up, and both the arable farmers in the hills and the nomadic people of the plains were severely affected. The fateful week when twenty people died of thirst at the relief centre at Serdo, on the main road to Assab, occurred in February 1974, when ambient day temperatures in the shade were over 40°C. This disaster happened because the government tank truck which was supplying the centre with water, broke down.

*Responses to the Water Problems*

Most of the reports which came to Addis Ababa about water problems in the latter half of 1973 were concerned with the highland areas of Wollo and Tigrai. In November the same year two engineers from the National Water Resources Commission (NWRC, now reconstituted as the Ethiopian Water Resources Authority) made a survey of fourteen famine relief centres in Wollo (6), which included thirteen in the highlands and one, at Serdo, in the lowlands. This was followed, in January 1974, by a more detailed study by a team of three comprising one of the NWRC engineers, a WHO sanitary engineer and a US Peace Corps volunteer, which led to the issue of a report in February 1974 with proposals for developing water supplies at the centres. (7). This led to an immediate response from UNICEF who allocated funds for supplying equipment and materials for these projects. Construction started on two of the sites in June 1974, and by the end of March 1975, ten of the fourteen sites had been completed. As a measure of long term development this was indeed a creditable performance; in less than a year ten semi-urban communities amounting to about 50,000 inhabitants benefited from some improvements to their water supplies.

In December 1973, under arrangements between UNDP and UNICEF, an experienced drilling consultant arrived in Ethiopia to advise the Government (NWRC) on an emergency programme of water supply in the recently drought-stricken areas of Wollo and Tigrai, to advise UNICEF on the specifications and requirements of drilling equipment and to liaise with all Government and non-Government agencies involved in the drought relief work. During this three-month study the consultant identified the areas in Wollo and Tigrai with acute need for water supplies, arranged a series of co-ordinating meetings with the government and non-government agencies concerned with water supply problems, made an inventory of all the drilling equipment at that time available in the country, prepared a comprehensive programme of drilling in the drought-stricken areas, and provided UNICEF with detailed specifications for two modern high speed drilling rigs, and appropriate equipment. (8). Again UNICEF acted expeditiously, and procedures were quickly set in motion for calling for international tenders and placing orders, and in due course the two rigs arrived in Ethiopia towards the end of 1975. One became operational in January 1976 and the other in May 1976.

The first co-ordinating meeting between Government and non-Government agencies was held at NWRC on 4 January 1974. In addition to NWRC, representatives from two other Ethiopian government departments, three international agencies, four bilateral agencies and seven non-government and voluntary organizations attended. (8). Following this and subsequent meetings a comprehensive drilling programme was drawn up for Wollo and Tigrai, involving twelve drilling rigs, as shown in Table 2.

*Table 2—Mobilization of Drilling Rigs for Wollo and Tigrai*

| Agency | No of rigs | Date effectively operational |
|---|---|---|
| Ethiopian Government | 3 | January 1974 |
| Ethiopian Government/UNICEF | 2 | 1 January 1976<br>1 May 1976 |
| British Government | 1 | 2nd half 1974 |
| Society of International Missionaries (SIM) | 2 | 1 mid 1974<br>1 cancelled |
| Ecumenical Development Assistance Committee (EDAC) | 3 | 2 mid/end 1974<br>1 cancelled |
| Lutheran World Federation (LWF) | 1 | mid 1974 |
| | 12 | |

The first SIM rig and the LWF rig were brought into Ethiopia by air from Britain and the United States, respectively. Although both were in the country at the beginning of 1974 neither was effectively operational for several months because of initial teething troubles. However by the end of 1974 there were eight machines working in the two regions. A year later two machines, EDAC and LWF rigs, had been transferred to other parts of Ethiopia, reducing the total to six, until the two large UNICEF machines started working in 1976.

As this drilling programme was getting under way some organizations turned their attention to other forms of water supply development, which, not being so heavily dependent on imported machinery, could proceed more rapidly. By the end of 1973 a roof catchment system was being constructed at a school at Alitena (Tigrai), and hand-dug wells were being excavated in various parts of the country under assistance from the Catholic Secretariat. Following a reconnaissance study (9) by an Intermediate Technology Services (ITS) team in November 1973, the Livestock and Meat Board started a pilot project early in 1974 for flood-spreading and irrigation at Weranzo, in the Dankil plains of Wollo, employing nomadic Affar under food-for-work. ITS provided the engineering designs, and two field staff for this project. (10.)

Also early in 1974 SIM started a low-cost water development programme in Wollo, and EPID (the Extension and Project Implementation Department, Ministry of Agriculture) began a programme of pond and dam construction by hand labour on a food-for-work basis. In January 1975 NWRC started a programme of hand-dug well construction in Hererghe Region, financed by UNICEF and Swedish Save the Children Fund. Later the same year a second similar programme was started in the El Kere district of Bale Region.

*Evaluation of the Emergency Measures*

From the foregoing sections it will be seen that, except perhaps in the case of the Danakil lowlands, once the urgency of the water problems became known there was no lack of response to the calls for assistance with water supplies in the disaster situation. But how effective was the response?

The famine disaster in Wollo and Tigrai reached its peak sometime between June and September 1973, leading to acute water shortages both in relief shelters in the highlands and throughout the escarpment hills and lowland plains from mid-1973 until rain started falling in March or April 1974. By the end of 1974 the immediate water crisis was over, but the measures adopted to meet it had not yet started to be effective. Water supplies for the relief shelters were beginning to be improved just as all the shelters but one had been emptied and closed. The emergency drilling programme started to show results several months after the real emergency was over.

Similarly, in the Ogaden lowlands of Hererghe in south-eastern Ethiopia the serious water shortages occurred between November 1974 and March 1975, but intensified water development activities did not begin to be effective until early in 1976.

## APPROPRIATE TECHNOLOGY FOR EMERGENCY WATER SUPPLIES

There are four essential requirements for any water supply system, and these are:—

(1) A suitable source
(2) Means of extracting water from the source
(3) Means of conveyance from source to place of demand
(4) Storage capacity.

If remedial action in an emergency is to be effective, all these requirements must be met quickly. This calls for a flexibility of approach to water supply problems which may be rather different from the traditional. But if the essential requirements exist or can be met it is not impossible to provide, at very short notice, an adequate, wholesome water supply. This is routine practice for military engineers, but there is no reason why civilian operators should not be able to respond quickly to a drought emergency if the problems are properly appreciated, if the right equipment can be made quickly available, and if there is a tolerably efficient organizational infrastructure through which to work.

*A suitable source*

In the context of an emergency, a suitable source is one which can be used immediately such as a river or stream, a lake or pond, or a spring. Water 50 metres below ground requiring several weeks of engineering work to make it available could not be called a suitable source. It is unlikely in a drought situation that the collection of rainfall would be a practical emergency solution, but it is a possibility which should not be forgotten.

A suitable source must also be an adequate source. It must be sufficient to meet the anticipated emergency demand, and if there is any doubt about its capacity (eg a spring or small stream) then its flow should be measured, and as much local information as possible should be obtained about its performance characteristics. In many parts of the tropical and sub-tropical world, streams can be ephemeral, rising to a flood after recent rainfall, and receding to a negligible flow in a few days or even hours.

*Extraction*

Methods of extraction will vary with the nature of the source. Spring sources present no serious problems as the water flows freely out of the ground and can be easily diverted or collected. But much can be done with simple tools and equipment to improve the collection of water from a spring, and this can be done with local labour under experienced supervision in a few days. The use of the source, however, can start immediately, and does not have to wait until the improvement works are completed. Wagner and Lanoix (11) described methods of protecting springs.

Where water is to be taken from a river, lake or pond, care must be taken in choosing a site for extraction where pollution risks are minimal, and where some appropriate water lifting device can be installed. Where demands are small, water lifting devices such as those described by VITA (12) or by Mann and Williamson (13) may be employed; for heavier demands, mechanical pumps will be needed. The possible use of animal power for lifting water should not be overlooked. Currently widespread interest is being shown in the use of hand-pumps in developing countries, and this was polarised recently at an International Workshop held at the WHO International Reference Centre in Holland and July 1976, which examined many aspects of hand-pump development.

In certain situations, where there is a suitable river and working site, and where the water required for extraction is about 10% or less of the total flow, a hydraulic ram pump may be used. The installation of this does require some engineering work, including a properly constructed diversion and some piping, but this is not beyond the resources of a trained team. A hydraulic ram need not be an expensive piece of equipment and designs are now available for their manufacture from locally-available pipe materials. (14), (15).

*Purity of the supply*

While the importance of the purity of a supply is paramount, a potential source which is polluted may have to be used in an emergency, and can be used if it is purified. The treatment required will depend on the quality of the raw water, but it will usually comprise the removal of physical impurities (sediment) and the removal of biological material. The simplest form of treatment is to store water for 48 hours before use, and this may be adequate to remove certain impurities. A more efficient form of treatment is by filtration through sand, and simple slow sand filters can be constructed using locally available materials and labour. L Huisman and W E Wood have made a useful study of this subject, describing the essential requirements for the design and construction of slow sand filters (16) and Mann and Williamson also describe the construction of simple filters. (13).

As slow sand filtration will not guarantee the biological purity of water, chemical treatment may also be necessary, and techniques have been developed for the emergency chlorination of sources, using calcium or sodium hypochlorite, bleach and other preparations which are readily available in most parts of the world.

Unless there are special circumstances which might lead to pollution (such as a pit latrine too near to a well) ground-water can generally be assumed to be pure and therefore need not be treated.

*Means of Conveyance from source to place of demand*

It took people in Ethiopia quite a long time to appreciate the importance of conveyance as an essential link in a water supply system. The deaths at Serdo already mentioned, occurred because this link broke. Much of the acute distress in the Ogaden plains in the south-east of the country arose from the inability to transport water in adequate quantities to the areas of need.

For short distances of a few kilometres, emergency pipe-lines can be laid above ground using easily-jointed plastic or light metal pipes. But for long distances, and in the absence of existing pipe-lines, the only practical method of conveyance is by mechanical transport. If a railway line exists, then this can be used, but in most cases conveyance will be by road vehicles. For road transport there is a choice between purpose-built water-tank lorries and water-tank trailers. The water-tank lorry has certain advantages over the trailer. It usually has a greater carrying capacity, it can be filled and emptied more easily (often with the aid of mechanical power) and it is more mobile in rough country. But it has one disadvantage compared with the trailer, which over-rides all its advantages when used in remote situations without repair facilities. If the tank lorry has a mechanical breakdown, the water supply breaks down with it. If a lorry towing a trailer breaks down, it is usually not difficult to find another lorry to pick up the load so that the supply can be maintained.

*Storage*

The provision of adequate storage in an emergency situation is perhaps the most difficult requirement to meet at short notice. A community of 1000 people will use a minimum of 20 cu m daily. If water is supplied daily, then at least seven cubic metres of storage should be available and preferably storage for a day's supply of 20 cubic metres. If water is brought in twice a week then about 100 cu m of storage would be needed.

Storage tanks of 2 or 3 cu m capacity can be fabricated in steel fairly easily and quickly in most countries, and can be transported to sites where they are wanted. But for capacities of over about 10 cu m there are three principal possibilities:

(1) Construction in situ in masonry or concrete,
(2) Prefabricated metal sections, to be erected on site,
(3) Prefabricated plastic materials.

Construction in masonry or concrete is not likely to be feasible because of the time required for construction. Prefabricated metal tanks can be constructed quickly if the necessary components are readily available. The prefabricated plastic tanks may be the quickest solution to the storage problem; these can be obtained from commercial suppliers made up either as completely enclosed tanks or as linings for open cisterns or reservoirs. (17). As these materials are not self-supporting, supporting walls are required. These may consist of the side walls of a pit excavated in the ground, or they may be constructed above ground in timber, corrugated metal sheet, metal mesh, brick or stone masonry.

*Capital and labour-intensive techniques*

In an acute emergency where human lives are at risk, capital-intensive technology may in fact be the best solution. No-one would advise against using air transport under such circumstances, and in the highlands of Wollo and Tigrai the helicopter played a very vital part. But highly sophisticated machinery and equipment is very expensive and can therefore be used only for comparatively short periods. Where large numbers of people are affected by a disaster, much can also be achieved to relieve hardship and improve conditions, using self-help methods and simple technology. One cannot expect people in advanced conditions of starvation to participate in heavy manual labour, but those who are still able-bodied can be mobilized to work for the community. This was done to good effect in the many food-for-work programmes which were started in Wollo and Tigrai during the disaster.

When it became known that the Affar nomads in the lowland areas of Wollo had lost most of their animals, the Ethiopian Livestock and Meat Board initiated food-for-work programmes which were highly labour intensive. They started with road construction in the plains, and these operations provided access to areas which were hitherto inaccessible to vehicles. These were followed by a pilot project for flood-spreading and irrigation. The EPID food-for-work programme for the construction of small dams and ponds was another example of a socially acceptable and largely successful labour-intensive operation.

In most cases the output under food-for-work schemes was not great and the operations have been criticized on this account. But in a situation where people are destitute and therefore have to be provided with food for survival, even a small amount of work in exchange for food is a net gain, not only to the community but also to the self-esteem of the people themselves.

*Waste Disposal*

When the relief shelters were put up in Wollo at the height of the disaster, attempts were made to provide toilet facilities. When the fourteen centres were visited in November 1973 (6) all were found to have pit latrines, though in some cases their capacity was quite inadequate. The best facilities were a pit 10 m × 2 m serving 300 people, and the worst, at Dessie, was one pit 8 m × 1 m serving 2,400 people. The construction of these latrines followed traditional rural Ethiopian practice, and while they were generally deep enough, their sanitary condition was far from satisfactory. As the use (or abuse) of toilet facilities is very much a social matter it is unlikely that any different technology would have had better results. Conditions would certainly have been improved with more latrine capacity in the shelters with large numbers of people, but, without adequate water supply, the deep pit latrine is the only feasible solution.

## CONCLUSIONS

It is not the intention of this paper to under-rate the efforts which were made at the time of the disaster to help meet the water supply problems in the drought-affected areas of Ethiopia. Once these problems became known and appreciated, an impressive flow of resources was directed towards their solution. There was, however, something wrong with the timing of the operations, so that remedial measures usually became effective too late. This happened because the remedial measures adopted were measures which could not be applied quickly, and this arose from a failure to distinguish between the requirements for immediate relief and the requirements for rehabilitation and development. Relief must be applied quickly to be effective: under hot, arid conditions, people will die without water in a few days, and drilling rigs are unlikely to meet their needs in time. Rehabilitation and development on the other hand are processes which take time and can proceed slowly.

Another conclusion which may be drawn from the experience in Ethiopia is that emergency action for water supplies will be more effective if certain preparatory measures are taken as soon as possible. Before any relief operation is started it is necessary to make a rapid appreciation of the needs for all basic requirements, which will include water supplies together with food, shelter, and medical care. As soon as this survey has been made and the needs have been identified, then steps can be taken without delay to assemble a stock of materials and equipment. In the field of water supply and bearing in mind the four essential requirements already mentioned, this stock should include water tank trailers, hand pumps, portable mechanical pumps, piping and fittings, 200 litre drums and other storage containers, synthetic rubber storage tanks, rolls of plastic sheeting, corrugated metal sheets, metal mesh, fabrication steel, timber, cement and other construction materials, hand tools, water sedimentation and sterilization chemicals and portable bacteriological water testing equipment. If equipment has to be imported, the government can do much to facilitate the importing procedures and this will be particularly appreciated if the equipment is in the nature of a gift from some outside organization.

In addition to equipment it is essential to have available people experienced in water supply engineering and capable of using the emergency equipment. Much of the manpower needed may be available locally, but there are usually serious difficulties in obtaining the release of people from their permanent jobs for emergency work. Action may need to be taken at a very high government level to bring about the necessary releases. Because the development of emergency water supplies calls for a technical approach which is rather different from traditional water supply practice, outside technical assistance may also be required, and agencies specifically concerned with relief should be able to make available specialists in this type of work who could form nuclei for teams made up of local personnel.

Finally, it can also be concluded that there is an important place for self-help activities in a disaster situation, provided that tools and equipment are available for the work to be undertaken. There were cases in Ethiopia of parties engaged under food-for-work road construction programmes having to excavate with their fingers because hand tools were not available for them. Here again the need for preparedness should be emphasised, and this means a willingness to respond to an emergency situation at all levels of administration and throughout all departments of public life.

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# Hover Barges

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WHEN reference is made to surface craft with an ability to hover one immediately begins to think of sophisticated vehicles such as SRN6 or SRN4 which are capable of carrying passengers and vehicles across waterways such as the Solent or the English Channel at speeds in excess of 40 knots. Hover barges are very different types of machines designed for a different use, usually having no built-in means of propulsion. They are designed to suit the particular requirements of the construction industry where barges are unrefined pieces of equipment with a slow speed of movement of some 8–16 km/hr. The development process of hover barges has included a capability of being used for operations across the shore line to assist in transporting bulky loads from ship to shore where no permanent harbour exists.

Their use was envisaged by a firm of contractors known as J T Mackley and Co Ltd who operate from Chichester and Southampton and specialize in tidal operations. Frank R Mackley, an ex-Sapper and Director and Chief Engineer of that company, foresaw the need for a hover barge when he was preparing a tender for a sewage outfall in Prestatyn in North Wales in 1970. In this area, as in so many parts of Britain, the water close in-shore is very shallow and the tide recedes for long distances. This means that excavating machinery mounted on barges in the normal manner can only be moved for a very short period close to high water and for the rest of the period between tides the barge has to take the bottom, restricting the amount of physical work which can be undertaken each shift.

Mackley conceived the idea that if a barge could be made to hover on an air cushion it could be moved at any state of the tide so allowing work to proceed throughout the whole twenty four hours of the day. He felt that for operations of this sort it would not be necessary for the barge to be capable of any high speed and it could easily be towed by normal work boats at high water or by tractors at low water.

As he studied this problem it was felt that the normal full size barge was un-

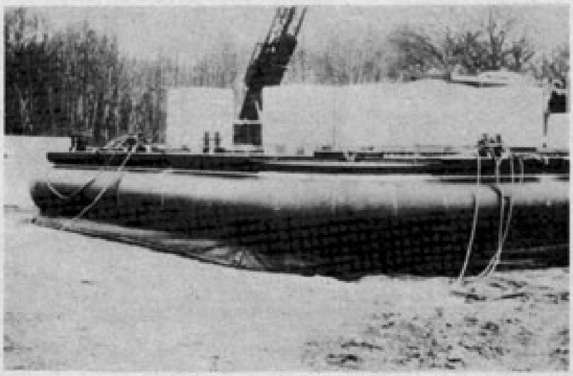


**Figure 1.** Prototype hover barge under test

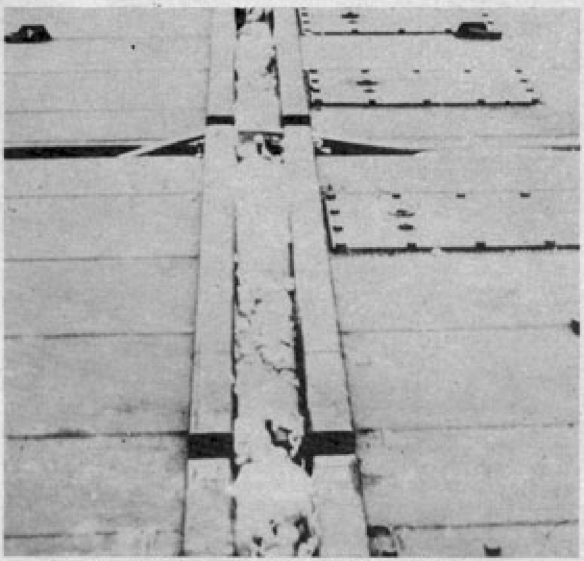


**Figure 2.** Joint between Uniflotes filled with formaldehyde foam

necessarily heavy and that much of the energy of the air cushion would be absorbed in lifting the barge itself leaving little capacity for pay load. It therefore occurred to him that the standard Uniflote pontoons, which his Company was in the habit of using for river operations, could be linked together so as to form a barge capable of carrying a medium size drag line excavator weighing some 30 tonnes. He made approaches to Air Cushion Equipment Ltd (ACE) seeking their advice, from which it transpired that simple ventilating fans driven by standard diesel engines of some 200kW would be adequate to handle the load envisaged. Figure 1 shows the prototype under test in J T Mackley's depot, using concrete kentledge blocks as simulated load.

Linking the Uniflotes created problems. In the first place flexible strips held in position by metal plates screwed at frequent intervals were tried. These joints proved to be very expensive to form because of the labour involved in bolting up the metal strip. After experiment it was found that urea formaldehyde foam could be poured between adjacent Uniflotes and could form a joint of some 6–9 inches deep which appeared to be immune to spillage of hydrocarbons, acids, etc. It was therefore decided to standardise on this method of jointing. (Figure 2.)

