THE SCEM 66 WATER CONTROL SYSTEM

BY

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Introduction

The uncontrolled flow or leaking of water into underground excavation or through dam walls, foundations and the like, can be one of the most annoying and difficult problems faced by engineers and operators. Once aquifers have been exposed by excavation it is generally impossible to effectively control or seal water flows through the use of conventional grouting methods and materials.

The *SCEM 66* water control system offers a solution to most of these problems.

Grouting Materials

Grouting may be defined as the injection of fluids, with or without fillers, into a matrix such as concrete, rock or soil to fill the voids. Grouting materials may be broadly classified according to the size of the contained solids as indicated in Table I.

TABLE I

Mean Particle Size	10^{-3}	10^{-7}	10^{-9}	10^{-11}
Type of Solids	Particle	Colloids	Molecules	Atoms
Grout Materials	Sand	Latex		
	Cement		Silicates	
		Microsilica		Acrylics
Grout Types	Particulate Grouts	Emulsion Grouts		Chemical Grouts

Grout Types

(1) Particulate grouts contain solids which when mixed with water do not dissolve but form a suspension. The water acts as a carrier to transport the solid particles into the matrix where the solids drop out of suspension to fill the voids. Due to the size of the particles, penetration into the matrix can be limited by the size of the fractures or orifice through which it has to pass.

(2) Emulsion grouts contain solids or liquids which do not dissolve but have been dispersed in water in the form of minute colloidal particles or droplets to form a suspensoid sol or an emulsoid sol respectively. These sols are stable under certain conditions, but when activated become unstable whereupon the dispersed phase rapidly coagulates. The emulsion may be injected in different formulations and when activated will coagulate and block any voids or flow paths.

(3) Chemical grouts contain solids or liquids which dissolve in water to form true solutions. These solutions are injected and react to form a continuous hydrogel which fills the voids.

SCEM 66

SCEM 66 can be classified as an emulsion grout. It is a patented blend of latex emulsions mixed with additives to promote flow and adhesion. The emulsion is stable until activated. It then breaks, and the colloidally dispersed rubber coagulates to form a jelly-like mass of matted rubber particles.

It contains no toxic or hazardous materials other than ammonia solution, which is present as a preservative.

The activation of *SCEM 66* emulsion may be achieved in three ways:

(i) Agitation
If *SCEM 66* emulsion flows through a small orifice or narrow fissure, the high shear action causes the colloidally dispersed rubber particles to flocculate. These rubber flocs then start to adhere to the side walls of the orifice or fissure. Continued agitation causes additional flocs to form, which in turn adhere to the now rapidly coagulating mass of rubber particles, which builds up to clog the orifice or fissure until flow ceases. The rate of coagulation can be delayed by the addition of an inhibitor.

(ii) <u>Chemical Activation</u>

If *SCEM 66* emulsion is treated with a chemical activator, the emulsion becomes unstable and then coagulates to form a jelly-like plug of matted rubber laths.

(iii) <u>Exposure to Atmosphere</u>

If *SCEM 66* emulsion is exposed to atmosphere for any length of time it will dehydrate from the surface and form a thin skin of very fine interlocking rubber laths.

Effect of Pressure

When first formed from the activated emulsion, the jelly-like plug of matted rubber laths holds a lot of water. As pressure is applied, much of this water is expelled, the rubber laths adhere to each other, and a denser, less compressible but more flexible rubber plug is formed. This consolidation of the coagulated *SCEM 66* is evidenced by a tendency of the seal to weep for a short while when first formed, this weeping soon stops to leave an impenetrable seal.

Because of the flexibility of the rubber plug, the build up of water pressure behind the plug forces the plug tighter into the orifice or fissure thereby improving the sealing effect.

SCEM 66 remains flexible and will therefore remain effective even when ground movement occurs, unlike other types of grout that react to set hard and may crack during ground movement and allow leakage to resume.