The next major problem to be overcome was the design of skirt to be used and also the method of forming the necessary plenum chamber or air duct to circulate the air around the perimeter of the hover barge. After much experiment it was decided to use a segmented loop skirt attached to a continuous loop plenum chamber, as indicated in Figure 3. The advantage of the segmented loop skirt being that it more readily conforms to unevenness in the ground as compared with the continuous

Hover Barges (2)

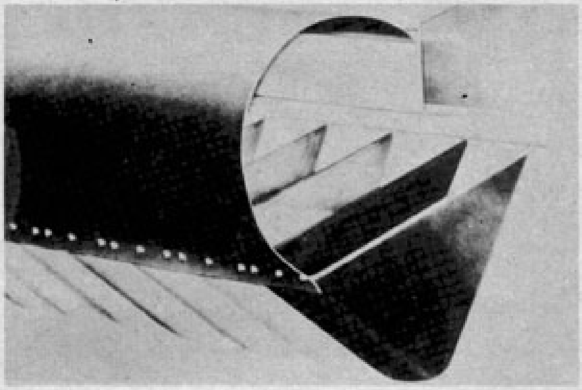


**Figure 3.** Section of plenum chamber with segmented loop skirt

skirt used in SRN designs. The skirt is manufactured from open-weave nylon coated with neoprene. It has been found that up to 10% of the loops can be damaged without causing the barge to come off its cushion as adjacent loops automatically swell to replace their damaged neighbour. It was found also that the loop type of plenum chamber was readily damaged by work boats berthing alongside the hover barge and this has now been replaced by a metal duct integral with the outside Uniflote units.

Tests showed that a barge of the type described would hover at a height of 650mm under full load (see Figure 1). On good ground conditions ie sand or mud, only one engine/fan unit was necessary to achieve full hover, the second fan being required only to compensate for air losses when used over gravel. The ground load of this

**Figure 4.** Launch of experimental hover barge at Browndown

Hover Barges (3 & 4)

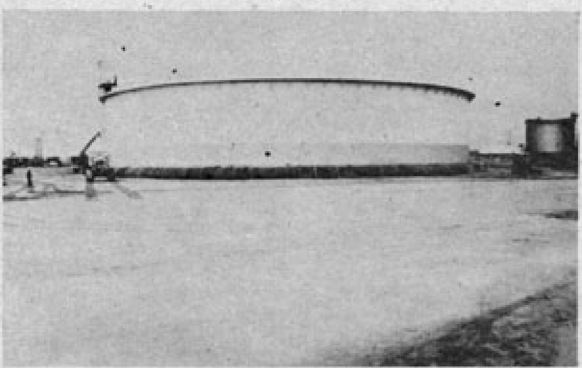


**Figure 5.** Large oil tank being hovered to new location

prototype hover barge was only 0·07kg/cm², ie approximately only one-fifth of the load applied to the ground by a normal human being.

As experiments continued it was felt that there would be advantages in having permanent links with ACE. Eventually a joint company was formed known as Mackley Ace Ltd. Having carried out the land tests the hover barge was taken to Browndown for its sea tests and the initial launch is shown in Figure 4. Sea tests proved the barge to be completely stable in all conditions and further experiments showed that modular barges of this type could be built to carry up to 90 tonnes pay load. In addition it was found that the towing force required was only one-fiftieth of the gross weight of the barge and that it was possible to winch a loaded barge up a beach having a gradient of 1 in 40. As far as power requirements are concerned for the provision of the air cushion, fan engines of approximately 2 kW/tonne gross can produce a hover height of up to 1·5 metres depending on surface conditions.

Various developments of the original design have taken place during the last six years and flexible skirts have even been attached to very large oil storage tanks so that they could be moved on an air cushion to a new location within a tank farm complex (Figure 5). Also hover trailers have been used for recovery of aircraft which have either over-run a runway or landed on soft ground. Hover trailers placed at suitable positions under the wings and fuselage have lifted the whole aircraft clear of the ground allowing it to be towed back on to the hard surface of the runway or taxi tracks.

A further development was the use of hover barges as river ferries. The most spectacular demonstration of this development has been in connection with the crossing of the Yukon river for the Alaska pipeline. The 1¼km wide river formed an almost impassable barrier to the pipline constructors without a diversion of more than 100 km. Mackley Ace were able to produce a solution. Two hover barges each with 160 tonnes pay load were manufactured and put into use on the Yukon river within a total time of ten weeks from the initial placing of the contract. These ferries operated continuously with great reliability over twenty-three working hours per day. In total they carried 600,000 tonnes of material in six months. The ferries shown in Figure 6, were cable operated and were used on a Ro-Ro basis in all conditions of the river flow including extensive periods when it was completely frozen over.

The next stage of development was brought about by a demand for equipment capable of carrying single loads of up to 250 tonnes for a new oil refinery in the

Hover Barges (5)

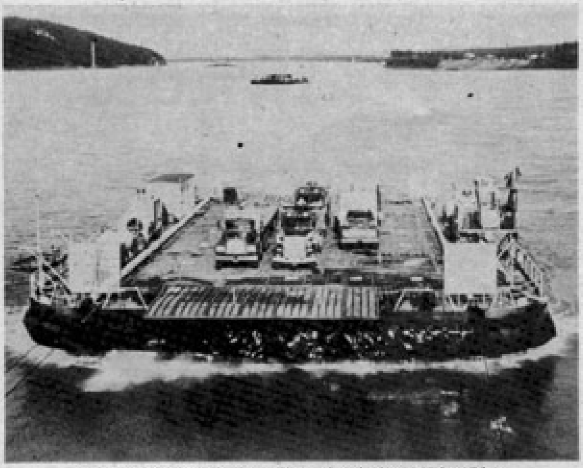


Figure 6. *Yukon Princess*, one of two river ferries on Yukon River

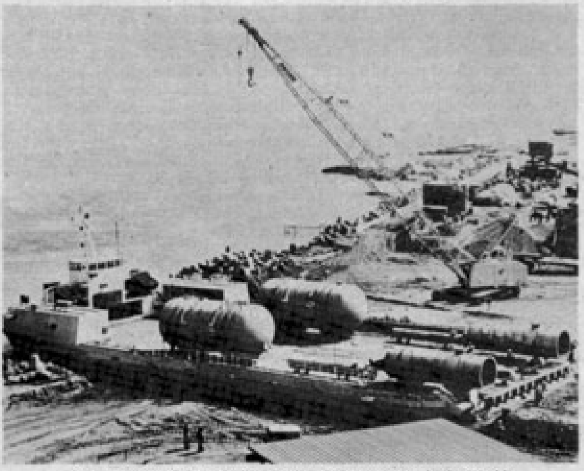


Figure 7. *Sea Pearl*, the largest air cushion transporter in the World

Hover Barges (6 & 7)

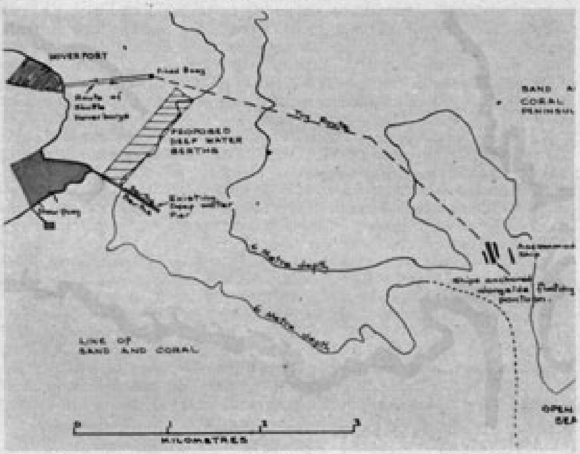



**Figure 8.** Proposed hover craft installation to overcome port congestion

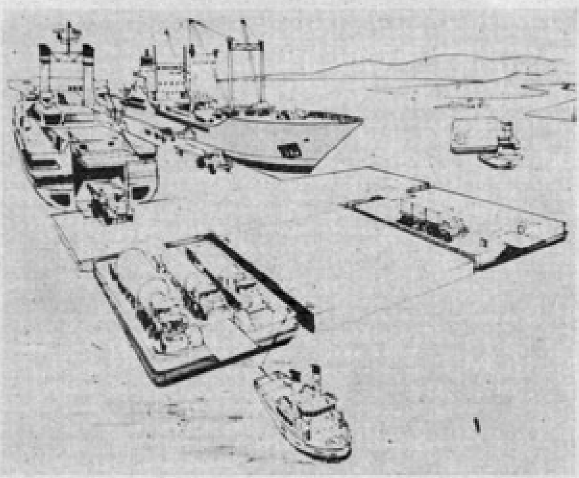


**Figure 9.** Proposed floating pontoon showing ships unloading direct on to hover barges

Hover Barges (8 & 9)

Middle East. For this requirement a rigid barge was constructed having a gross weight of 750 tonnes and clear deck space of 800m². This barge, known as *Sea Pearl*, is shown unloading cargo in Figure 7. It was found that it had a capability of transporting its maximum load over distances of up to 160kms and it was the success of this project which led to the final development which is the use of hover barges as a means of assisting in the clearance of seriously congested ports in different parts of the world.

Figure 8 shows a proposal for such a use where normal deep water berthage is only available for a very small number of ships. In this proposal a permanent floating pontoon would be installed in the position indicated and hover barges would be towed across shallow water to a fixed buoy, along the route indicated by the dotted line. From this buoy a winch operated hover barge shuttle would be used to carry the loaded barges to a new hover port on the outskirts of the existing port area. This facility would have an anticipated annual capacity of 750,000 tonnes. A suggested layout for the floating pontoon with ships lying alongside and hover barges being loaded is shown in Figure 9. As will be seen this arrangement allows for the use of either Ro-Ro ships or ships unloaded by derricks in the normal way.

From the military point of view it is appreciated that air cushion vehicles of all types have a limited use in an offensive situation owing to the ease with which their progress can be stopped by a few stakes driven into the ground because of the low energy available from the aircraft-type propellers normally used. In situations such as have just been described however, it would seem that the hover barge has a possible military use in that ships could be unloaded on to an established beach-head without the necessity of waiting for the building of permanent installations.

# Exercise Makefast XXV

LIEUT-COLONEL G W A NAPIER, RE, MA

ONE of the most important events in the Northern Army Group calendar is the annual *Ex Makefast*, officially known as "The indoor study period of the Chief Engineer NORTHAG". Those who have, in the course of various Makefasts, squelched along muddy river banks or lurched through the air in helicopters will know this title to be a misnomer. In particular it conceals the fact that Ex Makefast is highly regarded by the Army Commander and his Chief of Staff as it is the only NORTHAG indoor exercise of any arm in which tactical problems are considered in syndicate and discussed in open forum.

The responsibility for running the exercise each year falls, in turn, on the Chief Engineers of the four NORTHAG Corps, the CCRE in the case of 1st British Corps. By a happy chance this year's Makefast was the twenty-fifth in the series and as it was the turn of 1st British Corps to run it, it was for the UK a double Silver Jubilee.

Originally, Ex Makefast was the inspiration of the late Major General Sir Henry Sugden, who from 1952–1956 was Chief Engineer to the then Commander Northern Army Group, General Sir Richard Gale. The aims of the exercise have been summarised as:

"(1) To exchange ideas on engineer problems common to all engineer commanders and their staffs and by so doing create a better understanding between the engineer officers of the four nations concerned.

(2) To learn something of the methods and procedures of one's allies, whom one may possibly have to work with or support in an emergency.

(3) To create personal contact between engineers of different nations and by so doing help foster good co-operation between engineer units within NORTHAG."

The first Makefast was held on the Sennelager Training Area in 1953 and was a highly practical affair on the subject of barriers. During the demonstration parties blew craters with charges of 200 and 400lb of plastic explosive (PE)—a fact of interest to those familiar with today's restrictions on Sennelager and other ranges—

and laid mines and breached minefields in continuous rain and snow.

In the intervening years the exercise has been held at ten different locations and covered a wide variety of topics reflecting military development over the period.

The subject set for 1st British Corps to study in May 1977 was "Barrier operations in a GDP Setting" and planning began on this in May 1976. The first step was to decide the location. In view of the significance of the occasion it was agreed at the request of the CCRE, Brigadier M Matthews, that the exercise could be held at the RSME, who would lay on the administration while the CCRE would be responsible for the tactical problems.

It is worth outlining the way in which the exercise was planned, as the organisation of events on such a large scale, involving players of four different nationalities (and languages) and observers from many more, is not straightforward. Therefore any reader of this article who has the task of running one in the future might benefit from drawing on this experience.

Two complicating factors for 1st British Corps were, first, *Ex Spearpoint*, the major Corps FTX in November 1976, was to involve all the principals responsible for Makefast planning; and second, that there was to be a handover of CCREs in December. This meant that matters had to be brought to a high state of readiness before November so that the "silly" season of exercises and Christmas study periods did not unduly delay production of the exercise papers. On the other hand, no irrevocable decisions could be made or it would have been very difficult for the new CCRE, Brigadier J P Groom, personally to conduct the exercise using material on which he had had little influence.

In the event it was also found that attempts to get ahead too quickly were doomed to failure. It proved better to leave production of the exercise papers until it was plainly too late to incorporate second thoughts.

The timetable followed was:

| | | |
|---|---|---|
| May 1976 | — | Outline programme and theme for the exercise question published |
| September 1976 | — | First run through of exercise |
| December 1976 | — | Draft administrative instruction published |
| February 1977 | — | Second run through of exercise questions. Administration instruction sent for translation and printing |
| March 1977 | — | First Dress Rehearsal. Administrative instruction issued. Exercise papers and maps submitted for translation and printing |
| May 1977 | — | 5 May—Final Dress Rehearsal<br>9–13 May—Exercise |

It was also clear that the preparation would require extra staff to be based at the RSME. Major D G F Rycroft RE was appointed GSO 2 (Ex Makefast) from January 1977 and had, for his staff, WOI Welby and a clerk, Corporal Cutnik. However, in addition to these administrative aspects the RSME were to make major contributions to the exercise itself, in the form of presentations and a demonstration and static display, both of which required lengthy pre-planning and rehearsals. They also had to shoulder the burden of the Mess arrangements and of the detailed transport and security plans.

A basic requirement for all Makefasts is the arrangement for interpretation of the presentations and discussions in the Study Centre. For a four-language conference twelve interpreters are needed, although this can be reduced if three-way linguists can be located. A team of seven was eventually found by HQ NORTHAG, including two, Herrn Bloemen and Stuyven for both of whom this was to be their 17th Makefast. The equipment for the interpretation was supplied and set up by a hard-working team from 28 Signal Regiment, a Royal Signals unit under NORTHAG command. It provided for each delegate to hear, through an individual headset, a translation of the presentation into the language of his choice by selecting the appropriate channel with a switch on his seat.

The delegates arrived on Monday 9 May. The majority travelled from their pick-up points on the continent in Bundeswehr CH 53 helicopers—a somewhat painful experience aggravated by bad weather but having the advantage of delivering the passengers direct into the RSME. Some of the visitors elected to bring their wives and travelled privately. Those wives who came were generously looked after by the RSME during the working sessions.

Altogether there were 120 delegates at the exercise of whom seventy seven were players grouped into nine syndicates and the remainder were observers or Directing Staff. This being the Silver Jubilee Makefast each nation was entitled to bring one Special Observer guest—in most cases a retired senior officer with numerous Makefasts on his record. The British delegation consisted of twenty five from BAOR and a further eight from UK.

The first event was a highly agreeable cocktail party and buffet supper in the newly decorated Headquarter Mess which admirably set the tone for the exercise by lubricating rusty linguistic skills and stimulating international inquisitiveness.

The exercise proper was launched by the Commander Northern Army Group, General Sir Frank King, on the Tuesday morning after a welcome from our host, the Commandant of the RSME, Brigadier G B Sinclair.

The exercise itself comprised four "Problems", three run in turn by the divisional CREs and the fourth by HQRE 1st British Corps. In each case the scene for the problem was set by means of an introductory presentation and the delegates then withdrew to discuss the matter in syndicate. There was general agreement that these syndicate discussions are the really valuable meat of Makefast. They do lead to very worthwhile and often heartfelt discussions on problems which are common to all armies, and on matters of co-operation between the Corps. The syndicate discussions were followed by discussion periods in open forum conducted by the CRE concerned.

The first problem, presented by CRE 1 Div, Colonel J H Hooper, was a fundamental consideration of the nature of an obstacle, highlighting the three questions which engineers must ask their commanders—an obstacle to what, for how long and under what conditions? An elaborately prepared presentation, including some rare film of tanks moving through woods and vehicles attempting crossings over small water obstacles, reminded the delegates of the need for joint reconnaissance and for a philosophy on obstacles for the education of all-arms commanders.

The theme moved on for the second problem, set by CRE 4 Div, Colonel D H Bowen. It was related to the tactical setting of the exercise and examined the dilemma that faces engineer advisers choosing between linear or depth obstacles in the circumstances of the Covering Force battle where time and resources are at a premium. A potted view of the ground through the medium of maps, film, slides and diagrams gave the setting for syndicates to offer solutions which proved to be varied and original.

The third problem, set by CRE 2 Armd Div, Colonel R Jukes-Hughes, took the delegates into the main tactical setting and looked at the very real difficulties that might arise if a reserved demolition on an inter-Corps boundary changed hands between Corps of different nationalities. Many felt that this was an area worthy of even further examination. This problem also discussed the difficulties surrounding the employment of atomic demolition munitions.

Finally HQRE 1st British Corps produced the crystal ball and after an admirable introduction by a combined act from the RSME and RARDE, considered the part which remotely deliverable mines (RDMs) might play in future wars. A clear distinction emerged between RDMs as artillery and RDMs as an adjunct to conventional mines but the details of the eventual requirement were left to wiser heads to decide.

This dough of the exercise proper was leavened by numerous contributions from outside, partly on the theme of the exercise and partly designed to meet the second and third of the aims of Makefast given at the beginning of this article. Foremost was the RSME demonstration and static display laid on by the Field Engineer Wing at

Lodge Hill which was not only a vivid exposition of Royal Engineers capabilities and tactical doctrine but an object lesson in how to run such a demonstration. The RSME also contributed to the presentation on future barriers already mentioned and told the tale of engineer operations in Northern Ireland which, it was felt, would both be of interest to the NORTHAG delegations and by no means irrelevant to what could occur in N W Europe in a period of rising tension.

The delegates were also treated to a variety of foyer displays in the Burgoyne Study Centre demonstrating microfiche, survey and philately. A Makefast first-day cover sold well, particularly as it coincided with the new issue of the Silver Jubilee stamps.

Extra mural and social events were also on the programme. In addition to the opening party there was a highly successful pub visit following a coach drive through the Kent countryside, an industrial visit to the new Victoria Line and to two power stations by kind permission of the authorities and contractors concerned—these were arranged to leave the delegates in London for an evening out—and, possibly the climax of the exercise, the full Guest Night in the Brompton Mess preceded by a Beating of Retreat by the Chatham Band.

It had been hoped that the guest of honour on this occasion would be Major General Sir Henry Sugden, the founder of the exercise. Sadly his death only a few weeks before the exercise prevented this. However, the delegates were all extremely moved when it was heard that Lady Sugden had made a very generous presentation of a silver rose bowl to Ex Makefast in memory of her husband. This presentation was made during the guest night by her son, Lieut Colonel F G Sugden RE. According to Lady Sugden's wishes, the rose bowl was handed over to the CCRE as the current sponsor of the exercise, to be passed on the following day during the closing presentation to the next sponsor, the Chief Engineer of the 1st Belgian Corps. Thus

Exercise Makefast XXV.

the rose bowl will, like the Olympic flame, be passed on to successive sponsors and will form the centre piece at the traditional Makefast dinner.

So ended Makefast XXV. Connoisseurs of Makefast expressed themselves well satisfied by the fare offered.

To some such an exercise may seem a little like a survivor from a bygone age when people had the leisure to indulge in the luxury of "exchanging views" and "studying common problems" for four days on end–a sort of dinosaur of military life to be overtaken by evolution. The event itself gives the lie to this point of view. The problems which are set are taken very seriously by the participants. The extent of their concern is clear from the intensity of the debates. The duration of the Study Period is by no means too long for allowing people time to get to know each other. The cry was always: we needed more time. A more constructive view of Ex Makefast is that it is a phenomenon whose survival is proof of its value, which has demonstrated its ability to evolve with changing circumstances and remains a monument to the vision of its founder.

# Community Electricity Supply Scheme—Colonsay Exercise Revolt III

MAJOR M R GIBSON RE(V) C Eng, MIEE

*Foreword by Lieut Colonel R J Sage TD, RE (V), C Eng, MI Mech E, Engineer Specialist Pool*

*(Project Commander and Co-ordinating Officer)*

THE use of this Exercise, codename "Revolt III", continues a tradition in 504 STRE Power Station (V) for exercises involving rehabilitation of defunct power systems. A mention of some aspects of the development of this expertise within the RE Sponsored Units will help to place the success of this exercise in perspective.

The experience of military power supply work in 21 Army Group in NW Europe 1944/5 indicated the need for a strong power distribution element within an E&M Specialist unit. As OC of the apparently misnamed 504 Power Station STRE in the early seventies, a priority responsibility was the procurement of worthwhile training projects which were realistic and relevant to our wartime role in this respect.

Military sources were able to give little help at that time, but in 1974 with the help of a North of Scotland Hydro Board (NOSHEB) contact we were able to acquire a package task in the form of a section of 22kV overhead line in Benbecula (see *RE Journal* March 1975). To a great extent this task put us on the map as line experts, and led, via our subsequent close and helpful liaison with CRE Scotland, to our involvement in the HIDB sponsored Colonsay task, first as an Initial Recce and later the execution.

At the planning stage the relevance of the project to our role, and its realism as a training task, became uncannily authentic!

Realistic features included:

(1) Remote island situation with movement by sea (stores by LCT) and grass airstrip.
(2) Under-developed community.
(3) Minimum resources.
(4) Minimum accommodation dictating "greenfield" camp.
(5) Requirement for large supporting element from Regular units; also full time Storeman Tech.

I carried out the Detailed Recce in December 1976 employing 504 STRE's nucleus of distribution experts, and from this Major Mike Gibson prepared the design details and technical plan with assistance from CREs 62 and 64.

The remainder of the story is unfolded by Major Gibson in the succeeding pages, and the very successful outcome is to a great extent the result of his very considerable personal contribution at all stages.

We look forward to similar combined TAVR/Regular projects in the future.

RJS

INTRODUCTION

In February 1976 504 STRE (Power Station)(V) were requested to carry out a feasibility study on one of a number of interesting E&M projects which CRE Scotland had on his list of possible MACC and Training Tasks. This project at the outset seemed to be full of promise as it combined straightforward power generation and supply with an intriguing possibility of being involved with a research project using wind power for generation.

BACKGROUND

The Isle of Colonsay is one of a pair of islands some thirty six miles by ferry from Oban, twelve miles to the south of the Isle of Mull and to the west of Jura. The other island is Oransay which is smaller and is connected to Colonsay at low tide by a passable expanse of wet sand. A ferry service operates between Oban and Colonsay on three days a week. Colonsay itself is about seven miles long and three miles wide and has a population of about 100 although in the past it had supported some 1,000 souls. The island belongs to Lord Strathcona, it has one hotel, a shop, a post office, a primary school, some beautiful scenery, trout fishing and is an ornithologist's delight!

Electricity was brought to the community in 1955 when the Estate installed three small generating stations each with Lister diesel engines driving DC generators of between 5 and 10kVA. In addition a number of individuals had their own sets including the hotel. The Estate Farm at Kiloran also had its own separate generators and small distribution system. Between 1955 and the present, the generators and distribution systems had fallen into disrepair, the 110V DC supplies had become 240V AC at all except one location but these were a continual source of trouble with long supply outages, for one reason or another, accepted as normal. On top of all this the Estate was obliged to announce that for various reasons it would not be able to continue responsibility for the community electricity supplies after 1977.

The Highlands and Islands Development Board (HIDB), as part of a policy of trying to prevent the depopulation of the Islands, was able to arrange funds for the reconstruction of the generation and distribution systems but required to know details, both technical and financial, of a number of options. One of these was to include a wind powered generator as part of a research project with wider implications for cheap power supplies.

INITIAL RECCE

An initial recce was carried out on Colonsay from 6–9 February 1976. The recce party of five personnel from 504 STRE inspected all the existing generators and distribution lines and prepared estimates of costs and planning details for the following three options:—

(1) Repair the existing medium voltage distribution lines, repair or replace the existing generators and convert the DC system to AC.

(2) (a) Install a new single generating station, diesel powered.
 (b) Install an 11000V link across the island to connect to all existing consumers and to provide a supply to a number of new consumers.
 (c) Repair the medium voltage distribution and service lines.

(3) As option 2, except that the feasibility of utilising a generator, driven hydraulically, from a wind machine was to be considered.

The HIDB required a Preliminary Report quickly on the scheme allowing for a given optimistic forecast of load growth to enable finance to be sought and so a Report was submitted in March 1976 detailing the high voltage option and feasibility of wind powered generation. This Report involved detailed planning of the proposed system and included capital costs for the work and running costs assuming various levels of energy consumption.

Following further meetings during 1976 at which the establishment of realistic levels of energy consumption and load growth were considered in detail, a scheme along the lines of Option 1 was seen to be the most practical and economic.

During this period the commitment of the STRE was only for the feasibility and planning studies; it was at this stage that the Army was asked if it could carry out the work as well.

The revised medium voltage supply option chosen was considered to be within the capabilities of 504 STRE provided it was heavily reinforced by the addition of a work force to bring the unit strength from about twenty all ranks to a total of about fifty to sixty. It was also considered that the amount of work would require a period of at least three weeks instead of the TAVR two week Annual Camp commitment. The project was then accepted as a Training Task for 504 STRE for their 1977 Annual Camp and a Detailed Recce was planned for 19–26 November 1976 with a Detailed Recce and Planning Report being completed over Christmas. The work so far had been carried out in addition to the 1976 training commitment, it was with some satisfaction that we heard that the project had been accepted.

### THE WIND OPTION

The use of wind power for the generation of electricity has always been attractive, especially so on the west coast of the British Isles where there is always an abundance of the raw material required. The HIDB requested that the feasibility of a Research Project using wind power should be examined as part of one of the options for supplying electricity to the island. The proposal from the Cranfield Institute of Technology was to use a tower with 18·3m vertical blades directly driving a hydraulic pump. The oil was to be pumped to the generating station where a hydraulic motor would drive a generator. To gain the maximum benefit from "free" power this scheme was to be associated with a centralised generating station and a high voltage link between the east and west coast communities.

A study was carried out on the wind strengths and directions for this area and it was concluded that there would be a significant number of whole days and part days when the wind speed would be less than that required to generate the minimum power required. This meant that a diesel (or other fuel, eg Liquified Petroleum Gas (LPG)) prime mover would be required to drive the same generator through a change-over system or a duplicate set with auto change-over facilities. Both of these options were discounted due to the high cost and sophistication of the automatic controls required.

A later proposal which was considered was a much more practical scheme and one which may yet be incorporated. The scheme is to construct two towers each with 7·0 m blades directly driving a hydraulic pump as before, but over a shorter distance, to drive a DC generator set. The DC output provides the power for an electrolizer which produces hydrogen under pressure. The hydrogen would be piped to one of the two medium voltage generating stations where it could be stored in pressure vessels for use in a hydrogen fuelled engine driving a generator. All the technology for this scheme seemed to be available except for the hydrogen engine and so no work was in fact carried out for this during our Exercise on Colonsay. However space has been left at the new Kilchattan generating station for a third machine and the station is situated in a convenient position for such a project to be included at a later time. The hydrogen fuel concept is very interesting; one has been able to interest a firm specializing in LPG conversions of diesel engines in the work which is being carried out at various research centres into hydrogen fuel use, since much of the practical technology required has been already learnt in the LPG development. It is hoped to keep in touch with the developments in this field.

### DETAILED RECCE

This took place from 19–26 November 1976 a short while after the Team had completed their Annual Training in Gibraltar. It was during this Recce that it was decided, in conjunction with the HIDB and the Community Committee, that the reconstruction should consist of:

(1) Maintenance to existing overhead distribution lines and service lines of the community electricity systems.

(2) Convert part of the existing distribution systems to three-phase supplies in order to:

(a) Make a 3-phase supply available to prospective users.

(b) Assist in reducing voltage drops along the lines.

(c) Increase the capacity of the distribution system.

(3) Install two new 3-phase generators in each of two generating stations, one being an existing station on the east side and one being a new station to be constructed on the west side.

(4) Install voltage balancers where appropriate to reduce voltage drops on the overhead lines.

(5) Disregard the wind power research project as this had not progressed sufficiently far for the Army to become involved at this stage.

A Detailed Recce and Planning Report was written for this scheme and the Exercise set for the last three weeks in June.

### PLANNING AND RESOURCES

The planning of this project was carried out almost entirely by 504 STRE (V) and required a great deal of spare time effort. There is no doubt that there is considerable scope for close liaison with 62 CRE (Construction) and 64 CRE (E&M) who are experienced in both planning and setting up this sort of project and have the facilities for sharing the planning work. In this instance it was not until after the Detailed Recce and Planning Report was written, and the majority of the planning of necessity completed, that a firm commitment by 64 CRE (E&M) was made due to commitments elsewhere. An early involvement by the TAVR Specialist Team with its Regular Army counterpart in projects will benefit both.

Once the detailed planning was completed, lists of stores, tools and materials were prepared. Stores, tools and plant requirements were ordered through the usual Army channels while the lists of materials to be incorporated into the project were sent to the HIDB who were able to arrange for the North of Scotland Hydro Board (NOSHEB) to place orders through their suppliers. All stores, tools, plant, transport and materials were to be transported to the Isle of Colonsay on the regular LCT run to Benbecula; any spare capacity would be used to advantage.

The receipt and checking of all this equipment together with the return at the end of the Exercise presented a considerable resources task and to meet this a Regular Staff Sergeant Resources was appointed to be employed full time from April to July at Rhu and on Colonsay. This was an important part of the project and was done very well, it could not have been carried out by 504 STRE alone.

### MANNING

It had been thought that for this project 504 STRE might be reinforced by elements from within the Central Volunteer Headquarters TAVR Units but these were seen to be of use only as a labouring force when what was required was a mix of E&M tradesmen and Combat Engineers.

The obvious combination of units was of course the TAVR Power Station Team (more realistically to be renamed Power Supply) with the 12 Engr Bde Ad Hoc Power Station Team and it was to be this combination which, together with 62 CRE (Construction) and 64 CRE (E&M), formed the manning for the Exercise. (12 Engr Bde will perhaps insist that due to other commitments their personnel were an *ad hoc* Ad Hoc Power Station Team!). "Royal Engineers Project Team Colonsay" was brought to life.

The formation of trades for the Overhead Line Teams is of interest. It was decided that a total of six personnel in each team would be sufficient (providing that suitable pole erection and digging aids were available) and that four line teams could operate individually most of the time and as combined teams when required. In each line team at least two linesmen are required with two or three labourers, or preferable semi-skilled personnel, and ideally a Fitter or Plant Operator (POM) since it is always hoped that plant can be utilized. A bid was therefore made for personnel to make up teams comprising—

1—Tradesman NCO (Electrician) or Clerk of Works (Electrical) (C of W(E))
2—Electricians RE
2—Combat Engineers
1—POM or Fitter

This would give a somewhat high powered but experienced team able to work at maximum speed using any plant available and to work with a high degree of independence. For this project, having to complete the set task in a very short time scale, this arrangement was right. In fact we had more or less this establishment with two C of W (E) from 12 Engr Bde and two SNCOs from 504 STRE both experienced in overhead line work leading the teams. With more experience each line team could be led by a tradesman Sergeant or Corporal and one C of W (E) could supervise them all.

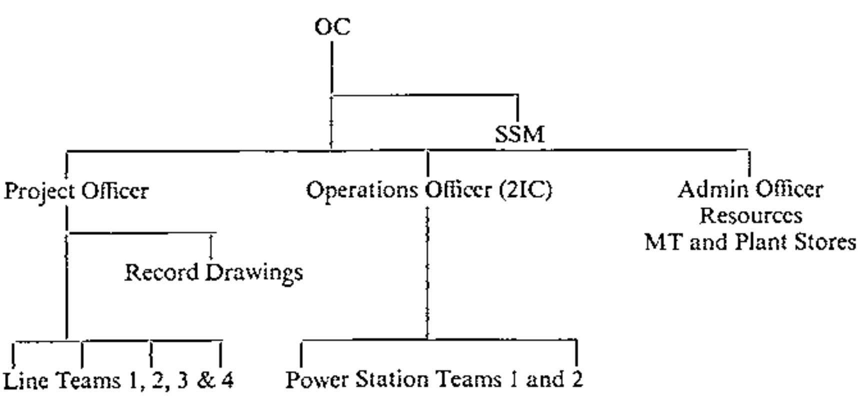
While it was intended that the line teams would normally work independently there were tasks which required the combination of two teams to provide an adequate work force. On occasions when erecting long lengths of overhead lines (eg 570 m of two-wire conductor pulled up and bound-in in one go) the team responsible was reinforced by the most experienced linesmen from the other teams. One cannot overestimate the value of having Combat Engineers in works teams. They are used to handling concrete mixers, compressors, ropes, pickets etc and are very adaptable. The Fitters and POMs were versatile and used to full advantage on a wide variety of jobs.

The Power Station Teams were easier to arrange, basically two Electricians and two Fitters in each of two teams reinforced as required for substation earthing, fuel installations etc. The remaining technical personnel were all allocated tasks and areas of responsibility as required to complete the project, eg the DC/AC change-over.

The Project Team was a completely self administrating unit which is not usual for a Specialist Team who are normally sponsored by a host military unit. A support organization was set up consisting of three Cooks, Resources NCO, Stores NCO, Chief Clerk, MT/Plant NCO and of course a Sergeant Major, all kept very busy before, during and after the Exercise.

The organization chart shows how the responsibilities were arranged. It was essential to keep the responsibilities for the project work and the running of the electrical supply system completely separate. To achieve this the Operations Officer took over full responsibility for the running of the generation and supply system from the community at the start of the Exercise and handed it back at the end. He was

ROYAL ENGINEERS PROJECT TEAM COLONSAY



COMPOSITION OF PROJECT TEAM

| | TAVR | Regular | Total |
|---|---|---|---|
| Officers | 3 | 1 | 4 |
| SNCOs | 12 | 4 | 16 |
| ORs | 6 | 29 | 35 |
| Total | 21 | 34 | 55 |

then responsible for arranging shut-downs on request from the Project Officer and issued all permits to work on a daily basis. The Operations Officer was also responsible for the installation and running of the new generators. The Project Officer was responsible for all work outside the generating stations including the co-ordination of the work of the four line teams, the voltage balancers, earthing, arranging shut-downs, services and fault finding. The Administration Officer was responsible for everything non-technical although he was one of the most highly qualified persons at Camp!

The manning of such a project by a combined unit including a TAVR Specialist Team depends on:—

(1) the existing personnel in the Specialist Team.
(2) the availability of the required trades from outside the Specialist Team to make up the work force to carry out the task.

Specialist Teams are by design high powered with a predominance of senior ranks each with their own special expertize. It is inevitable that they will be mis-employed on occasions but they bring with them versatility and the ability to mix in and get a job done.

PRELIMINARY WORKS

In addition to the planning and resources effort required prior to the Exercise dates, there was also work which had to be completed before the Project Team arrived in order that the work planned for that team could proceed. To this end the assistance of a Recruit Party from 1 Training Regiment RE was provided. The main task of 77/3 Party from 28 Training Squadron was to prepare the concrete footings and slab for the new power station at Kilchattan and to concrete the fuel tank slab and lay-by at each of the two stations. This was carried out between 6 and 13 May in appalling weather. The construction work was supervized on site by a C of W from 62 CRE (Construction) who had prepared the detailed plans of the new power station together with the lists of stores required for its construction. The recruits also distributed poles around the island and carried out a number of other tasks which were of considerable assistance to the main Exercise.

The building of the new power station was to be the responsibility of the islanders but it is true to say that over 80% of the work was carried out by the Army. How fortunate that the TAVR contingent just happened to include a builder and a carpenter and joiner!

THE TASK

The project consisted of the following:—

(1) Design and build a generating station at Kilchattan complete with fuel installation.
(2) Modify the generating station at Scalasaig to house two new generators and move the fuel installation outside.
(3) Install 1 × 16·5kVA and 1 × 12·5kVA generators at Kilchattan complete with auto change-over panel, mains distribution panel and earthing.
(4) Install 1 × 25kVA and 1 × 16·5kVA generators at Scalasaig complete with auto change-over panel, mains distribution panel and earthing.
(5) Convert existing 50kVA 3-phase generator at Scalasaig from single-phase connection to original 3-phase connections.
(6) Change rotten poles as necessary and as time permits.

(7) Convert approx 2,200 m of two wire single-phase overhead line to 3-phase four wire line.
(8) Install approx 550 m new overhead line, single and three-phase.
(9) Replace service lines as necessary.
(10) Install three voltage balancers.
(11) Install new stays and remake as many as time allows.

The priority tasks were to equip the generating stations with the new sets, complete the three-phase sections of overhead line to improve the voltage on the very long distributors and to link the existing DC system to the new generators and change to AC.

A bar chart programme was drawn and it was concluded that the task could be completed in a three week period with an optimistic forecast for all work complete if all went well and according to plan, and a pessimistic forecast of the priority work described above only completed if the actions of man and weather went against us.

The two factors affecting the forecast for completion (assuming all stores, plant, tools and personnel on site on time) were:—
(1) Weather
(2) Digging

*Weather*

The Exercise dates were chosen on local residents' recommendations that June and September were most likely to have least rain while July and August would certainly have rain plus the most visitors. June was chosen as having the most number of daylight hours in the day. Of course local knowledge proved correct it started to rain on the 1 July, the day we left!

*Digging*

There is a lot of surface rock showing on Colonsay and not very many places where one would judge that digging would be easy. An early decision was made not to take an auger attachment for the plant and indeed it would have been of no use. The hardness of the rock was more difficult to determine, in some places it had weathered and was like shale when attacked with a bar. Again local knowledge was sought and we were told of difficulties which were encountered with the digging when the original poles were installed. Many poles could be seen to have been concreted into place while several had concrete around the base plus two side stays—it was obvious that compressors were going to be essential items of our list.

Why not explosives? Many poles were close to buildings and the possibility of causing damage together with the security precautions required brought a decision to rely on plant. In hindsight I think we should have had a go and used small charges to shatter the rock and make the digging out quicker.

A policy was established that digging more than 1 m in rock was too time consuming and at that depth the pole or stay would be concreted in place.

## SPECIALIST TOOLS AND EQUIPMENT

The capability in the Corps for overhead line construction as far as suitable tools and equipment are concerned is practically non-existent. If the Project Team were to have relied on equipment from Army sources very little work would have been carried out on the overhead lines.

Access was difficult to most of the pole positions so that using vehicles for erecting poles was impractical. Ladders could have been used (although not recommended) except that, although ordered, not one suitable double extending wooden ladder was available. It was decided that standard Electricity board type pole lifting "pikes" would greatly speed up pole erection and would suit site conditions. Two complete sets comprising 2 × 12 ft and 2 × 8 ft pikes were manufactured to a standard design and these were used. Once personnel became confident and used to handling them pole erection became easy and quick.

Line tensioning draw vices were a problem or rather the lack of them was. There were six sets available suitable for power lines but these were not complete, the wire

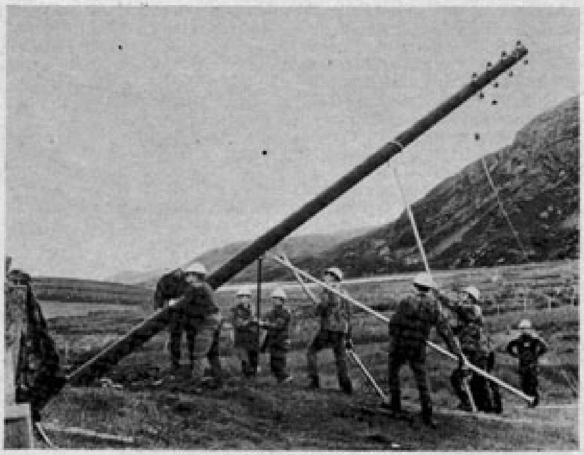


**Photo 1.** Pole erection using "pikes"

slings being missing as they had previously been used for high voltage work where slings are not required. However, because of the known requirement for as many sets as possible, up to eight sets for each line team ideally, six complete sets had been borrowed from one of the Electricity Boards and these, together with four sets which had been ordered for retention on Colonsay, were all that were available. At one time there were eight in use on one pole by one linesman so a great deal of movement of tools and co-ordination of work by the four teams was necessary to avoid too much wasted time. Another useful piece of kit borrowed from the same sources as the draw vices was a pole jack. This was used for jacking old poles out of the ground and was extremely useful.

Rammers for consolidating earth in pole and stay holes are no longer obtainable so a very successful model was made by welding a flat steel plate on the bottom of a compressor tool.

A variety of linesman's belts and climbing irons were used. The linesmen from 504 STRE brought their own, while the others used issue equipment. The climbing irons in the linesmens' tool kits were satisfactory, they had the straight pattern hook, other climbing irons had the curved hooks situated low down near the foot; these were considered dangerous and were banned. They should be withdrawn from service.