Method of Injection

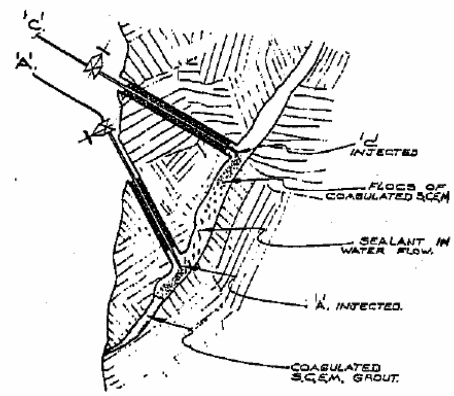
SCEM 66 is injected into the water flowing in a crack or fissure via a hole drilled to intersect the crack or fissure for this purpose. A multi-port packer is inserted into the hole through which the *SCEM 66* is injected. As the emulsion flows with the water along the crack or fissure it will be activated by the turbulent agitation it encounters, and a steady build up of the coagulated rubber laths will occur which then form a seal. If the flow conditions dictate, then a chemical activator can be injected, either downstream from the *SCEM 66* injection point, or at the same injection point through a different port in the multi-port packer (Figures 1 and 2).

Generally, in situations where the water make is low, *SCEM 66* will be sufficiently activated by agitation alone to seal the leaks. In high flow situations, chemical activation may be required.

Whereas the addition of activator results in *SCEM 66* becoming unstable, followed by rapid coagulation, the addition of an inhibitor increases the stability, thereby reducing its tendency to coagulate when subjected to agitation. This enables the emulsion to be transported for greater distances through the formation before coagulating.

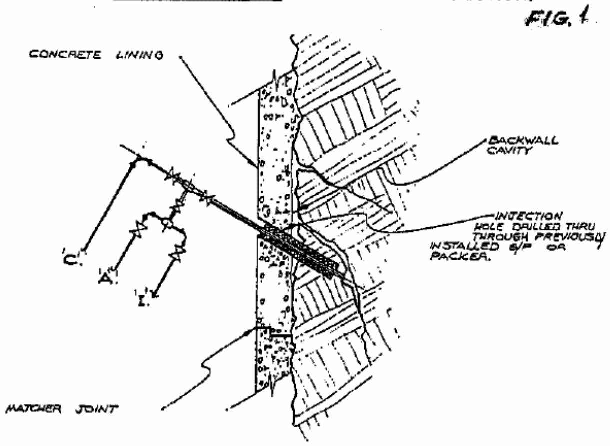
Because *SCEM 66* becomes unstable when agitated, conventional high pressure pumps cannot be used for injection. A special passive displacement pump was designed for injection of *SCEM 66*. Injection pressures can be adjusted to suit the various requirements. For applications where injection pressure limits are critical, safety relief valves are set to the required relief pressure, together with a rupture disc which is set to relieve pressure if predetermined maximum injection pressures are exceeded.

The activator and inhibitor are both true solutions and can be injected through conventional high pressure pumps.



INJECTION POINT —TWIN-POINT INJECTION.

FIG. 1



INJECTION POINT SINGLE POINT INJECTION.

FIG. 2.

Formulation of *SCEM 66*

The reaction of *SCEM 66* with water depends on the characteristics of the water, such as pH, salinity, mineral content, temperature etc. The formulation of *SCEM 66* can be varied to achieve the desired reaction with the specific water being treated. It is therefore essential to carry out tests with water from the area to be treated prior to finalizing the formulation.

The rate of water flow also influences the selection of the appropriate formulation of *SCEM 66*. High flows through large fractures require rapid response to activation, whilst fine fissures or cracks require more stability to achieve better penetration into the aquifer or crack before coagulation.

Cost of *SCEM 66* Water Control System

Like any superior system, *SCEM 66* grout treatment is not cheap. However, the system is no doubt cost effective. The cost compares favourably with the cost of sealing with cement. The differences are that *SCEM 66* requires much less time and that much finer passages can be penetrated and sealed.

The positive sealing effect of *SCEM 66* makes it possible for experienced personnel to predict the likely success that can be achieved after careful inspection and evaluation of each water make problem. Contracts for water sealing can therefore be negotiated based on the success rate achieved.

Precautions

As *SCEM 66* is not toxic or hazardous, other than the less than 0.5% W/W ammonia solution which is present as a preservative, there are a few precautions that need to be observed:

- Ensure area is well ventilated
- *SCEM 66* will adhere to skin and hair when it coagulates, so gloves and protective clothing should be worn.
- Prevent spills or leakages of *SCEM 66* from entering water pumping systems as the coagulated rubber may soon block or bind pumps.
- Prevent spills or leakages from entering drainage pipes as coagulated rubber could block these.