There are a number of other items of equipment which are in common use in the Area Boards which were not available and which would have assisted in carrying out the work more quickly and efficiently. However, the items described in detail above, excluding the pole jack but including wooden ladders, really are essential and must be made available in realistic quantities if this sort of work is going to be carried out by the Corps.

### TRANSPORT AND PLANT

Transport is always difficult to obtain. This Exercise used three 4-ton vehicles, one being FWD and having a winch, and four Landrovers, one of which was a radio vehicle. This provision was about right although it was more convenient to use the

Community Electricity Supply Scheme (1)

small vehicles on the single track roads on the island. It would have been ideal to to have had a Landrover and trailer for each works team to enable them to be independent and keep their tools and materials together. Luckily the distances involved on this Exercise were small and so there was not too much of a problem.

Plant was essential and consisted of:—

1—Bray Light Wheeled Tractor (LWT) with backactor and forks
1—Michigan LWT with backactor
2—Meadows compressors
1—Meadows 27½kVA generator trailer mounted
1—Concrete mixer

They were all very useful equipments with the LWTs and compressors always in use. In addition a third compressor was hired from a civilian contractor on the mainland and this too was essential.

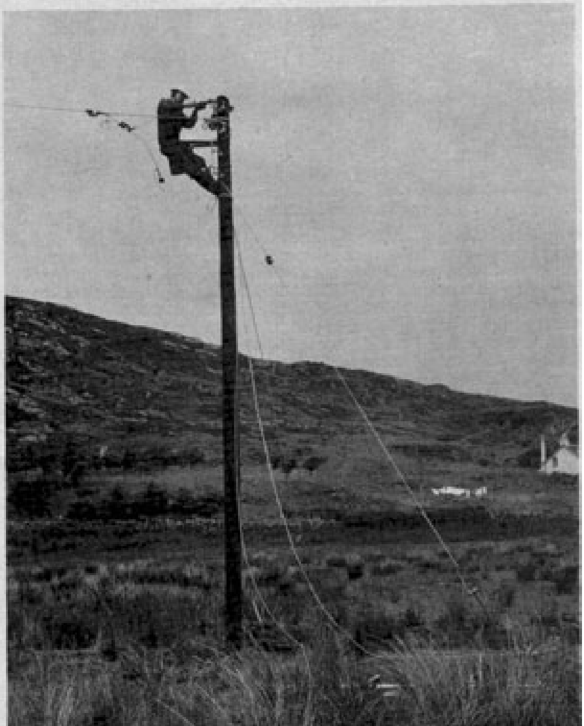


**Photo 2.** Linesman tensioning conductors on a replacement pole

Community Electricity Supply Scheme (2)

All POL was taken for the Exercise with the petrol being about right in quantity and the diesel over provided. A lot of care is required in estimating quantities and types of POL to avoid over or under provision.

### ACCOMMODATION

This was to be a "greenfields" camp and was centred around the wooden building, known as Kiloran Hall, situated more or less centrally in the island. This was to be the messing hall and social club and first option for living accommodation if the weather was bad. Behind the Hall was a (fortunately) dry field on which were erected two marquees, one for stores and one for sleeping, together with a number of 160 lb tents for additional sleeping spaces. Ablutions were in the Hall with an outside wash area and camp toilets augmenting the sparse facilities. SNCOs had the luxury of a many bedroomed farmhouse usually used as a rented holiday home so it was fully furnished. The bad news was that it only had one bath and toilet between up to sixteen seniors which is a bit tight. Officers had more space in a nearby empty cottage which was not quite like home but was habitable. The two houses had hot water and bath facilities which were made available to the junior ranks. If the weather had been bad for long periods, or particularly cold, the facilities would have been a bit rugged. The advantage was that all the accommodation was handy to the Hall where common messing was enjoyed due to the magnificent cooking from the camp kitchen and our ACC Cooks. Luncheon was taken on sites to save disrupting works by travelling to and fro.

### WORKS

What a difference the weather makes! The first weekend was similar to the Recruit Party's weather, very cold wet and miserable—indeed an SOS was sent out to the Hotel for a loan of blankets after the first night resulting in a loan of over fifty from the Hotel, the Doctor and local residents. Naturally the urgent despatch of over two hundred blankets from HQ Scotland ensured that fine weather persisted from then on! Other provisions for fine weather were Lieutenant Bill Hobbs, the Project Officer, carrying his Combat Jacket every day (whatever the weather) and the OC's weekly supplications in the Kirk!

If the weather had been bad, living and working conditions would have been made difficult, resulting in a reduced amount of work completed. Anxiety about the weather changing for the worst and affecting the external works resulted in the pace being forced during the first long week of eight days when a considerable amount of work was completed on both East and West Sites. Had the weather then changed the first priority work could still be completed and a considerable improvement in the supply system still have been possible; these works were:—

(1) Building of the new power station.
(2) Generators and switchgear inside both stations.
(3) Service line to GPO (new and very important consumer).
(4) Three-phase line Scalasaig to Glas Aird main road.
(5) Connection between Kilchattan system and Port Mohr DC system.
(6) Connection from new power station to Kilchattan line.

The second priority work was to complete the three-phase lines to the planned positions to enable existing service lines and a few new ones to be balanced. Poles and lines were replaced as this work progressed through the second week and the voltage balancers were installed.

The third priority work was to replace service lines if necessary (and it mostly was). When services were changed insulated wire was used for the phase conductor which was run below the bare neutral conductor. Also in this priority was the changing of further poles and replacement of existing stays to include a stay insulator.

The work actually completed was:—

(1) One new power station built and an existing station adapted.
(2) Two new generating sets installed in one existing power station and two new

sets in the new station complete with control panels, electrical distribution switchgear and fuel systems.

| | | |
|---|---|---|
| (3) Rotten poles replaced | 21 | |
| (4) New poles installed | 13 | |
| (5) New stays installed | 10 | |
| (6) Stays remade | 10 | |
| (7) Single-phase overhead line converted to 3-phase 4 wire | | — 2,200 m |
| (8) New 3-phase 4 wire overhead line installed | | — 550 m |
| (9) House services replaced | | — 25 |
| (10) 3-phase balancers installed | | — 3 |

This was all accomplished in seventeen working days since the whole camp and all stores, materials and tools had to be checked and packed before the Team dispersed.

The commitment for the reconstruction of the electrical generation and distribution community system was completed but inevitably there was work left which the Team would have liked to have seen through, notably the reconstruction of the distribution system belonging to the Farm and Estate. However, this work, while urgently required, was not part of the set task and so reluctantly no action was able to be taken. Only a two or three week extension to the Exercise period would have enabled the whole work to be completed through the island. Thus a considerable amount of work was accomplished to a high technical standard in a very short period of time.

Inevitably the question is asked whether the TAVR or Regular Army could have taken this type of task on their own. Of course they could. But by using the expertize of each to the fullest extent this particular task was accomplished in the very short time available, was done very well indeed and in addition the training value to both was high; alone, none of these achievements would have been fulfilled.

## LESSONS LEARNT

This Exercise was good training value because:—

(1) It accomplished a real and worthwhile task.
(2) It required a high level of expertize from everyone involved.
(3) It utilized the majority of personnel at their trade.
(4) It provided complete integration of TAVR and Regular Army personnel each relying on the other's special skills.

Deficiencies in tools, equipment and in techniques have been highlighted. If the Corps wishes to retain a capability in power generation and supply systems then up-to-date training and equipment must be made available.

## PERSONAL

I was privileged to have been the OC of a Project Team carrying out an Exercise where the aim was achieved and a splendid Corps spirit engendered in the integration of TAVR and Regular Army personnel at all levels both during the Exercise and elsewhere.

With such a small closely knit community being almost doubled in numbers by soldiers, with large vehicles and plant continuously circumnavigating the small island, some conflict would seem inevitable. That there was none, that the relations between Army and community was friendly and co-operative throughout enhances the value of the training and puts the Corps once again at the "Top of the Pops".

With so many units involved in releasing personnel for this Exercise it has not been possible to contact all COs and OCs but let me assure them that their tradesmen worked very hard and are very good.

Let me also thank the Regular Staff of my own CVHQ without whose dedication to the success of the Exercise the project would have floundered.

* * *

# Pre-War Life in India for the Young Royal Engineer Officer—Part I

LIEUT-COLONEL (RETD) R W OBBARD, MA

## INTRODUCTION

I WAS commissioned on 1 September 1927 and from then until I embarked for India in September 1934, I completed No 18 Young Officers Course, obtained a BA degree at Cambridge, served in 59 Field Company RE (Fd Coy RE) at Bordon and Canterbury, in 49 Fortress Company RE (Fort Coy RE) at North Queensferry and finally ended up as Garrison Engineer (GE) Glasgow—a sound spread of training.

I was an impecunious subaltern without private means as not only was I the youngest of a family of six but my father and grandfather had both served in the Indian Army, the latter raising a Regiment during the Mutiny. I had, prior to my departure for India no experience whatsoever of foreign countries and practically none of hunting, shooting and fishing which at that time, except overseas, were considered to be the preserves of the wealthy—though thought of as necessary skills by the Army.

## VOYAGE TO INDIA

I embarked for India on 7 September 1934 on *HMT Neuralia* at Southampton and I found that I was due to share a cabin with two other junior RE officers one of whom was luckily junior to me and so was automatically appointed "baggage master" for the whole ship.

The troopship had a fine send off and as it edged away from the quay with a military band playing "Auld Lang Syne", with the troops cheering and women weeping, it really was a desperate heart breaking moment as most of those aboard and ashore would have to face up to a five/six year separation.

Before embarking I had begun to think of the world as a shrinking place as there was already limited air travel but before the troopship reached Bombay on 3 October, nearly four weeks later, I had revised my opinion. In those distant days $\frac{1}{5}$ of the world's land surface was coloured red on every atlas and $\frac{1}{4}$ of the world's population belonged to the British Empire and Commonwealth and so the troopship had to call at many ports en route to India. This however merely lengthened the voyage by two to three days as the ship only berthed at Gibraltar, Malta, Suez and Aden for a few hours though it stopped overnight at Haifa and Port Said. The trooping stop at Haifa enabled a small party of us to visit Nazareth, Jerusalem and the Dead Sea, the stop at Port Said was to enable the ship to be coaled by hand! Entertainment aboard was housy-housy (Bingo) for the troops and boxing matches were arranged on the foredeck.

I travelled from Bombay to Poona by train and my first impressions were of the green of the countryside—the monsoon rains were still not over and this was the first green grass I had seen since I left England—and then of the rugged splendour of the Western Ghats. I was struck by the upright carriage of the women as they carried heavy loads on their heads and by the ugliness of the water buffaloes. Finally after arrival when I was temporarily ensconced in luxury in the Club of Western India there was the all pervading noise of the locust-like cicadas.

## TALK BY CRE

I had been posted as Assistant Garrison Engineer (AGE) Poona in the Military Engineer Services (MES) and my CRE gave me the usual talk, given to every subaltern on arrival, which stressed that he must:—

(a) Carry out all his MES and military duties to the best of his abilities. Working hours were to be adhered to and exceeded as necessary and the stories about subalterns sleeping every afternoon were no more than fantasies—I was so naïve that when the MO used to say after lunch that he was off to "study the profession" I actually thought he was going to work and not just to sleep!

(b) Call on the senior officers and all the married RE officers in the station.

(c) Qualify in his Urdu exam. He would not be granted leave back to the UK until he had done so.

(d) Play his full part in the life of the station.

(e) Spend his long leave on a jungle shoot and if dangerous animals were wounded they must be followed up and killed. The shooting of a tiger or panther would count as a secondary qualification for UK leave.

At the time rupees were worth 1/6d each, the rate of exchange being pegged at Rs13·33 to the £1, and my initial problem was how to make essential purchases as my capital was only £200 and my pay as a subaltern even on Indian Army rates of pay was only about Rs450 a month, ie £405 per annum. However I found that my capital was more than sufficient to set me up with essentials and yet leave money over for additional tropical kit etc.

My major purchases over a two months period were:

| | | |
|---|---|---|
| (a) | A 1931 Ford Tourer | Rs900 |
| (b) | A grey Arab polo pony | Rs550 |
| (c) | A double barrelled Vickers ejector shotgun | Rs100 |
| (d) | A Winchester rifle | Rs75 |

Thus for Rs625, ie £122, I was fully equipped and I may say that my purchases proved most successful and remained with me until after the outbreak of war.

## LIFE IN INDIA

Meanwhile I was learning the fundamental essentials of life and survival in India.

(a) On arrival I had been provided with a bearer who for under Rs30 per month was on twenty four hours call, would see to my clothes and equipment, would accompany me wherever I required him and would act as interpreter when necessary.

(b) I had learnt that my bedding roll was an essential item of travelling equipment and would be used when staying overnight with friends or in dâk, forest, MES or Government bungalows. These bungalows were available throughout India and the cost of a night's stay was normally Rs1.

(c) Elementary precautions against cholera, dysentry and malaria were vital. Any water used whether for washing up or for washing fruit vegetables etc would first be treated with permanganate and known as "pinky pani", whilst drinking water outside the main cantonments would have to be boiled. Some of the water one drank whilst on shikar really was very bad; it gave one a shock to see the well, canal or river from which it was drawn. Anti-malarial precaution had to be taken after sunset and one always slept under a mosquito net at night unless out shooting or on military exercises when one covered one's exposed face and hands with oil of citronella—mosquitoes seemed to be attracted by it! Anti-malarial drugs other than quinine were not then in use.

(d) Bathing was normally in a tin tub and there was no water-borne sanitation even in the large cantonments—one used a commode, commonly and accurately known as a "thunderbox", which was emptied by the sweeper. In jungles the ideal latrine would be a white ant hill with its top removed!

(e) Subalterns—unless married—shared a bungalow or possibly a building with a nickname such as the "Almshouse" or the "Workhouse" at Kirkee built specially for them. They had to change into mess kit and dine in the mess on five evenings a week though it was possible to sign out when essential.

## LIFE IN POONA

### *MES Duties and Military Training*

As AGE Poona I was responsible for work at outstations at Belgaum and Purandhar and I acted as GE Kirkee on occasions. I was assisted by British Sub Divisional Officers (SDOs) who held warrant rank. Funds were short and work as a whole was simple maintenance and design though I had the misfortune to be in

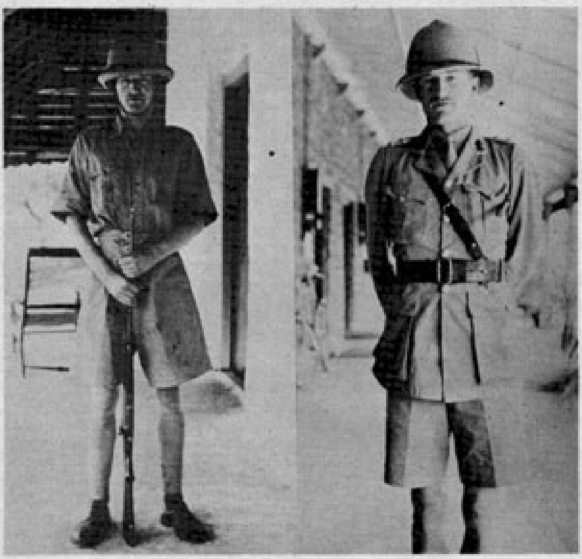


**Photo 1.** *Right* Author in standard uniform as worn on duty; and *left* in skikar kit

**Photo 2.** The "Almshouse" verandah, Kirkee

Pre-War Life In India- Part 1 (1 & 2)

charge of all Married Quarters. Belgaum was an especially difficult station as the Senior Officers School was there and I had the unenviable task of converting two old buildings into suitable quarters for a Brigadier and a Colonel. There was also a shortage of water—spring loaded taps were always tied open by the *malis* (gardeners).

For military training I was attached to the Somerset Light Infantry (SLI) for a fortnight in November/December 1935 for combined training at Koregaon Camp.

*Calling*

Most married officers left boxes for calling cards at their gateways so that only a few actual visits were involved. Thereafter, having called, one could expect invitations to dinners and cocktail parties and so one got to know the other officers in the station, their wives and families.

*Urdu*

I have always been hopeless at learning languages and so the knowledge, after my arrival in India, that I had to pass my Urdu examination before I could get home leave came as a most unpleasant surprise. In common with all officers I employed a *munshi* (language teacher) and finally passed my lower standard Urdu examination at the third attempt late in 1935 and was awarded the princely sum of Rs100—claimed as a present by the *munshi*. Very fortunately this was all that was required in the MES and in the QVO Madras S and M where I was subsequently posted.

*Social Life*

There was a good Gymkhana Club in Poona and the following were all available in the Poona/Kirkee area; cricket, hockey, tennis, golf, squash, polo, hunting, racing, swimming, sailing, rowing and fishing not to mention dinners, dances, picnics. I myself avoided cricket and rowing and never did more than crew on a few occasions when sailing on Lake Karakvasla but I made full use of the other facilities, enjoyed early morning hunting for jackal with the Poona and Kirkee Hounds and became reasonably proficient at polo—my little Arab pony, to the amazement of all, used to watch every chukka with interest whilst waiting to take part, though it was really too small to stand up to the chargers (walers) of other officers.

There were a number of charming girls in the station but serious romances were limited as at that time the Army frowned on all officers who married under the age of thirty, gave them no marriage allowance and in general made life as difficult as possible for them. In fact the accepted "Code of Practice" was subalterns musn't, captains may, majors should and colonels must be married!

In addition the promotion prospects amongst the British Regiments were horrific and when I arrived in Poona the SLI had a number of elderly subalterns with over eighteen years service—on one occasion I actually saluted a bald headed elderly officer only to discover he was a subaltern with nineteen years service. Most of these officers subsequently jumped direct to Major on 1 August 1938 when the Hore Belisha time scales for promotion were introduced.

The hill station for Poona was Mahableshwar situated high up amongst trees on the Western Ghats. It was a small hill station in which ancient Victoria carriages were the chief means of transport and the main entertainments were driving to magnificent view points and picnicking. All very pleasant and leisurely.

Finally there was a convalescent station at Purandhar—a Mahratta Fort only about twenty five miles from Poona. One was normally carried up the path to the station from the road in a chair carried by four men with another four men in reserve. Purandhar was one of many magnificent Mahratta forts such as Sinhgarh, Rajgarh and Torna to be seen from the Poona area. These forts were on the tops of mountains the natural precipices around which had been further scarped to make them unscalable. They had large water catchment tanks inside their perimeters—the tanks at Purandhar provided water for the whole convalescent station—and their only gateways were very strongly fortified. In fact before the introduction of siege trains they could only be captured by surprise and this in short involved a large iguana lizard harnessed to a thin cord and trained to climb upwards and over the outer rampart and then hold fast when the cord was pulled, a small boy aided by the

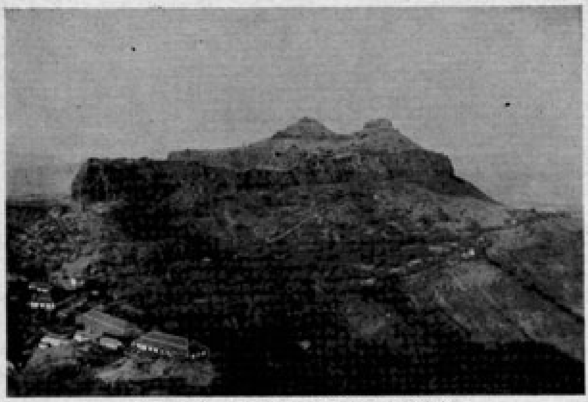


**Photo 3.** Purandhar Fort and Convalescent Station

cord would follow and then pull up and make fast the first rope for the assault party.

*Shikar*

There were really three types of shikar:

(1) *Short weekend shoots* when one drove out a few miles for a day, or stayed overnight in a dāk bungalow or equivalent, and shot blackbuck, sandgrouse etc.

(2) *Christmas shoots.* These were short one/two week shoots. The first Christmas I went off with Ronnie Dinwiddie of the Royal Bombay Sappers and Miners then stationed at Kirkee to the canal bungalow at Wadgaon and we shot blackbuck, peacock, snipe and sandgrouse. The second Christmas we went to the North Kanara jungles about 100 miles from Belgaum. These jungles contained tiger, panther, bison, sambhar, spotted deer and elephants—the last named being considered as vermin.

The local population were African in origin having been brought to India as mercenaries in the old days by an Indian rajah and our *shikaris* were cheerful and physically strong.

Stalking was difficult in the dense jungle and though we gained plenty of experience and sighted panther, bison, and deer and saw many signs of elephants our bag was minimal. We lived mostly off chickens at 1 anna ($\frac{1}{16}$ rupee) each and our Christmas treat was a tin of tomato soup!

(3) *Long Leave Shoots.* In April/May 1935 Ronnie and I went off to the teak forests of the Melghat in Berar for four/five weeks. These jungles were comparatively open, the teak trees were small and their leaves made silent movement off forest tracks almost impossible.