Licensing Arrangements

Currently, the following companies have been licensed to use the patented system:

- United Kingdom – Cementation Mining Limited
- Republic of South Africa – Sovereign Water Control Pty Ltd
- Australia – Sovereign Water Control Australia Pty Ltd

Brief case histories from these countries are given below:

United Kingdom

A. Monktonhall Colliery – Scotland

Monktonhall Colliery is located in the northern part of the Lothians coalfield, which consists of a large synclinal basin, about 8km south-east of the city of Edinburgh. The colliery came into production in 1964.

Situated in the heart of the oldest mining district in Scotland, mining operations of one sort or another have been undertaken in this locality since the beginning of the thirteenth century. Consequently, the productive coal measure seams occupying the area around Monktonhall Colliery are now exhausted in the landward area. A complicated interconnected network of old workings exist in this area. Water levels within these workings were controlled by pumping from several locations within the basin, the last of which ceased pumping in 1979. These now abandoned collieries pumped an estimated total of 15,230 litres/min to control the water entering the workings.

The abandonment of pumping has resulted in the flooding of the old workings and a progressive rise in ground water levels throughout the basin resulting in increased water leakage into remaining operating collieries.

Monktonhall is serviced by two shafts. After November 1975 there was a steady increase in water entering both shafts above the 1400ft pump station. By late 1982 water inflows were such that a programme of remedial measures was undertaken.

A series of relief holes were drilled through the shaft linings before a total of 64.60 tons of cement were injected behind No 1 shaft walls and 59.05 tons behind No 2 Shaft walls.

Within a year a substantial increase in the water flow, mainly from the relief holes, was experienced in No 2 Shaft. A further 6 month cement grouting programme resulted in reduction of inflows from 2500 litres/min to 545 litres/min. Much of this residual leakage was through passages too fine to be sealed by grouting with cement.

By 1986 the problem was considered serious as the water inflows were causing disruption to colliery operation. British coal and a consulting group carried out studies to determine the best solution to the problem. After considering all available options they concluded that *SCEM 66* offered the most cost effective solution.

The water make in No 1 Shaft had risen to 2730 litres/min by early 1988, and was therefore treated first. The *SCEM 66* grout treatment started on 7 June 1988, on which date the water make from the shaft interval 0-1015ft was 2880 litres/min. By 21 July 1988 the water make over the same shaft interval had been reduced to 104 litres/min. A total of 180 holes had been drilled out and injected, using a total of 15,000 litres of *SCEM 66* to reduce water inflow by 96%.

Following the successful sealing of No 1 Shaft it was decided to seal No 2 Shaft as well. Work started on 29 August at which time the inflow in the shaft interval 0 to 986ft was 785 litres/min. After injection of 16,500 litres of NOH20 through 234 holes, this watermake was reduced to 110 litres/min by 13 October 1988. Additional work was undertaken in the area 1000 to 1400ft where inflows were reduced from 188 litres/min to 47 litres/min.

Costs and Benefits

Cementation Mining Limited were able to offer a guarantee on the projected results in the form of reduction in price if their target reduction in water inflow was not achieved. The contract provided for a lump sum price to reduce the quantity of water to 450 litres/min in the relevant part of the shaft. In the event progress established that the water flow could be reduced considerably below 450 litres/min. Negotiations with the contractor resulted in a rate being agreed for every litre per minute achieved below 450 litres/min target.

Savings were achieved from reduced pump operating time, reduced maintenance requirements, less operating time for water treatment plant and an improved operating environment of the shaft system.

The *SCEM 66* system proved highly successful where conventional methods could not succeed.

Dartford Tunnel (East) – England

The M25 London Orbital Motorway currently passes underneath the River Thames via the two twin-lane Dartford Tunnels, southbound M25 traffic flowing through the Dartford Tunnel (East) and northbound through the Dartford Tunnel (West).

The Dartford Tunnel (East), the later of the two tunnels to be constructed, has been leaking small quantities (less than 5 litres/min) of the water at a number of different locations which together with one isolated leak of 80 litres/min amounted to a total tunnel water make of 350 litres/min. The tunnel operators, Dartford River Crossing Ltd, arranged to close the tunnel from 9.00 pm to 5.00 am to permit access through the road deck to the tunnel invert for the *SCEM 66* grouting team to treat a trial 100m section of the 1400m long tunnel.