We shot sambhar, barking deer and wild boar and I was fortunate enough to shoot a seven foot panther but alas we failed to get a tiger though I had a truly wonderful chance to do so—however that is another story!

Life in the forest was quite strenuous as one spent most of the day walking, searching for pug marks, stalking deer and deciding where *machans*—small wooden platforms—were to be fixed. Then at night one often sat up, alert to the slightest sound of movement, in a machan in view of a kill or of a young water buffalo (*boda*) or goat that had been tied up on the possible route of a tiger or panther. The bodas would settle down quietly but the goat we had acquired had considerable character and when we left it was still flourishing having seen off a hyaena which I subsequently

**Photo 4.** ". . . on the way back to Poona the car had to be pulled across the R Godaveri by water buffaloes . . ."

shot, frozen motionless and allowed a tiger to pass within fifteen feet of it and finally—believe it or not—broken its tether and departed at speed when a tiger actually made a kill close to it.

Using "tie ups" may sound rather like looking for a needle in a haystack but it tested one's skill and forethought and later, after I'd moved to Jubbulpore, I shot two tigers—one of which I unfortunately wounded and had to follow up and kill whilst on foot—and in both cases they were approaching strategically sited live tie ups. Nowadays I presume one would take photographs rather than shoot.

My old 1931 Ford tourer had a real bashing on the forest tracks and we used it to motor by the forest route to Chikalda—a small hill station where the forest officer lived. The track up the mountain was absolutely hair raising and approaching Chikalda there was a drop of about 2000ft on one side and near vertical cliffs to the fortifications of Gawilgarh Fort on the other. The fort was abandoned and overgrown but had once been famous and during the 2nd Mahratta War had been stormed by Sir Arthur Wellesley after his victory at Argaum. At that time in addition to a population of 25,000 it was sheltering the remnants of Berar's army.

Finally on the way back to Poona the car had to be pulled across the River Godaveri by water buffaloes and later a wheel came off but no serious damage was done in either case! As a complete contrast I finished my leave with a week in Bombay and a few days in Mahableshwar.

As a last word big game hunting in Central India was extremely cheap as Ronnie and I never had to pay more than Rs2 each day for the hire of the forest bungalow and the block of jungle which went with it. Even including the pay of shikaris, beaters and trackers the total cost came to under Rs200 each per month and we relied almost entirely for food on the game which we shot.

## POSTING TO MIDNAPORE

I enjoyed life in Poona to the full until out of the blue came an order posting me to 44 Divisional Headquarter (DHQ) Company Madras S and M as a Company officer in charge of a detachment at Midnapore, Bengal. This move and my life in India up to the outbreak of war will be the subject of later parts of this article.

* * *

Pre-War Life In India- Part 1 (4)

# Early History of Sapper Tunnelling

COLONEL N D CLIFFORD, MBE, B Sc, C Eng, MICE, AMBIM

THIS article is an edited version of a paper presented by Lieut Colonel (as he was then) Clifford to the British Tunnelling Society on 16 October 1975. It was first published in *Tunnels and Tunnelling*, which publishes all British Tunnelling Society papers, and we are grateful for their permission to republish the proceedings including the main discussion.

Military tunnellers like, I believe, most of their kind, are men of few words. They kept very few records and they wrote even less about how they did the job. Tunnelling skills definitely seem to have been learnt on the job.

In any historical survey one must fix the end points with some care. The end of sapper tunnelling is quite clear. The last Royal Engineers Tunnelling Squadron was disbanded in 1968. But choosing the starting date is not so easy. Military tunnelling was an accepted and established art long before there was a Corps of Royal Engineers. So it is perhaps best that I start at the beginning.

When did man first start tunnelling? I suppose it is reasonable to assume that the earliest cave dwellers would have done some simple do-it-yourself home improvements; in other words, some primitive tunnelling. Later we find examples of artificial cave dwellings dug out of soft rock, perhaps inspired by burrowing animals. If one accepts that the Stone Age ended, by definition, with the discovery of metals, then the extraction of buried ores was probably the birth of tunnelling proper, and the first known miners were the ancient Egyptians, who started mining copper around 3800 BC.

Around 2000 BC, there was a Neolithic flint mining industry flourishing at Grimes Graves in Norfolk, and the site was worked for some 300 years. Investigations show that a typical mine consisted of a wide circular shaft some 12m deep, with tunnels radiating from the bottom of the shaft into the flint bearing chalk horizons. The miners worked with picks and shovels fashioned from the antlers and shoulder blades of deer. They lit their workings with chalk lamps containing animal fat and wicks made of moss. I have not found any reference to the use of timbering, but this would seem to have been necessary because at least one skeleton of a miner has been unearthed from the workings. Old workings were backfilled with the arisings from new headings. The basic tunnelling techniques that were used at Grimes Graves did not change in any material way for the next 3500 years. At the same time, in 2160 BC, the Babylonians were said to have built a foot tunnel under the River Euphrates. This is the first known underwater tunnel.

Probably the first deep mines in Britain were those of the Cornish tin mining industry dating from about the fourth century BC. Unlike the shallow flint mines of Norfolk, the Cornish mines were very wet so that the tin miners would have had to devise methods of draining their workings.

The ancient world contains many examples of underground works, although it is perhaps only natural that those which survive are mostly in rock, not soil. The Nabataens built the rock city of Petra some 600 years before the birth of Christ, and possibly the early art of tunnelling reached its peak under the Romans, many of whose tunnels and underground cisterns survive in use to this day.

### TUNNELS AND WARFARE

If tunnelling was one of man's earliest occupations, warfare was another, and the association of the two must be very long indeed. Putting either one's belongings or oneself below ground level still affords the best protection and concealment from an enemy, and so we may reasonably assume that tunnelling has always been a necessary part of the military engineer's skills.

The role of the military engineer in ancient times was much larger than is often realized. Whenever man resorted to arms to defend what he had or to get what he wanted, the military engineer would be there to provide defensive works, weapons and, of course, the communications needed to open up newly won territories. Many of the great engineering works of antiquity were built for military purposes. It was not until the middle of the 18th century that the term "civil engineer" began to be used to denote an engineer who concerned himself solely with works for peaceful purposes.

So let us now look at the military uses of tunnelling. I want to confine my attention to the construction of underground works on the battlefield, in other words, the tactical use of tunnelling, since the preparation of underground military facilities in peacetime is no different from any other form of underground work and, indeed, it would normally be done by civilian tunnelling contractors.

There are two main tactical uses for military tunnelling. The first is to give protection and concealment to essential and vulnerable facilities, such as headquarters, field hospitals and communication centres, by burying them below ground. The second is to attack a well-entrenched enemy by burrowing under his outer defences to attack the heart of his positions from below. This latter process is called military mining; the term has nothing to do with the extraction of minerals but rather with undermining an enemy's defences and, one hopes, his morale.

Underground work is at the best of times a fairly slow process, and so military mining is only possible in a static war situation. It is, for the same reason, almost always done in soft ground. I will therefore mainly consider the business of military mining in soft ground. Nevertheless, the Sappers have had considerable experience of hard rock tunnelling, notably in Gibraltar, and I shall return to this later.

The art of military mining has its origins in the Middle Ages, when most military operations consisted of investing and besieging an enemy in a massively constructed and heavily defended base, such as a castle or a fortified town. If you were on the other side, of course, you were concerned with keeping your enemies out of your castle or your town. Siege warfare was a very protracted business. Operations might last many years. Sieges often became logistic battles, the winner being the side that could last the longest, and it was by no means always the besiegers who won.

Long before the Middle Ages the Israelites went on record as having breached the Walls of Jericho, by marching round it with colours flying, bayonets fixed and bands playing, but this method has only worked the once, notwithstanding the efforts of some modern musicians to repeat the feat. Thus it was the job of the military engineer in any besieging army to devise ways and means of breaching the enemy's defences. This usually meant only one thing: how to get through the walls of the fortress. In those days, the engineer was the man responsible for all military technology.

All weapons systems, other than small arms, were known as "siege engines". These would include crude armoured vehicles such as scaling towers, and missile projectors such as catapults. All these machines would be built locally, and the armaments industry, if it could be called that, consisted of little more than the village blacksmith and the bowmaker. I think it is interesting to note that just as the civil engineer is the root from which all the other engineering disciplines have developed, so it was the military engineer who fathered nearly all forms of military technology.

But back to the castle walls. Despite the obvious use of battering rams and scaling ladders, often the only way to get into a castle was to attack the walls themselves. Of course, castle walls are built and designed to prevent this. Certainly they are strong enough to deter a casual attack by hammer and chisel. So when soil conditions permitted, a more favoured way was to breach the walls by undermining their foundations, and this is the origin of military mining. The technique has an elegant simplicity. It is one of those developments of engineering that are so obvious that one wonders whoever thought of it. Consider a castle with ourselves on the outside; defenders inside. One started off by digging a tunnel, from a suitable concealed position where the defenders could not get at you. The tunnel would be dug down and forwards until it reached the foundations of the wall. Once under the castle walls you started to chamber out, and to stop the walls falling on top of you, timber propping was put in. Once a sufficient length of wall had been undermined in this way, the timber props were packed around with brushwood, tallow and anything else that would burn well, and the whole lot set alight (presumably by lighting the blue touchpaper and retiring); the timbering would burn through and the castle walls should, in principle, collapse into the void underneath. One can however imagine considerable problems of ventilation. How do you get enough air in to make sure your fire does keep going?

### EXPLOSIVE MINING

The advent of gunpowder did away with the need to use timber propping. All one needed to do was to construct a small chamber, fill it with gunpowder and blow it up; this would form a canopy camouflet (an explosively formed chamber) into which the foundations should fall. An alternative was to chamber the walls themselves and use explosives to blow them out. This is the origin of the present military use of the term "mine", which denotes any explosive charge laid in or on the ground and detonated as the enemy passes by. This early use of explosive mining was fairly short-lived because the introduction of gunpowder brought with it the cannon. Artillery developed very rapidly, and the castles of the 13th and 14th centuries were, in fact, no match for sustained bombardment from cannon. Siege warfare thus became a thing of the past. Armies developed mobility, and the basic strategy turned to the destroying of an enemy's army in the field rather than seeking to capture his cities and castles.

Throughout the Middle Ages military tunnelling remained an art. It certainly was not a science. There was no formal teaching, and military miners learnt from their forebears, or from their mistakes. The same, I think, was true of mining generally. Possibly the first textbook on tunnelling was written by a German, one George Bauer, who in 1556 published *De Re Metallica*, which was translated into most European languages. It was illustrated with woodcuts and remained, I believe, the only tunnelling handbook for nearly 300 years.

So the 15th century passed, and the 16th century saw the reappearance of fixed fortifications on a huge scale, not necessarily because of a change of tactics but largely because the spread of navigation and the discovery of the New World had brought with it an increase in trade and the growth of industry. The importance of protecting trade routes, both on land and at sea, led to the need to construct and garrison fortified strongpoints. These new fortifications were expressly designed to withstand artillery attacks. They were themselves heavily armed. Indeed, the siting of gun batteries was a prime consideration in their design. They have a low silhouette. All the living quarters, the stores and the magazines would either be underground or would be buried under huge earthen ramparts. The plan of this fortification was such that every face of the wall would be covered by other positions so that no face was blind, no enemy could approach a face without his being subjected to fire from the defenders. The system is usually linked with the name of Vauban, who was chief engineer to Louis XIV at the end of the 17th century, but in fact it had been well established long before this and the Valetta Lines in Malta built between 1556 and 1570 are one of the earliest examples. This system of fortifications was used throughout Europe from the 16th up until the 19th century and, indeed, some were in use as late as the Franco-Prussian War of 1870, where they gave good account of themselves. The system became very formalized, like much of 18th century architecture. Fort George, near Inverness, which was built between 1746 and 1769 is a good example. The main defences were sited to defend it from landward attack, not from the sea.

Despite that very good example of a Vauban type fortification, the British built few like it. Fort Augustus and Fort William were not built up to the same extent. Some of the dockyards of the South Coast were fortified in a similar manner, but compared with the French, the Germans and the Belgians, we built very few of them; probably because no British Parliament was prepared to foot the bill. Nevertheless, for some 300 years, until late in the 19th century, these fortifications were the main subject of study for military engineers. Their construction involved much work below ground and mining was an obvious means of attacking them. It was during this period that the training of British engineer officers came to be conducted in a much more formal and scientific manner than had ever been the case before. So at this point I will consider briefly the history of the Corps of Royal Engineers.

## CORPS OF ROYAL ENGINEERS

In fact, the Corps has only held its present form since 1856, but the first British military engineers were appointed by William the Conqueror. These early King's Engineers, as they were known, were not, of course, full-time soldiers. For example, Gundolphus, Bishop of Rochester, became the King's Chief Engineer in 1078. This pattern of appointing men to act as military engineers as and when the need arose continued for several hundred years, and it was not until the beginning of the 18th century that a permanent body of military engineers was formed. Even then they were not granted military rank until 1757, and one wonders if the engineering profession had status problems even in those days.

In 1716 the Army consisted of two distinct parts, the Infantry and the Cavalry, under the Commander-in-Chief, who had his headquarters at the Horse Guards, and the Royal Regiment of Artillery and the Engineer Department, as it was then known, under the Master-General of the Ordnance, who was head of the Ordnance Board and a political appointee, so not necessarily a professional soldier. The artillery and the engineers had both descended from the Royal Ordnance Train of the 17th century. Their officers were the only members of the Army with any formal technical training. This training was done at a Military Seminary which was set up at Woolwich in 1719. Later, in 1741, this became the Royal Military Academy, Woolwich, and Gunner and Sapper officers continued to be trained there until 1939, although all other officers of the Army had, since 1812, been trained at Sandhurst where, of course, all officer training is done nowadays.

Until well into the second half of the 18th century the Engineer Department consisted of an officer corps only. Artisans and the labour needed for military construction projects were hired locally, and this might well explain why engineer officers who had charge of civilians, not soldiers, did not hold military rank. This system of providing engineer support meant that the engineer element of an army consisted mainly of civilians who were not in any way subject to military discipline or to military control. As a system it had many drawbacks. The labour force was not trained. It was not properly equipped. It certainly was not equipped to live in the field, and often the men were not properly supplied with food. They certainly did not expect, as civilian employees, to work under fire.

Things came to a head in Gibraltar in the late 1760's when the civilian artisans who had been sent to build up the defences on the Rock, then under threat from France and Spain, refused to work. The despatches from Gibraltar in those days suggest that they were a pretty useless bunch who devoted most of their energies trying to drink The Rock dry of wine. So to overcome this the First Company of Soldier Artificers was raised in 1772.

This is probably the start of the Royal Engineers as we know it. This company was raised by recruiting carpenters, masons, blacksmiths, etc., for duty as soldier artisans, so they were subject to military law and they were paid out of the defence funds.

By 1787 sufficient artificer companies had been formed for them to become The Royal Corps of Military Artificers. At the same time, the Engineer Department of the Ordnance Board became The Corps of Royal Engineers. This gave rise in 1787 to the peculiar situation of having two engineer corps in the British Army, one consisting of officers, and the other of the rank and file. The two were entirely separate. They only met on military projects. Standards were appallingly low. Nevertheless, this strange duality continued until their amalgamation in 1856.

### SAPPERS AND MINERS

In 1813 the Royal Military Artificers became The Corps of Royal Sappers and Miners. This change of name reflected their prime concern with fortifications, and it is perhaps rather surprizing to recall that what we now call field engineering (which is the main role of sappers nowadays)—building roads, bridges and defence works for an army in the field and carrying out demolitions—was done not by the engineers, the Sappers and Miners, but by a forgotten body called the Royal Staff Corps, which was set up in 1799 and disbanded forty years later.

The name "Sappers and Miners" has an interesting derivation. Mining, as we have seen, was the art of breaching a defence by attacking its foundations. A sap was a protected trench dug towards the enemy from below ground. Let us first consider what is known as a single sap. I will try and explain how the principle worked. One started off from a line of trenches which were dug facing the enemy, as trenches normally were. A fascine, a large bundle of sticks and metal poles, would be put up on to the parapet of the trench and slowly rolled towards the enemy. Behind its shelter, one man, lying down, could start digging a shallow excavation. At the same time as the fascine was rolled forward a row of gabions would follow behind to build up the height of the trench, and subsequent diggers would widen and deepen the trench. A double sap would have gabions both sides. A further development was called the Russian sap, where as well as putting gabions to build up the height of the walls, more fascines would be added to give overhead cover; it is an early form of cut and cover tunnelling but with all the work done from the inside. The art of "sapping" was highly developed in the 18th century. It was used a lot in campaigns in India. The word, in fact, is derived from the Italian "zappa", a spade, and is why military engineers throughout the world are known as "Sappers".

This leads me back to the development of military mining techniques. You will recall that in the 17th and 18th centuries military thought had reverted to defences based on fortified strongpoints; the Vauban system. Hundreds of such fortifications were built all over the length and breadth of Europe. Some were even being built in the latter half of the 19th century, but it is an interesting aside to recall that nearly all the important battles of this era, the decisive battles, such as the campaigns of Marlborough or Wellington were fought in the open field not against fortifications. Nevertheless, the construction, the defence and the methods of attack of fortifications was a proper subject of study for engineer and artillery officers, and so in 1741, the year that the Royal Military Academy at Woolwich was established by a warrant of George II, John Muller, who was Professor of Fortifications and Artillery at Woolwich, proposed, and I quote from his letter: "That there shall forthwith be prepared and erected in some convenient place in or near the Warren at Woolwich the front of a polygon"—in other words, the standard form of defence work—"of the largest dimensions that the ground will admit. Each front shall be made of earth and turfed, and to consist of two demi-bastions, two flanks and a curtain between them, with a ditch, a ravelin, a covert way, a place of arms and a glacis, and this front shall be attacked every other summer"—so obviously they were thinking of economy even in those days—"under the direction of the engineers belonging to the military branch of the ordnance with all the form and regularity that is used in a real siege. Parallels shall be drawn and trenches opened, and batteries shall be raised by the besiegers at proper distances and in proper places. Mines shall be made by the besieged to blow up the batteries, and the besiegers shall also carry on mines to make breaches. The whole attack to be traced by the engineers assisted by the chief master of the school."

### TUNNELLING IN SILENCE

That quotation vividly portrays the whole essence of military mining. Saps, or more likely, tunnels, would be dug to reach under an enemy's battery or defence work. Once there a chamber would be excavated and charged with explosives and the resulting mine exploded to destroy the battery or breach the defences. Such work, of course, would only be carried out in soft ground, for two reasons: speed and noise. Speed was important and rock tunnelling, especially with hand labour and crude blasting techniques, would be unacceptably slow. But much more important was secrecy and hence the need to tunnel in silence. One can well imagine that the ground around a fortification would soon become riddled with workings, and I shudder to think what the state of the Warren at Woolwich was after a few years of these comings and goings, because not only would the defenders be tunnelling out, and the attackers would be tunnelling in, but both sides would develop a system of countermines in an attempt to intercept the other's tunnels.

In 1757 Muller wrote a book entitled *The Attack and Defence of Fortified Places*. Much of this book was given over to the science of tunnelling and it described methods of digging shafts, galleries (ie tunnels) and chambers, using timbered supports. In 1815, the year of Waterloo, Isaac Landman had taken over from Muller as professor and he wrote a treatise on mines for the use of the Royal Military Academy. This was one of the first books to deal solely with military mining, and it covered all aspects of soft tunnelling theory and practice; it was, I believe, the first book to describe the use of driven timbered headings and the use of spiling boards in bad ground.

A few years earlier, during the Peninsula War, Wellington had had cause to complain to the War Office about the poor performance of his engineers. He wrote that: "their bravery far exceeds their knowledge; so much so that they are very often killed in battle before they can learn by experience." Wellington called for the setting up of an Engineer School separate from Woolwich, at which NCO's and men of the Military Artificers could be properly trained. The Military Engineer Establishment, now The Royal School of Military Engineering, was set up at Chatham in 1812. Its first director was Captain Charles Pasley, who had been one of Wellington's most trusted engineers until he was invalided home from the Low Countries in 1809. Pasley was a remarkable man. Not only did he set up the original establishment within three weeks of the Ordnance Board acceding to Wellington's demands, but he remained in charge of it for twenty nine years, rising to the rank of Major-General in the process. Pasley proved a brilliant choice for the job. He was an erudite man of science. He developed much of the earlier military applications of the new technology of the 19th century and became an acknowledged expert on all the engineering disciplines of his day. He was an accepted engineer in civilian life as well as in the Army.

The Engineers Establishment at Chatham taught both officers of the Royal Engineers, and NCO's and men of the Sappers and Miners. Siege operations, including military mining, took up much of the curriculum and the early teaching at Chatham was based on Professor Landman's Woolwich treatize. However, Pasley and his staff developed techniques in a rather more scientific manner.

### PASLEY'S RULES

In 1824 Pasley published the first practical manual of military mining entitled *Rules for the Practise of Military Mining in any Soil Excepting Rock*. These rules are extremely comprehensive. They cover practically every aspect of soft tunnelling by hand in the minutest detail. Everything is quantified with precision. Because Pasley was eminently practical in his approach to engineering, nothing was taught at Chatham until it had been tried, tested and quantified by practical trials by his staff, and his attitude is best summarized by quoting briefly from the preface to Pasley's *Rules*: "As there will be found many deviations in the rules from the former practice of this Establishment and from the rules contained in the most approved writers on mining, it may be observed that nothing new has been adopted without due consideration and after a full trial by actual experiment." This was true of all Pasley's works, and as well as teaching mining, of course he had to teach every other aspect of military engineering, and he virtually wrote all the early textbooks single-handed.

Pasley's rules for tunnelling dealt with the design of mines, excavation, timbering, ventilation, and he even had his Clerk of Works design portable bellows. He was a great advocate of prefabrication. He determined the best size of tunnel for optimum speed of construction, and laid down precise specifications for size and quality of the timber frames and shoring to be used. Most of his rules dealt with sinking shafts and excavating galleries and chambers in ordinary soils, which Pasley described as "common earth of middling tenacity as is most frequently met with in practice". But he also dealt with ways of covering bad ground, although he had to admit that there was an impossibility of tunnelling in running sands, by which, he said, "it is proper to explain is meant by pure quicksand which runs as in an hour glass". Pasley's students practised their tunnelling skills in the grounds set aside for the defence of Chatham Dockyard, itself fortified in the grand manner at the end of the eighteenth century, but all traces and records of this work have long since disappeared.

Pasley's book remained in use for many years. Indeed, there is a striking resemblance between what he wrote in 1824 and what is contained in the current manual of soft tunnelling in the Army. Although military mining was, in the 19th century, a very well established sapper task, it was not much used, I believe, at least by British troops, and the heyday of military mining was undoubtedly during the trench warfare of the First World War. However, it would be hardly proper for me to dismiss the rest of the 19th century without making at least one reference to the work done in civilian tunnelling by Sapper officers. I refer, of course, to Colonel Beaumont and his "Boring Machine".

## CHANNEL TUNNEL

Albert Mathieu-Favier first suggested a tunnel under the Channel in 1802, but nothing much happened until 1881. In 1880 Beaumont, who was a prolific inventor and, like many sapper officers in those days, devoted much of his energies to civil works, had produced a tunnelling machine driven by compressed air, and so it was employed when the first pilot galleries on the English side of the Channel were driven in 1881–2. I would add that Beaumont's machine, certainly in those days, had no military significance. The machine was mounted on rails laid in the tunnel invert and the cutting head had a pair of revolving arms, fitted with steel picks which scraped out the chalk as the machine advanced making a smooth bore a little over two metres in diameter. Mucking out was done by a bucket chain, which picked up the broken chalk lying in the invert of the tunnel, hauled it out and tipped it into skips, running along behind. Boring rates of up to 500mm an hour were achieved, but one assumes that the chalk was fairly competent because it was solely a boring machine; it was in no way a tunnelling shield. There seems to have been no provision for lining the tunnel until certainly the machine had travelled its own length.

Nearly 4km of tunnel were dug by the machine, and the longest went 1·5km under the sea. As a machine it was very successful. It was certainly years ahead of its time, but in practice it proved unreliable to use for any length of time, and to my knowledge it was never used again.

## THE GREAT WAR OF 1914–18

The Great War of 1914–18 was to have been a war of movement, following the pattern set by other recent battles, and so it was for the first few months. But by the time both sides had been fully mobilized they were so evenly matched that stalemate arose—mobile warfare had given place to siege tactics.

The practise of siege tactics had fallen into disuse over the previous fifty years because improved weapons, particularly the explosive shell, had in their turn caused the downfall of Vauban's system of fortifications. There had therefore been a falling off in the study and practise of military mining, until the discovery in 1914 that stationary trench systems brought back all the old features of fortress warfare. In the

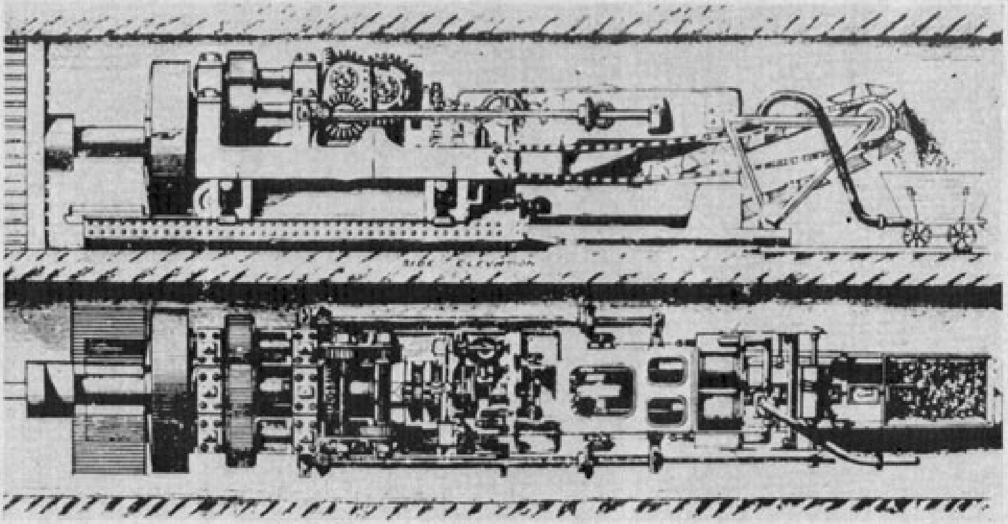



Photo 1. Beaumont & English's Compressed-Air Tunnelling Machine

Early History Of Sapper Tunnelling (1)

British sector of the front our forward trenches were in many places only 30 or 40m from the German lines. The Germans were, in fact, the first to begin mining operations, and by the end of 1914 there had been at least two cases of mines being exploded under the British trenches. The British were ill-prepared for mining operations. The British Expeditionary Force (the BEF) had been trained for mobile warfare. Although the last major mining trials had been carried out at Chatham as recently as 1907, the sappers in the BEF had only had a very cursory training in military mining and that had been done in ideal ground conditions. The principles of military mining were, of course, well known, and Pasley's Rules of 1824 still contained all the essentials. Indeed, his teaching needed little modification throughout the war, although there were obviously many innovations, such as the use of electricity for lighting, pumps and ventilating fans. But the essentials were unchanged. The basic requirement remained an ability to tunnel with accuracy in soft ground in complete silence. The only way of doing this was manually, using hand tunnellers—the "clay kickers". There were not any of these in the Army.

The British High Command took its time about deciding to start mining operations, so most of the initiative for mining and the setting up of mining and tunnelling companies came from the civilian tunnelling industry. There is an excellent book on this part of the industry's history by Bernard Newman, called *Tunnellers*. In it he gives a graphic account of the mobilization of tunnelling companies, and relates how on one occasion men who had been digging sewers in Manchester on a Thursday found themselves digging mines in Belgium on the following Monday.

Space prevents me from dwelling long on all the details of military mining in the First World War, but there were one or two important developments. Electricity was one, but probably the most important new dimension in military tunnelling was the employment of geologists to forecast soil conditions, and throughout the mining operations of the First World War much effort was given to studying the geology of the battlefield, both to seek the areas and the depths most favourable for tunnelling and more especially, to determine and forecast variations in the water table. There is, indeed, a complete volume of the Military History of World War I devoted to mining geology. And because mining operations were used not only in static conditions but also to preface an attack, the influence of geology soon became a factor in deciding not only tactics but strategy.

Mine safety and rescue techniques also developed rapidly. Breathing apparatus became increasingly important, not only because of the use of poison gas in trench and tunnel warfare, but also because towards the end of the war tunnels encountered ground impregnated with the toxic fumes of earlier mining explosions. Curiously, little use was made of mechanical plant, other than the narrow gauge railways. Again, the chief reason for this, apart from its unreliability, was the problem of noise. Seismic listening techniques, although very crude by comparison with modern electronic equipment, were developed to a very high degree. People became great experts at listening to noises in the ground. It is related that on one occasion when a tunnelling shield was tried out at the Front, apart from the fact that its direction could not be controlled, it made so much noise that neighbouring infantry units claimed that it would be heard by the German High Command in Berlin.

### BLOWN UP WITH THEIR OWN MINES

The scale and tempo of military mining in the 1914–18 War is hard to appreciate—whole areas of the front became riddled with chambers and galleries. Frequently, one side would break into the workings of the other and fierce hand-to-hand battles ensued. Mines were often charged and never used until, as the tactical situation changed they were discovered and blown by the other side—truly a case of the engineer "hoist with his own petard"!

The mining feats of the 1914–18 War have never been repeated. The zenith, I suppose, of 1914–18 mining was the mining of the Messines Ridge. The statistics are fascinating. In total 500 tonnes of high explosive, most Ammonal, were detonated in the space of thirty seconds. Half of it was concentrated on a front barely 4000 metres long, in fourteen mines between 18 and 30m deep.

Nowadays the scale of things is totally different. Airborne delivery systems are a much more rapid and accurate way of planting explosives on an enemy position, and the atomic bomb completely changed the scale of explosive power. By way of comparison, the bombs dropped on Japan at the end of the Second World War were each equivalent to 20,000 tonnes of TNT, forty times that of the mines placed at Messines. So the story of military mining as such really ended in 1918. It has never been used since as a weapon of war, although soft ground tunnelling was much used in World War II, particularly in bomb disposal.

The last time that we used tunnelling in a tactical setting was in Korea. The most famous example was the Battle of the Hook, where a hilltop was hollowed out to form a company strongpoint, and although on several occasions the North Korean troops overran the hill the British infantry inside were never dislodged.

Coming more up to date, the Vietcong used tunnels to great effect in Vietnam, and recently there were reports of the North Koreans allegedly tunnelling under the border into South Korea.

That ends the story of military mining which was, in effect, soft tunnelling by hand. But, as everybody knows, the Sappers have had a long association with rock tunnelling, particularly in Gibraltar.

## DIGGING IN THE ROCK

The story begins during the Great Siege of 1779–83. Gibraltar was surrounded by the French and the Spanish Forces, and by 1782 the Spaniards had advanced so far along the peninsula that they were under the lee of the northern cliff and could not be attacked by our own batteries. The Governor of Gibraltar, a former sapper officer himself, wanted, therefore, to put guns high up on the top of The Rock where they could bring fire to bear on the Spanish. Sergeant Major Ince, of the Royal Military Artificers, was sent for and ordered to start a tunnel up inside The Rock to the top of the northern face, which I suppose if said very quickly, sounds quite easy. In fact, half way up the tunnellers, suffering from poor ventilation, blew a hole in the side of the tunnel and found that they had reached a point which gave them an excellent field of fire over the peninsula. So they never actually bothered to get to the top of The Rock.

The tunnel was enlarged into a gallery, now called St George's Hall, and fitted with twelve cannons. Immediately after the siege, in 1784 and 1785, two more galleries, mounting a further ten guns, were built in roughly the same area. We know very little about the methods used by Sergeant Major Ince and his military artificers. None of them had any mining skills as far as one can tell. The tools would be crude—metal chisels and crowbars and hammers; they would have wished to use gunpowder for blasting, but probably none could be spared from the artillery—remember, Gibraltar had been under siege for three years. So they probably had to break the rock by fire setting, building fires against the face of the rock and then quenching the heated rock with water to crack it, but it is also reported that Ince did break the rock by driving boreholes, charging them with quick lime and then slaking the lime to cause it to expand and split the rock. Progress was slow. The tunnellers averaged about 200m of $2m^2$ tunnel in one year. But when one considers their working conditions, their crude tools, plus the fact that they were not experts and they had been suffering the privations of a siege, their accomplishments were quite remarkable.

After 1785 there was a pause, but then between 1790 and 1800 there was a great flurry of activity and virtually the whole of the garrison of The Rock of Gibraltar was put underground into batteries, galleries, billets, stores, hospitals and magazines. Nothing else was done until 1895, when a series of natural caves were discovered and linked into the tunnel system to act as more stores. After 1895 the sappers did no more tunnelling in Gibraltar until 1940, although both the Admiralty and the City

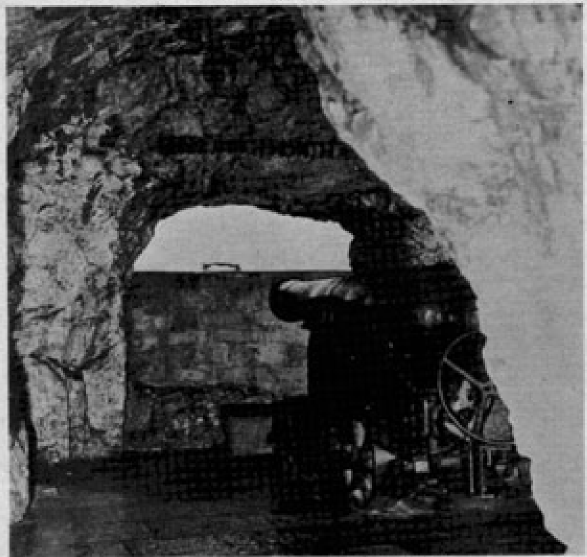


**Photo 2.** Gibraltar—"an excellent field of fire"

Council, following the Army's early example, built roads, sewers and some eleven storage reservoirs inside the Rock. By about 1939 there were 8km of tunnels inside Gibraltar.

In 1940 we were really no better off than we had been in 1914. There were no sapper tunnelling units, and they had to be formed up by recruiting civilian miners and tunnellers. Much of the work done in World War II was in fact done by Canadian mining units, and they introduced more modern techniques, such as wet drilling and the use of diamond bits, to the tunnelling in Gibraltar, which was certainly at the start done by British tunnellers using dry drifters and air drills.

The work in the Second World War was very similar in essence to that done during the Great Siege. Obviously, the requirements were larger and more facilities were required. One of the things put in was a power station, and because the rock in Gibraltar is a porous limestone the tunnels are nearly always wet, except during very long dry spells, so any underground facility had to be housed in a free-standing building built inside the chambers. After 1945 work continued at a lesser tempo until 1967, mainly to enlarge existing chambers and to complete vital links in the tunnel system; much of Gibraltar is linked by tunnels, not surface roads.

That really was the end of the history of sapper tunnelling. We now have no tunnelling units, and we hold no tunnelling equipment. We do keep a certain amount of expertise alive by attaching a few officers and technician NCO's to civilian firms to gain experience for the Corps in modern tunnelling methods. Bomb disposal engineers are still trained to a very limited amount in soft rock or common earth hand tunnelling. So it really is the end of an era.

Early History Of Sapper Tunnelling (2)

**Photo 3.** Gibraltar—Moles End Way. The last Sapper driven tunnel in Gibraltar

## NUCLEAR THREAT

What of the future? Modern war nowadays is highly mobile, with sophisticated weapons systems in mobile carriers and everybody behind armour. He who sits still for any length of time will be found, and he who is found is destroyed. At least, that is the theory. Certainly the threat, if it is never more than that, of nuclear weapons prevents static concentrations of troops. So one certainly does not foresee in any major battle—and I am here not talking of low scale wars or bush wars or internal security operations—the siege tactics that re-emerged in the 1914–18 war. But, of course, the massive destruction that is threatened by nuclear weapons does mean that protection again becomes a premium. It is all very well to have fighting formations rushing around above ground in armoured vehicles, but what of the rest—the headquarters, hospitals, and stores? They need protection. This, I believe, is where we should start thinking again of the use of tunnelling. What every sapper would like is a tactical tunnelling machine, preferably one that will go in the back of a Land Rover, and still dig a seven metre diameter tunnel, but if we cannot manage that we want something which can dig the sort of chambers that we have in Gibraltar, with all the dexterity and economy of effort that the miners of the First World War had. So I believe that the future of military mining rests very much with the civilian tunnelling industry.

## DISCUSSION

Brigadier Constant: In the war we used to have some boring machines for vertical shafts. They would go down 20ft (6m)

Early History Of Sapper Tunnelling (3)

Lieut Colonel Clifford: This was for bomb disposal?
Brigadier Constant: Yes. I have used them on small bombs. Later we were confined to hand tunnelling.
Lieut Colonel Clifford: Nowadays rotary truck-mounted boring rigs are used. They have limitations as to when you can use them in bomb disposal work. If the bomb is deliberately designed not to go off on impact, you are not quite sure until you have found it what sort of fuse there is and what will trigger it. Also, if the fuse has been damaged when it fell it is still likely to go off if some impulse is put on it. So one uses mechanization as much as possible but, as I am sure you will agree, the end effort is very gingerly done by hand digging.
Sir Harold Harding: May I add something about the boring machine? I was lent by my firm to the bomb disposal people at the Duke of Yorks's Headquarters to give them free advice, if they wanted any, on timbering. We found that the boring machines were built on the theory that bombs fall vertically. We then found that they did not; they went skidding away underneath, and one I was involved with under the National Physical Laboratory went about 20ft. It went down through the water bearing gravel. The sappers had been given a set of well points. Not knowing how to use them they put one little manhole in and all the well points within 6in (150mm) of it. I had to show them what to do. There was one other thing about the bomb disposal people. They never had a second timber man. There was one corporal who had been an assistant borough surveyor. They were in far more danger of burying themselves than from any bomb!
Mr Glover: I would like to assure Lieut Colonel Clifford that at least one other Beaumont machine was built, and it worked on the French side about 800 metres out in the Channel. Also a pilot and ventilating tunnel for the railway tunnel under the Mersey was dug by a Beaumont machine, although we do not know whether either of the Beaumont machines is still under the Channel, or whether each one of them was recovered and used to drive under the Mersey.
Mr Finch: Going on from Lieut Colonel Clifford's remarks about Colonel Beaumont, he was of course linked with another sapper officer. The first effort was for the Whitlow Mines in Ireland, which did not work at all. He was assisted by a Major English of the sappers. The Channel Tunnel and the Mersey Railway machines were both Beaumont & English machines, but Beaumont and English appear to have quarrelled, and that is perhaps the reason why there was no further development. But the history of the sappers and machines does go back a bit earlier still. The minutes of the proceedings of the Institution of 1881 record that a Captain Penrise, late Royal Engineers, said that he believed he was the first person who had applied machinery to rock boring. During the Crimean War he made two machines for the English Government and two for the French, but the Siege of Sebastapol was over before they were completed. The French Government applied for their machines with the request that he should accompany them to instruct their officers how to use them. Their money was returned and he was ordered abroad. Some years afterwards a similar machine was constructed at Gateshead.
Brigadier Constant: I think we should also mention the works at Corsham before the last war when Jerry Minnis, then a Sapper Colonel, was put in charge of the construction of an underground ammunition depot, about 30m below the surface. The limestone stratum, from which Bath stone has been extracted by room and pillar methods, had been repacked with waste stone to support the roof. This stone was removed to clear the way for storage and the pillars were given extra strength by reinforced concrete "corsets". In most places the roof was sound, but some beams were required, particularly where haulage roads were being widened to lead to the railway sidings, which formed part of the main line tunnel at Box. Many vertical shafts were dug for ventilation purposes and inclined shafts were driven and lined for additional haulage purposes. Surface buildings were provided, as well as underground accommodation. This multi-million pound task was subsequently extended for other users, and must rank as one of the largest underground achievements of the Corps.

On a different subject, the workings at Gibraltar have been mentioned. I think that the whole scale of tunnelling in The Rock really changed completely when diamond drills became available. The big workshop was, as far as I can remember, 400ft long and had a very considerable span. That was entirely done by making a pilot tunnel and then progressively blowing it down in layers, and the last bit that came down was a complete cross-section and a wonderful sight. It was all done by diamond drills. One of the other uses of the diamond drill which applied in Gibraltar —and I have not seen a great deal of it elsewhere—was to build mini-tunnels. I think perhaps the biggest one was 1km long for cables. As well as all the normal tunnels big enough for people to use, there are a certain number of these for cables, power cables and other things. With those lengths the diamond drill behaves like a missile and takes a ballistic path.

# Freedom of Hameln

FRIDAY, 3 June, proved a busy day in the historic town of Hameln. The Stadt authorities had elected to confer the Freedom of the Town on the Corps of Royal Engineers and the British Garrison had simultaneously selected this day to celebrate Her Majesty The Queen's Silver Jubilee. The celebrations were therefore combined into a joint Band Display and Freedom Parade in the Burgergarten followed by a Troop of the Town, a Jubilee Reception in the Officers Mess 28 Amphibious Engineer Regiment, and an official Freedom Day Luncheon arranged by the Stadt. Finally, it was planned to end the day with a Garrison All Ranks Jubilee Ball arranged by 35 Engineer Regiment.