The *SCEM 66* grouting works commenced at the 80 litres/min ingress which had not been sealed despite four previous attempts by other contractors. A series of 3 No. 25mm diameter x 100mm deep holes were drilled into the segmental concrete tunnel lining and then each drilled on at 19mm diameter through the lining and into the surrounding strata. Each hole intersected ground water with inflows of around 45 – 60 litres/min prior to the installation of ¼" n.b. mechanical packers. The outer two holes were then injected with *SCEM 66* which rapidly connected with the water inflowing from the leakage zone. The inner hole was then injected with *SCEM 66* "Activator". The leakage rate started to reduce within minutes, and within 20 minutes of first injecting *SCEM 66*, the leak was sealed.

The remaining leaks along the 100m trial section of the tunnel were treated with a total of 22 separate injections. It was frequently noted that after sealing a leak close to the point of injection, the *SCEM 66* could be seen in ground water trickling in from various other leaks up to 5 metres away. Each of these leakages would seal off in turn and the injection cease. After six shifts of *SCEM 66* grouting all the leaks over the 100m trial section had been sealed, and the total tunnel inflow had reduced from 350 litres/min to 125 litres/min, a reduction of over 64%.

Aldersgate Car Park (London)

A 1m thick x 30m diaphragm wall, recently sunk by Cementation Piling and Foundations during the construction of a 14 level underground car park at Aldersgate in the City of London, showed a number of areas where a small amount of water was leaking through joints between the panels of the wall. The leaks ranged from at worst "a drip per minute" to "beads of water on damp concrete" and though small, still required sealing.

Cement grouting would probably not be sufficiently penetrating to treat the fine leakage paths concerned, and would present a problem with control of grout spillage and washings in a partially completed car park. The *SCEM 66* grout is penetrating and has the great advantage that grout spillages can be rapidly coagulated to solid rubber and then swept up for easy disposal.

The Cementation Mining *SCEM 66* team successfully applied the *SCEM 66* grout treatment to several of these leaks – the drips stopped dripping and the damp patches started to dry out.

The *SCEM 66* emulsion is reasonably stable, and it will remain in the fluid state as injected behind the diaphragm wall. It is anticipated that further sealing will occur as this *SCEM 66* slowly percolates through the existing minute leakage paths and is coagulated by the combined effects of turbulence and changes in chemical environment.

British Coal Whitemoor Mine - England

During a period of several weeks, the Whitemoor No 2 shaft at the British Coal Selby Mine complex experienced an increase in shaft water make from around 90 litres/min to over 410 litres/min.

The Cementation Mining SCEM 66 grouting team was called in and successfully sealed the source of this major increase in water flow. It proved to come from a corroded valve fitting at the 150m level which was attached to a hole drilled through the concrete shaft lining during the construction phase.

Sealing this leak allowed the corroded fitting to be replaced and the hole through the lining to be sealed with a *SCEM 66* rubber plug. Leaks at several other levels were also treated, and the total shaft inflow was reduced to 10 - 15 litres/min.

Australia

A. No 5 Ventilation shaft – Broken Hill, New South Wales

Lead, zinc and silver has been mined continuously around Broken Hill for more than 100 years. A programme of modernisation of the Pasminco Mines required the construction of a new 6.0 metre diameter upcast ventilation shaft.

Assessment of the hydrogeological regime of the area where the shaft was being constructed, indicated that water flows of up to 700 litres/min could be expected to flow into the 1.8m diameter raise bore hole which would serve as a pilot hole for shaft construction. When this pilot hole was enlarged to 6.5 metres diameter, the volume of water would substantially increase. This situation would not only overload the mine pumping system but would reduce the efficiency of the ventilation fans and cause an unwanted spray of water around the shaft area which would adversely affect re-vegetation of the tailings dam area and could cause problems with nearby overhead power lines.

Before the pilot hole was drilled, a grouting programme was carried out to a depth of 120 metres. Three concentric rings of holes were drilled up to a 9 metre radius around the shaft centre, and a total of 126 tons of cement injected. When the 1.8 metre diameter pilot hole was completed, a water make of 300 litres/min was measured at the bottom. Enlarging this pilot hole to 6.5 metres would also increase the water flow. A decision was therefore made to embark on a programme on in-shaft grouting using the *SCEM 66* system. During reaming of the pilot hole to 6.5m diameter the combined flow from various areas down to 200 metres in the shaft was measured at 850 litres/min.

This flow was successfully reduced to 15 litres/min by drilling holes into the aquifers from the sinking stage, followed by injection of *SCEM 66*. Holes were also drilled through the concrete lining to seal residual leaks behind the lining.

Problems were experienced in obtaining connections to the aquifer zone from holes drilled at some levels. The injection of cement would have sealed the larger aquifers and even re-directed water flows which made it difficult to determine the trend of the water flow.