Hameln, of Pied Piper fame, is perhaps more famous in sapper eyes as the home of the RE Bridging Camp and the many briding and training sites—with such well known names as Upnor, Wouldham and Gundolph. Royal Engineer units have been stationed in Hameln since 1946 and have enjoyed some thirty years unbroken friendship with the Stadt and its citizens. It was in recognition of this long association with the Corps that the Stadt authorities wished to grant the freedom of their town, the first occasion that such an honour had been conferred on any British Corps as a corporate body.

The Corps was represented on parade by ten Guards, each of 3 officers and 37 men. Guards were provided from 73 Independant Field Squadron representing 2nd Armoured Division Engineer Regiment from Osnabruck; 21 Engineer Regiment from Nienburg; 26 Engineer Regiment from Iserlohn; 32 Engineer Regiment from Hohne; 74 Engineer Regiment (Volunteers) from Northern Ireland and the host Hameln units of 28 Amphibious Engineer Regiment, 35 Engineer Regiment and 65 Corps Support Squadron. The Royal Engineer Band (Aldershot) and the Pipes and Drums of 74 Engineer Regiment (Volunteers) provided the Band Display and also took part in the Parade and the Troop through the Town. In all, some 530 officers and men took part in the ceremonies.

The representative unit Guards converged on Hameln on the morning of Tuesday 31 May for an intensive two days training. Rehearsals were a complicated affair, since the Parade itself was due to take place on the hallowed lawns of the Stadt Burgergarten and permission could not be obtained to use this venue for the rehearsals. Practices therefore were held on to the Garrison cricket ground and included one separate wet weather rehearsal in Gordon Barracks and a practice Troop through the Town. Fortunately, the weather was kind and enabled the full rehearsal programme to be completed.

Assured of a clear, fine day by the Meteorological Office, we were not surprized to awake on 3 June to a dark, overcast sky and fine drizzle! However the rain was insufficiently heavy to cancel the fine weather programme and by 1030 the Burgergarten was beginning to fill with spectators. At 1100 the Corps Band and Pipes and

**Photo 1.** The Burgermeister Dr Kock, accompanied by the Parade Commander, Lieut-Colonel J J Stibbon RE, inspects the representative troops of the Corps of Royal Engineers

Drums began their display in front of the VIP guests and over 3000 spectators. The bands, resplendent in their dress uniforms and Isle of Macdonald Tartan ended their display with an arrangement of "Wings". The ten representative regimental Guards then marched on and formed up around three sides of the Burgergarten, with the bands in the centre. The Union Jack was raised for the Royal Salute and this was followed by a General Salute for the Burgermeister as the Federal Republic of Germany flag was broken out. The Burgermeister, Dr Kock, then inspected the Parade accompanied by the Parade Commander Lieut-Colonel J J Stibbon, the Chief Royal Engineer General Sir Charles Richardson, the Garrison Commander Brigadier J P Groom and the Services Liaison Officer Lieut-Colonel J W W Auger.

Following the inspection, the Burgermeister conferred the Freedom of the Town of Hameln on the Corps of Royal Engineers, ending with the words "Freedom means Freiheit. We shall strive together in the future for a free Europe".

In response, the Chief Royal Engineer presented the Stadt with a Corps side-drum bedecked with names of campaigns in which the two nations had fought together as comrades in arms; the Peninsula 1808, Walcharen 1809, America 1812, Waterloo 1815 and the Boxer Rebellion of 1900. In his acceptance address, the Chief Royal Engineer said: "On behalf of the Corps of Royal Engineers I accept with great pleasure the Freedom of the Town of Hameln. Engineer units have served continuously in Hameln since 1946 and have enjoyed an unbroken span of thirty years friendship and hospitality from your citizens. The co-operation and kindness shown to us, together with the beauty of your town and its surrounding countryside, have made Hameln one of the most popular postings for our soldiers and their families. In accepting this signal honour that you have conferred upon us today, the Corps of the Royal Engineers would like to present the Town of Hameln with a Corps side-drum. It is I think fitting that the battle honours inscribed on this drum mark an association of my Corps, as comrades in arms with your people, going back in history some 170 years. I now ask you, Herr Burgermeister, to accept this Corps

Freedom Of Harlem (1)

**Photo 2.** On the dias the Burgermeister Dr Kock and the Chief Royal Engineer at the Granting of the Freedom to the Corps and the Presentation to Stadt Hameln of the Drum and Table. The Hameln Garrison Commander Brigadier J P Groom CBE stands on the right

**Photo 3.** The Pied Piper of Hameln heads the Freedom March. Lieut-Colonel J J Stibbon RE leads the troops

Freedom Of Harlem (2 & 3)

Drum as a mark of our gratitude for the hospitality and kindness shown to the Royal Engineers over the past thirty years."

On completion of the presentation ceremonies, permission was obtained for "the Corps of Royal Engineers to Troop the Town of Hameln with bayonets fixed and drums beating" and the parade marched off headed by the Parade Adjutant Captain M W G Hurford carrying the Freedom Scroll. The salute was taken by the Burgermeister and Chief Royal Engineer on the Rathaus steps, the route being lined by 131 Independent Parachute Squadron (Volunteers) and 28 Amphibious Engineer Regiment Workshop. The Troop of the Town continued through the older parts of Hameln and ended at Bindon and Gordon Barracks, where the participants sat down to a Silver Jubilee Lunch and beer provided free by the Stadt.

By this time the Jubilee reception in 28 Amphibious Engineer Regiment Officers Mess was well under way, attended by some 320 guests, about 30 of whom later went onto the Official Stadt Luncheon. At this lunch, a further presentation of a Silver Jubilee dish was made to the Stadt who in turn presented two engraved prints of Hameln to 28 Amphibious Engineer Regiment and 35 Engineer Regiment.

The afternoon saw the semi-finals and final of the inter-regimental "Freedom Day" soccer competition, which was won after a hard fought final by 73 Independant Field Squadron. The celebrations continued into the evening with the All Ranks Jubilee Ball, again attended by both military and civilian German guests. Many participants in the day's earlier events felt they could now let their hair down and it is not surprising that the Ball was still going strong at 2am!

It had been a busy day and as is always the case, the events turned out to be far less complicated than predicted. Much of the credit for this must go to Lieut-Colonel John Auger who, as Services Liaison Officer, prepared the way with the Stadt, smoothed over many a problem and made the planning much easier.

# When I Became an Engine Driver

MAJOR E R B HUDSON, TD

*Major Roy Hudson recalls when, as a British Army Officer, he volunteered for temporary duty with the Burma Railways during World War Two. This article was first published in the Sunday Magazine of the Bangkok Post. We are grateful for their permission to republish.*

I SUPPOSE that nowadays small boys hanker to become an astronaut, but it was traditional in my young days for a boy to want to grow up to be a railway engine-driver—though I cannot remember any such ambition for myself. However, as it happened, fate decreed that for at least a fortnight I would become, of all things, a railway engine-driver.

Perhaps I should describe the scenario. The year is 1942, the month March, the place Burma. Scene 1 starts with the Japanese invasion of Burma through Mae Sot and Kawkareik, and ends with that brilliant operation by their 33rd and 55th Divisions at the Battle of the Sittang which dealt a crippling blow to the Allied 17th Indian Division, one of the worst disasters in the annals of British military history, about which I hope soon to write a personal account.

Scene 2 sees 17th Indian Division withdrawing from the Sittang towards the southwest and Pegu, whilst my own unit turns north to rejoin its parent formation, 1st Burma Division. I was a subaltern (lieutenant) in the Royal Engineers, aged twenty two, serving with the Nawab of Malerkotla's Own Sappers and Miners.

No, this is not a tale from the Arabian Nights, every word is true, my memory refreshed by notes I wrote thirty five years ago, and though I would like to explain more about this campaign-experienced unit with many battle honours to its credit, I must keep to one story at a time, and move on to Scene 3 "I join the Burma Railways".

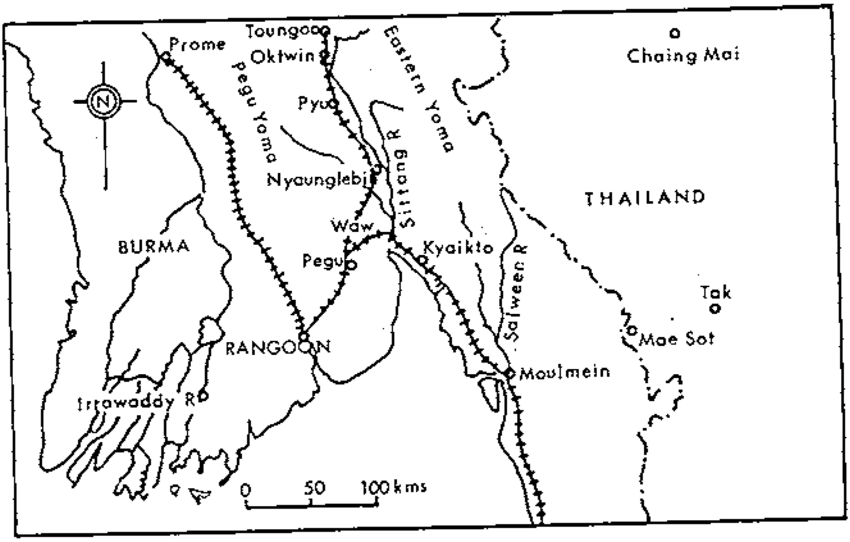
FORMIDABLE

My unit staged at Nyaunglebin, where 2 Burma Brigade was preparing to defend themselves against the coming Japanese attack. After offering some advice about the construction of some defensive positions, I left with my section of sixty men, and the rest of the unit, for Toungoo. This largish town is on the banks of the Sittang River, and there was some fear that the concrete road-bridge leading east to Mawchi might be destroyed by enemy air attack so we sappers were given the job of preparing an alternative way of crossing the river, a formidable task that we decided to do by constructing a floating bridge of bamboo, boats and empty oil-drums.

Just about then, the Japanese cut the main road and railway line between Rangoon and Mandalay, at a place called Pyuntaza, a few miles south of our brigade in Nyaunglebin, just sixty miles south of Toungoo. This action by the enemy had the immediate effect of so frightening the staff of Burma Railways that no engine crews could be found to take a train anywhere south of Toungoo. So a call went out to the sappers (always the first thing to do in an emergency) to provide steam-engine crews for three engines. As it happened, I had one man, Naik (Corporal) Sardar Ali Shah, who was a qualified steam-roller driver, so naturally he was put in charge of one crew, someone else took over the second crew, whilst I myself headed the third and last one.

What made me think I should volunteer for temporary duty with the Burma Railways? To answer this question, the scenario must here include a flash-back to 1936. I was at school near Guildford, in England, but as I was born in the Argentine, there was a possibility, nay, a probability, that I would be called up for military service in that country. This probability became a certainty in 1940 when I received an order to report myself for service with the 1st Division in Buenos Aires. By then I was already in the British Army fighting the Germans, so I sent back my apologies for not being able to comply. I never heard anything more, and I believe I was granted an amnesty in 1946 (Argentine Embassy please note).

Anyway, the Argentines had a splendid regulation by which a high score on the rifle-range earned up to six months remission of service, so when I enlisted in the Officers' Training Corps at school, I joined the Bisley Squad, and eventually became Vice-Captain of the Shooting VIII. I used to attend camp during the summer holidays at Bisley, well-known the world over for its shooting ranges. There was a short railway branch-line running from Brookwood to Bisley, and we cadets were allowed to take turns at travelling on the footplate of the engine, appropriately



named the "Bisley Bullet", when we were off-duty. Thus it was that I considered myself an engine-driver, albeit of rather limited experience, and understandably I reported for duty at Toungoo Station with some apprehension.

The civilian official in charge of affairs at the station was called Burroughs (I think), and he introduced me to this colossal giant of an engine, and also, I was very glad to note, to an Indian stoker. I was thankful to add the stoker to my crew of four sappers for two reasons, first, none of us yet knew how to stoke the coal into the red-hot furnace, and second, I would be able to draw on his railway experience.

Our daily mission was to proceed alone to Nyaunblegin, contact the brigade, make sure that their "tactical train" was in order (I had put Naik Sardar Ali Shah in charge of the engine), and return with as many loaded railway wagons as we could couple on to our engine, for at that time it was still the intention to hold on to Upper Burma.

As the monster was already watered and fed, with a professional tug at the whistle I pushed aside the regulator (accelerator to those less knowledgeable than I on these matters), and away we went. We had not gone more than three miles when we reached the first station, and the stoker pulled the engine to a stop. "What's up?" I inquired. "Signal against us," was his reply. "No matter," I said, "We have to get on, and there's only one other train on the line, so let's go." "Sorry," said the stoker, "company regulations forbid proceeding against a signal, unless permission first be obtained from the stationmaster." Poking my head out of the cab, I pointed out that the stationmaster was in all probability back home packing as fast as he could, and that company regulations or no, we were not wasting any more time, and so with another toot and a shove, we moved slowly ahead.

### BLASÉ

It was a pleasant experience, chugging along at about 40mph, working the regulator, letting off steam, checking the water injector, glancing at the gauges and above all, hooting the whistle. We passed through numerous stations noting more and more Indian refugees and their bundles of possessions, hopelessly waiting for a train to carry them north. I got a bit blasé after a while, and was nearly knocked off my feet when, on approaching a largish station, the engine suddenly jerked to one side and raced along, not in front of the platform as usual, but behind it. Refugees scattered left and right from our path, also taken completely by surprise, and how we managed to avoid running over dozens of them was more a tribute to their quick reactions than to our own feeble efforts to stop our hissing monster.

Once we had completed our tasks at Nyaunglebin, we started back, not before we had encountered some trouble in getting on to the "up" line. I was unable to master the levers in the signal boxes, so with a couple of blows from a sledgehammer we broke the padlocks of shunting levers on the ground, and were soon on the right track again. We searched for wagons, and hitched them on until we had a full load of forty, after which we thankfully started back for Toungoo, reaching there two hours later with 400 tons of stores of some sort or other, saved for another day.

It was by then always dark, and we were tired, thirsty and filthy, so we handed over our engine and rake of wagons, and made for our unit lines situated in the compound of a well-known firm called Steels. The officers occupied the "chummery", which was the living quarters normally used by bachelor officials, a huge one-storey building on stilts, made of teak, of course. There I would bath, eat and sleep, ready for another trip on the railways early the following day.

At breakfast one morning I was greeted by Jim Norfield, our second-in-command, with the news that they were selling Red Label cheaply, at the ration point, and that he had bought a dozen bottles for the Officers Mess. I dashed off to the station, and as usual I was curious to know what was in the wagons I had hauled back the night before. Sometimes it was rice or sugar, sometimes rifles and ammunition, sometimes earthmoving equipment, and, I am glad to note, sometimes refugees. But today it was whisky!

There, in front of my very eyes, was a sergeant of the Burmese Army Service Corps unloading TEN TONS of Johnnie Walker Red Label into his truck! Taking in the situation at a glance, I stepped forward and claimed sole ownership of several hundred cases, but told the sergeant I would give up my inherent rights if the next two cases were loaded into my own vehicle, not his. Luckily he saw the force of my argument, and I drove off happily to report to Burroughs as usual. As soon as he saw me, he took me into his office, and in a confidential manner, asked me if I'd like a half-dozen or so bottles of Red Label, as a token of his regard for the help I was extending to Burma Railways. Thus it was that the Malerkotla Officers' Mess was able to broach a bottle of whisky every night for quite a number of nights to follow.

EXHAUSTING

Being an engine-driver is not altogether very pleasant, it is exhausting work, one gets very hot, even burnt, and terribly sweaty, filthy with coal dust and flecked with oil. So it was very early in my new career that I searched for means of making life more comfortable, and I soon spotted a neat little coach, all shuttered and screened, of the type used by senior railways officials when on tours of inspection. I found it belonged to an Anglo-Burman whom I had seen once or twice at the station, and so I asked him what he was doing. "I'm Inspector-of-Railway-Bridges, Southern Burma" he told me. "In that case, as the whole of Southern Burma is now in the hands of the Japanese," I said, "what about letting me use your coach whilst I'm on this job?" I was very glad when he agreed and we walked up to it so that he could show me over.

In the living room was a bunk running lengthwise, and a table opposite, with fans and a small paraffin-operated refrigerator. Next door was a shower and lavatory, and next to that was a small kitchen. I was delighted, but what delighted me even more was the introduction to May, a lovely lithe Burmese lass, who was handed over to me as resident hostess for the duration of my tenure.

As many will already have anticipated the daily trip down to Nyaunglebin and back took on quite a different aspect. Instead of climbing on to the slippery engine footplate, I would board my clean cool coach, give my men the green signal (all of them by then could drive with confidence) and off we would go, with yours truly being ministered to in the most attentive way by the delicious May. An iced whisky or two would appear before a dainty little meal was served, and to finish off, May would ply me with the nicest cups of coffee I have ever tasted.

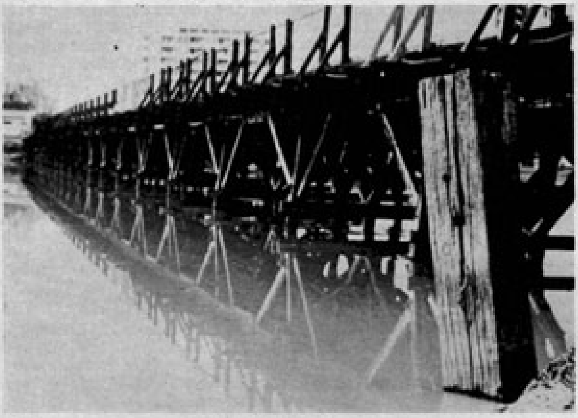
Rudyard Kipling, whose writing and poems I have long admired, never even spent a night on Burmese soil, but he admits to having "fallen deeply and irrevocably in love with a Burmese girl at the foot of the first flight of steps" leading up to a pagoda in Moulmein, and he later pictures her as "a-smokin' of a wackin' white cheroot." Though I cannot remember having fallen irrevocably in love with May, she did start me off on cheroots, to which I've been addicted ever since. But perhaps she did make me fall irrevocably in love with the East, as eventually I married the Siamese girl next door so to speak.

Scene 3 ends suddenly when I receive fresh orders—no more playing at trains, but to go and hand over some demolitions to the Chinese 200th Division. In case any small boy is reading this now, may I offer a word of advice? Don't, sonny, be an Engine-Driver; it's far more fun being an Inspector-of-Railway-Bridges in Southern Burma, if you have the choice.

# Bridge over the Milnerton Lagoon, Cape Town

S McCONNEL B Sc (Eng), FICE

For some fifteen years the Author, who served as an officer in the Australian Engineers in World War I, has lived in the immediate vicinity of this structure built



by the Royal Engineers during the Boer War to serve a fort and camp about six miles from Cape Town.

Despite its age it is still in daily use and may be capable of a further life of possibly ten to twenty years. Consequently it is of considerable interest as few timber bridges of this age and very light construction still survive.

The decking is not original and has been replaced a number of times, but the whole of the original piles, bearers and bracing still function. All this timber is *Jarrah* imported from Western Australia. The iron work however was badly corroded and the $\frac{3}{4}''$ bolts had been reduced to the thickness of a lead pencil when they were recently replaced by stainless steel ones.

The bridge consists of some 19 No 17′ 6″ spans with 11′ 0″ spans at each end, and the type of construction is clearly shown in the photograph.

Each pier is a bent of four piles at approximately 4′ 0″ centres at deck level with the two outer ones driven at a rake of about 1 in 12. These are 9″ × 6″ in section while the two internal ones are 6″ × 6″. They were driven into the silty bed of the Lagoon and are connected by a pair of 6″ × 3″ horizontal walings just below corbel level. Another pair of walings is placed about 4′ 0″ below and the intervening spaces have diagonal 6″ × 3″ bracing on the opposite faces.

The four bearers to which the decking is attached are bolted to the sides of the piles and jointed at this place. Underneath these joints are corbels of 6″ × 3″ timber 18″ long which rest on the upper walings and support the 9″ × 3″ bearers. Each bearer has a horizontal straining piece of 6″ × 3″ bolted to the underside of the centre third of the length of the bearer. Against this 6″ × 3″ diagonal struts carry the load to the lower set of walings.

There is one unusual feature, due to the fact that the bearers are bolted to the side of the piles. The bearers and corbels secured to the outside of the piles with a rake are vertical and consequently have to be let into the side, so that the lower ends of the inclined struts will abut against the side of the 9″ × 6″ piles, but in the case of the inner 6″ × 6″ vertical piles the lower ends of the inclined struts abut against a short piece of 6″ × 3″ bolted to the pile and resting on the lower set of walings.

The Lagoon is tidal but the piles, which have a permanent skirting of marine

Bridge Over The Milnerton Lagoon, Cape Town growth about 2′ 0″ deep, show no indication of *toredo* attack. The bridge has a camber of about 18″ at the centre and the lower set of horizontal walings are just above high tide level. Only about six feet of the piling below the bottom walings is exposed above ground level, and the lagoon is very shallow at low tides.

At the present time there is a 3 ton load limit and 12 miles per hour speed restriction, which appears to be generally ignored.

It would be of interest if any bridges of similar age and light construction could be located.

* * *

# Memoirs

## COLONEL G W SHEPHERD, OBE, BA

*Born 26 March 1918, died 30 August 1977, aged 59*

GEOFFREY WINGFIELD SHEPHERD OBE BA died suddenly on 30 August 1977 at his home in Liss, Hants. Geoff Shepherd was commissioned in the Royal Engineers from the "Shop" in January 1938 following a long family tradition in the Corps and, on completion of his young officer training, he joined No 1 Railway Training Centre to begin a long and distinguished career in transportation.

In March 1940 he joined 8 Railway Coy RE with the British Expeditionary Force in France from where he was evacuated in May 1940 to proceed immediately to Norway, again to return to the United Kingdom in June that year. Geoff Shepherd spent the next three years in the UK being promoted to Acting Captain in 1941. He returned to Europe with 21st Army Group in June 1944 where he was mentioned in despatches. Early in 1945 he returned to the UK to attend the Staff College and was promoted to Major. This was followed by a number of staff appointments in the Far East where for his services he was awarded the MBE.

The next ten years saw him serving in UK, Burma, Australia, USA and BAOR and during this time he was awarded the OBE. The early 60's saw Geoff Shepherd serving as an Instructor at Longmoor, the place he always thought of as home, and by July 1965, on the formation of the Royal Corps of Transport, he was Colonel Q Mov in the MOD.

On leaving MOD he assumed his first Field Force appointment with his new Corps as CRCT in Aden where he served with great distinction, again being mentioned in despatches, until the end of 1967. On leaving Aden he spent two years in Singapore, first as a Colonel Transport and later as Deputy Commander and Colonel AQ of Singapore District. Following a course at the NATO Defense College, Geoff Shepherd spent the last tour of his service with Supreme Headquarters Allied Powers Europe from where he retired in March 1973. For the past four years Geoff Shepherd kept in close touch with the Army and both Corps as a personal friend of many serving officers and in his employment with Defence Industry.

Geoff Shepherd was greatly loved and admired by all who had contact with him and his warm personality endeared him to all who served under him. Totally unselfish, his only thoughts were for others and for their welfare. Geoff Shepherd married Hilda May Glover in April 1942 and Geoff and "Jill" became inseparable companions and were greatly admired by all who knew them in the Service. Geoff also leaves behind a son, Peter, an officer in the Royal Hampshires, and a daughter, Julia, married to a Sapper officer, to continue the long and distinguished military tradition of the Shepherd family.

Both Corps and the Army will long remember him and we offer our deepest sympathy to Jill and her family.

HRD

# Correspondence

## THE JAMAICA RAILWAY DISASTER

Major R J Wade RCT, B Sc, FCIT
RMCS Shrivenham
Swindon
Wilts SN6 8LA

Sir,—Brigadier Langley's article in the June 1977 *Journal* reminds me of an amusing railway incident in 1958.

Colonel R G (Jacko) Jackson retired from the Transportation Directorate to become General Manager of the Jamaican Railways; soon, a signal arrived at Longmoor requesting a copy of our *Railway Operating Manual* (*MRE Part* 4, 1942) and a supply of train graph paper. He was obviously going to start work with a very clean sheet.

I suspect that Brigadier Langley was the pre-war author, or instigator, of that very serviceable manual.—Yours faithfully, R J Wade.

## 1937 PONTOON EQUIPMENT

Brigadier S A Stewart CBE MICE FI Struct E
Friday's Farm
Warninglid
Sussex

Sir,—Your excellent article in the September Journal on Wet Bridging in the 1940s has awoken many memories. I can well remember the accident shown in one of the photographs.

As you explain, the GS requirement for the new pontoon equipment underwent several changes as the Tank *v* A/T gun argument proceeded. Originally the bridge was for the 14-ton Vickers tank, but it had to be increased by stages, first to take the Covenanter, Crusader and Valentine group, and finally for the 26-ton Matilda. These changes involved frantic re-calculation and re-design, plus gnashing of teeth. The prototypes were actually under manufacture, and changes were not easy. The pontoons for instance, which were being made at Saunders-Roe, had to be lengthened by about 3ft and incorporate a revised steel framework. Delivery could not be stopped for the first six and trials had to be done with these, the set for troop trials having to be ordered straight off the drawing board. History has drawn a veil over these headaches, and forty years later it is pleasing to see that the changes seem to have been coped with easily.

The problem at EBE (Experimental Bridging Establishment) was to find suitable loads to test this new equipment since none of these tanks was in service, and the few prototypes that existed were certainly not available to us. An experimental 17-ton tank with sprung tracks had been made a year or two earlier, but production had been vetoed because of its cost. This was the apple of the eye of a Brigadier in Bulford whose name I cannot recall, and it was only by much personal pleading that he was persuaded to lend it to us. We had to explain that nothing could possibly happen to it. To our horror as soon as it reached the trestle on the way out to the floating part of the bridge, a foot-rope failed and one foot began to slide down the bank. This happened quite slowly and we thought it would never stop. However it finally did, just short of the tip-over point. Our big 45-ton World War I tank was shackled to its tail, and it was pulled back to safety, unmarked. There then arose the temptation not to tell the Brigadier, but after discussion we decided that this would be unethical. Besides the driver knew all about it! The Brigadier did finally forgive us, but said "never again".

You are quite right in saying that this incident caused a loss of faith in trestles for heavy loads. We did produce an extended trestle foot, but this was awkward to handle, and everyone breathed a sigh of relief when trestles were finally replaced, first by long landing bays and finally by the floating Bailey.

The 1937 pontoon equipment was quite a reasonable bridge as first conceived, but suffered by being stretched in design. The third pontoon in a raft was uneconomic, but had to be used for 26-ton loads which became the normal form of construction. It was fortunate indeed that we were able to use the expensive Mk V pontoons for the floating Bailey, so all was not lost.

One other memory might be of interest. Your article refers to the load classification system, but this was not adopted without a struggle. For many years every vehicle coming into the Army had to be assessed by EBE and classified into Light, Medium and Heavy. The results appeared in a table in a Military Engineering pamphlet. This was always several years out of date and there was no certainty anyway that all vehicles were included. Also "Heavy" was only eighteen tons—well behind the times. EBE had proposed a classification system on several occasions, but this had always been turned down by the GS because "vehicles already carried too many numbers". I remember that one of the arguments used by us was "surely it is more important for a vehicle to carry a sign showing what bridges it can cross, than one showing whether it has wheels or tracks". Anyhow it was finally adopted, and basically the same system is still in use today throughout NATO.

Your article mentions the high speed of development in those days. It is amazing how easy it is to get approval for things when war threatens.—Yours faithfully, S A Stewart (Superintendent EBE 1936–41)

# Book Reviews

## DESIGN OF STRUCTURAL STEELWORK

PETER KNOWLES

(Published by Surrey University Press. Price £5·75)

PETER KNOWLES served in the Corps from 1948–60 and many will remember him as a clear headed officer. He is now a lecturer in the Department of Civil Engineering at the University of Surrey. This book is exactly what one would expect of him; it explains the design methods and shows how the method is applied using simple calculation sheets; it is clearly and logically presented and is not heavy going.

Design is an open-ended subject in which there are no unique solutions. Some people have difficulty in accepting this fact. The book presents the essential design aspects of one structural material—steel. It will not make you into a designer—this takes years of experience—but you will be able to design competently and safely. The calculations are based on the current version of British Standard 449.

Although primarily aimed at the undergraduate/student the book will be more than useful to the more experienced engineer designing in an unfamiliar field or who is a little "rusty".

EEP

## GREAT STORIES OF THE VICTORIA CROSS

BRIGADIER THE RT HON SIR JOHN SMYTH Bt VC MC

(Published by Arthur Barker Ltd. 192 pp. Price £4·95)

WHEN Queen Victoria in 1856 instituted this greatest of all awards for gallantry in battle she expressed the wish that the new decoration, wrought from the metal of one particular Russian gun captured in the Crimea, should always be highly prized and eagerly sought after. Her object has certainly been achieved, and the fact that there have only been 1352 awards of the Victoria Cross, one to an American Unknown Soldier, during the last 123 years shows how sparingly it has been given. Only three bars to the Cross have been won; to Arthur Martin-Leake and Noel Godfrey Chevasse both of the RAMC, and to Charles Upham of the New Zealand Infantry. Almost without exception the common link of humility bind this gallant band of men together.

Sir John Smyth, the author of numerous books on military and other subjects, children's books and plays, with Ian Hay, is himself one of the most famous of all VCs, and is the greatest living authority on the Victoria Cross. He has attended every VC and GC Reunion since 1920, founded the Victoria Cross Association in 1956 and was Chairman of the subsequent Victoria Cross and George Cross Association for the first fifteen years of its life. On the death of Sir Winston Churchill he was elected Life President, and has included on the back cover of his book a delightful photograph of the Queen, Patron of the Association, who has graciously consented for it to be dedicated to her.

The author skilfully and concisely covers an immense ground, interweaving pearls of wisdom on strategy and tactics with vivid descriptions of many acts of valour. In a chapter on the *Model Battle of Hamel* in July 1918 he shows how tanks, artillery and infantry in one of the earliest surprise attacks "with a good dollop of Scotch Whisky and Rum" overcame all obstacles in a remarkably short time with very few casualties, setting the scene for the final victories of World War I. He also succeeds in defending and criticising Haig's decision to fight out the Somme to its costly conclusion, saying "in the final reckoning it could be argued that had it not been for the Somme the German Army might never have lost the war; conversely had it not been for the Somme the allied armies might have won it earlier."

The ribbon of the Victoria Cross was originally blue for the Navy and red for the Army, but the colour was made red for all services on 22 May 1920.

The author has selected thirty two great stories representing a balanced cross-section of history, some of them starring several holders of the award. They begin with the incredibly stupid but gallant "Charge of the Light Brigade" in 1854, after Lord Cardigan had been called from his luxury yacht, and progress through the horrible tales of the Indian Mutiny, the taking of the Chinese Taku Forts, the Zulu War where seven VCs were won by the South Wales Borderers at Rorke's Drift, to the greater and bloodier wars of the twentieth century.

In a small book, which the author admits cannot be comprehensive, and which deals with household names like Lord Roberts and his gallant son, the legendary deeds of Chard, Freyberg, Carton de Wiart, Gort and Leonard Cheshire, naturally many tales of valour have had to be omitted. But Jackie Smyth, a subaltern of the 15th Ludhiana Sikhs when he won his own VC during the early gas attacks of May 1915, gives pride of place to the eight VCs awarded to the Indian Army (five of them Indian sepoys and NCOs) who braved the first savage French winter. He also tells the story of three very brave RFC fighter pilots, one of them McCudden, once a Sapper boy, who accounted for fifty four enemy planes, the thrilling saga of the "Q Ships" crews, six heroic padres including a civilian of the Bengal Civil Service, the Battle of Jutland's almost forgotten midshipman, the unbelievable doggedness of HMS *Glowworm* off Norway in 1940, the repeated courage of Bomber pilots culminating in the meticulous planning and execution of the *three* dam-busting simultaneous raids on the Rhuhr. And many deeds from conventional and midget submarines fill two exciting chapters.

One therefore hopes that the author will produce a sequel. Sappers will find only four of their fifty two VCs mentioned, possibly because their individual feats don't easily fit into the narrative; but it would be fascinating to read of the extraordinary exploits of young Sapper officers who later rose to high British or Indian Army rank. Graham of the Crimea, Prendergast of the Indian Mutiny, Bell of Ashanti, Hart and Leach of Afghanistan immediately spring to mind, with Aylmer of Hunza Nagar in the Pamirs, Neame in the trenches of World War I and Bhagat Singh of the Royal Bombay Sappers and Miners during Wavell's conquest of Abyssinia.

One also misses the story of Captain Augustus Agar VC, DSO, an intrepid sailor and secret agent, whose exploits in the Baltic after the Russian Revolution earned him his Victoria Cross when, single-handed in a flimy coastal motor boat now preserved by the Imperial War Museum at Duxford in Cambridgeshire, he sank the Russian cruiser *Oleg*.

People of all races and ages will read this splendid book with pride, and "like Oliver Twist" in the author's words, ask for more.

DB

## PANZERTRAP

CHRISTOPHER WHITE

(Published by White Lion Publishers Ltd, 138 Park Lane, London. Price £3·75)

THIS is "the first novel in a tense, gripping series about the men who dared and died as Commandos in the dark years from Dunkirk to D-Day"; so reads the "blurb" on the dust cover of the Commandos Book I.

It is the story of a handful of men in a special Commando who are dropped into Nazi occupied Belgium, occupy a house which is in fact a radio station, use the radio to transmit fake orders and thereby reroute and trap a Panzer Division which is then annihilated by the RAF.

I read it and was entertained. I read it again as a reviewer and wished I had left well alone. It did not stand up to this treatment!

Like most "commercial" novels it does not have an individual style but is a mongrel cross of James Bond, The Dirty Dozen, Flint and many others one could name. It combines a staccato style with the over-elaborate. An example, dealing with an electrically initiated demolition with a broken cable: "He reached the wire, put the end of it in his mouth, bit into the plastic cover and pulled, baring an inch. The wire tasted bitter. . . . Ron squeezed the handle of the generator. Thirty thousand volts sped over the thin fragile signal cable. It ignited the detonator, the detonator fired the instantaneous fuse cord. The flame and shock ran down the separate strands of the fuse cord and into the detonator of each of the charges. There it fired the primer. The primer fired the main bulk of each explosive."

The novel rolls along at a good pace and there is little doubt that it is a good example of the mass appeal books which appear to be designed for train/plane journeys. Surprisingly it has less sex than one would expect but, be warned, it is overburdened with four letter words.

EEP

## MILITARY ENGINEERING VOLUME XIII—PART IX FIELD AND GEODETIC ASTRONOMY 1976

(Obtainable only from School of Military Survey, Hermitage, Newbury, Berks RG16 9TP. Price £11·73 including postage and packing)

A REVISED Part IX "Field and Geodetic Astronomy" has just been published. The author is Dr A R Robbins, B Sc, MA, D Phil, Reader in Surveying and Geodesy at Oxford University. It is a publication of considerable significance as, although it replaces both "Textbook of Field Astronomy 1958" by Lieut-Colonel C A Biddle, MA, FRICS and the interim Part IX published in 1969, it is designed to meet the needs of *any* surveyor required to make astronomical observations of latitude, longitude or azimuth (of any order) by standard practice. It also develops the theory on which the standard practice is based. The older graphical methods for the solution of the astronomical triangle have been discarded in favour of the use of the pair of stereographic nets supplied.

"Field and Geodetic Astronomy" joins a number of ME Volumes which have become standard works on their specific subjects and which are available to the general public. It should be on the bookshelves of every individual and organization working in this and related survey fields.

EEP

## BOOK NEWS FROM INSTITUTION OF CIVIL ENGINEERS

*All books in this section are published by Thomas Telford Ltd and are obtainable from the Marketing Dept, Thomas Telford Ltd, Telford House, PO Box 101, 26–34 Old Street, London EC1P 1JH*

### CIVIL ENGINEERING EDUCATION AND TRAINING 1976

*Price UK and Eire £4·00; overseas by air £5·00*

Proceedings of a Conference organized by Institution of Civil Engineers and held in Swansea on 23/24 September 1976

Radical changes have recently been made in the education and training of civil engineers and technicians. This conference proceeding represents an up to date survey of the methods and principles based on the Chilver Report now being implemented in Britain, together with some comparisons of Continental methods. The conference brought together many of those concerned with the education of engineers from University, through post-graduate professional training and on into continuing career development.

The twenty two papers are grouped under three heads: "The British and European systems of professional education"; "Technician Engineer and Chartered Engineer"; "Implementation of the Chilver Report" and all the discussions are well reported.

### A REVIEW OF DIAPHRAGM WALLS

*Price UK and Eire £5·00; overseas by air £7·00*

Proceedings of a Seminar organised by the Institution of Civil Engineers and sponsored by the Piling Group and held in London 9/10 September 1976

The papers and discussion published in this book are based on an earlier conference "Diaphragm Walls and Anchorages" held in 1975 when it was agreed that further information and explanation concerning the techniques in current use in this rapidly developing field were badly needed.

In this volume the fruits of the most recent technical developments on design and installation are presented together with invaluable reports of practical experience. This and the earlier volume are essential reading for the engineer who wishes to keep himself abreast of advances in these increasingly useful techniques.

As this seminar was based on the earlier conference a special price is offered to those who also wish to purchase a copy of the first conference proceedings; "Diaphragm Walls and Anchorages 1975". (Normal UK selling price £16·00; overseas £19·00). Both books together, UK £17·50; overseas by air £22·50.

### SURFACE MODELLING BY COMPUTER

*Price UK and Eire £3·50; overseas by air £5·00*

Proceedings of a Conference sponsored jointly by The Royal Institution of Chartered Surveyors and the Institution of Civil Engineers and held in London 6 October 1976.

A surface model is the mathematical representation of a surface in such a form that it can be used in design calculations. The use has increased in parallel with the development of computers and computer programmes which can make rapid calculations and process large amounts of data such as would be impracticable manually.

The book covers the technique of data collection in land surveying, consideration of accuracy when processing data, hydrographic and geological applications, civil engineering and building industry applications, a state of the art review and the equipment and programmes available.

### MEASUREMENT IN CONTRACT CONTROL

*Price UK and Eire £7·00; overseas by air £9·00*

### EXAMPLES OF THE CESMM

*Price UK and Eire £1·75; overseas by air £2·50*

*both by* MARTIN BARNES B SC (ENG), PhD, C ENG, MBCS, MICE

THESE two books are probably the most important to appear this year from the Institution of Civil Engineers. They are written by Martin Barnes who was the chief architect of the new edition of the *Civil Engineering Standard Method of Measurement* (*CESMM*). This caused major changes in the principles and techniques of measurement.

*Measurement in Contract Control* is intended as the standard work on the use of CESMM and will be invaluable to experienced engineers using the CESMM for the first time as well as for students, young engineers and surveyors. The book follows the form of the CESMM itself and gives detailed explanations of how each section should be used. Examples of bills of quantities compiled using the CESMM are presented and the rules for measurement in each of the twenty-four classes of work are discussed. Descriptions of Method-Related Changes, classification, coding of items, the format of bills of quantities, the close relationship of the CESMM to the ICE Conditions of Contract, the rules of measurement, all backed up by some very useful diagrams bring the subject to life. The book is intended as a permanent reference tool for the professional and student alike.

*Examples of the CESMM* is an extract from the fuller text reviewed above. The booklet is intended as a practical working guide to the use of CESMM and contains all the examples in its sister publication.

One might ask why the two books? I would suggest they should be likened to the ME Volumes and RESPBs, the book deals with why and how and the booklet with how.

No engineer who deals, or is likely to deal, with construction at a professional level can be without one or the other; unless he be an expert, and in constant practice, the larger book must get my vote.

### CONCRETE AFLOAT

*Price UK and Eire £10·00; overseas by air £13·00*

Proceedings of a Conference "Concrete Ships and Floating Structures 1977", organized by The Concrete Society in association with The Royal Institution of Naval Architects and held in London 3–4 March 1977.

In 1848 and 1849 Joseph Louis Lambut, a French horticulturist built two small rowing boats by plastering a sand/cement mortar over a framework of iron bars and mesh. Both boats have survived. From this small beginning concrete structures in excess of 250,000 tons have been subjected to long deep-sea tows.

There is still a lack of authorative information on many of the aspects of present day construction, operation and maintenance of prestressed concrete hulls. Leading authorities throughout the world presented this information for the benefit of all concerned with design, construction, quality control, classification, economics, operation and maintenance of ships and other large floating structures.

This well illustrated book presents the papers and the discussion.

### DESIGN AND CONSTRUCTION OF OFFSHORE STRUCTURES

*Price UK and Eire £16·00; overseas by air £19·00*

Proceedings of a Conference jointly sponsored by the Institution of Civil Engineers, The Institution of Structural Engineers and the Society for Underwater Technology and held in London 27/28 October 1976.

Development of offshire oil resources really got under way in the early 1970's. As the end of the decade approaches there is a need for consolidation and assessment of the various solutions which have been used to bridge the gap between the oil source and the sea surface. The longer term problems also require study. How will concrete behave after long periods at great depth? How are such huge structures to be maintained over what may be a thirty year life? What are the potential failure factors and how can these be avoided? These and other problems are dealt with in the papers and discussions recorded in this volume which summarises the most up to date information available on this vital subject. The North Sea has posed these problems in their most acute form and the solutions produced are already proving of wider application. Work in the Arabian Gulf, off the coast of Africa and in other areas is also considered.

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