B Raise Bore Holes – Broken Hill

Two 2.4 metre diameter raise bore holes were drilled from surface down to 5 level, 220 metre deep. The first of these is being used to transport road base material underground. Therefore the water make of 60 litres/min into the hole was a nuisance. This flow was successfully reduced to less than 5 litres/min by use of *SCEM 66* injected through holes drilled into the aquifers from within the borehole.

The second 2.4m diameter hole is used as a ventilation supply for the service decline system and the 120 litres/min water make caused problems with the roadway in the decline. This flow was reduced to less than 20 litres/min by the injection of *SCEM 66* into the aquifer zone.

No other system could seal exposed aquifers as effectively and as quickly as *SCEM 66*, it is doubtful that any other method could even reduce the leakage under these circumstances.

SOUTH AFRICA

A Water Sealing at Northam Platinum Mine

Northam Platinum Mine is situated down-dip of the Amandelbult section of Rustenburg Platinum Mine. The mine is situated on the north-western limb of the Bushveld Complex. The sinking of a twin shaft complex commenced during

June 1987. The initial prospect holes did not indicate the presence of water bearing fissures at depth, although numerous holes intersected water associated with the perched water table. As a precautionary measure, the shafts were sunk using a 45m – 7 hole cover round and all development and station brows cut as part of the sinking program were covered for water and gas using double sided cover. All cover holes were grouted with cement on completion and in general the grout acceptance was relatively low (4.0 tons per hole).

During November 1988 the sinking crew at No 1 Shaft reported intersecting water in a pilot hole at 4 level (depth 1483m BC). Attempts to pump grout via a telescopic pipe proved fruitless. The drilling of additional cover holes in the area enabled geologists to create a model of where the water was coming from. These additional water holes, together with the grouting programme, fractured the surrounding rock so that, what was once an intersection in a pilot hole had now become a general breakout through numerous fractures in the face and sidewall (Figure 3). The water quantities increased to approximately 850 litres/min which should be compared to a bailing capacity for the sinking shaft of 1,700 litres/min.

The geological model indicated that the water was associated with a near vertical fracture zone approximately 1m in cross-section. The fracture zone consisted of some 5 to 6 fractures and diamond drill core indicated the presence of calcite within the fractures. The primary source of water feeding into the fractures has not as yet been determined. However, carbon dating indicated that the initial flow was “fossil water” and the subsequent flow graded to more recent water. This showed that the water was being replenished and the prospects of draining the system in the short term were bleak. An aggravating factor was the high temperature of the water (+ 55°C) some 2°C higher than the Virgin Rock Temperature in the area, suggesting that water was coming from below the workings.

Goldfields Cementation Co were called on to assist with the sealing operation and it was decided that the best method would be to relieve the pressure on the face by means of a number of relief holes drilled into the fracture. A seal on the face would then be attempted using conventional grouting techniques. Once the seal on the face had been established, the relief holes would be pumped at low pressure and the face seal consolidated. This cycle of operations was attempted over and over again, but a satisfactory seal was never achieved.

It became evident that the high static water pressure (17mPa) and the relatively weak tensile strength of the rock (14mPa), coupled with the proximity of the fracture to the face, would simply break open any seal.

It was decided that the ground immediately around the break out was too fractured and that a more remote seal, which would seal the water closer to it's source, should be attempted. To this end the fracture zone was sealed near the shaft and the development pushed through to point A (Figure 4). From this position numerous holes were drilled into the fracture $\pm$15m and deeper into the footwall of the break out. Attempts to create a remote seal proved partially successful in that the water was eventually channelled into a zone approximately 15m long (on plan). The velocities within this zone were simply too high for an effective grout seal.

In the second week of January 1989 it was recognized that although the water had been channelled into a relatively small zone on the fracture plane using conventional grouting practice, further progress would require the use of some new technique.

The services of Sovereign Water Control, a company specializing in *SCEM 66* grouting chemicals were requested.

The *SCEM 66* emulsion cannot be injected using conventional ram-type positive displacement pumps because the turbulence generated within the valve boxes causes the *SCEM 66* to coagulate and rapidly block the pump. It was decided that a gravity feed via the 25mm grout columns located in both No 1 and No 2 Shaft would suffice.

It was realized that for this sealing system to work we would require three holes into the fracture:

Hole 1 would intersect the fracture approximately 15m in the footwall of the face.

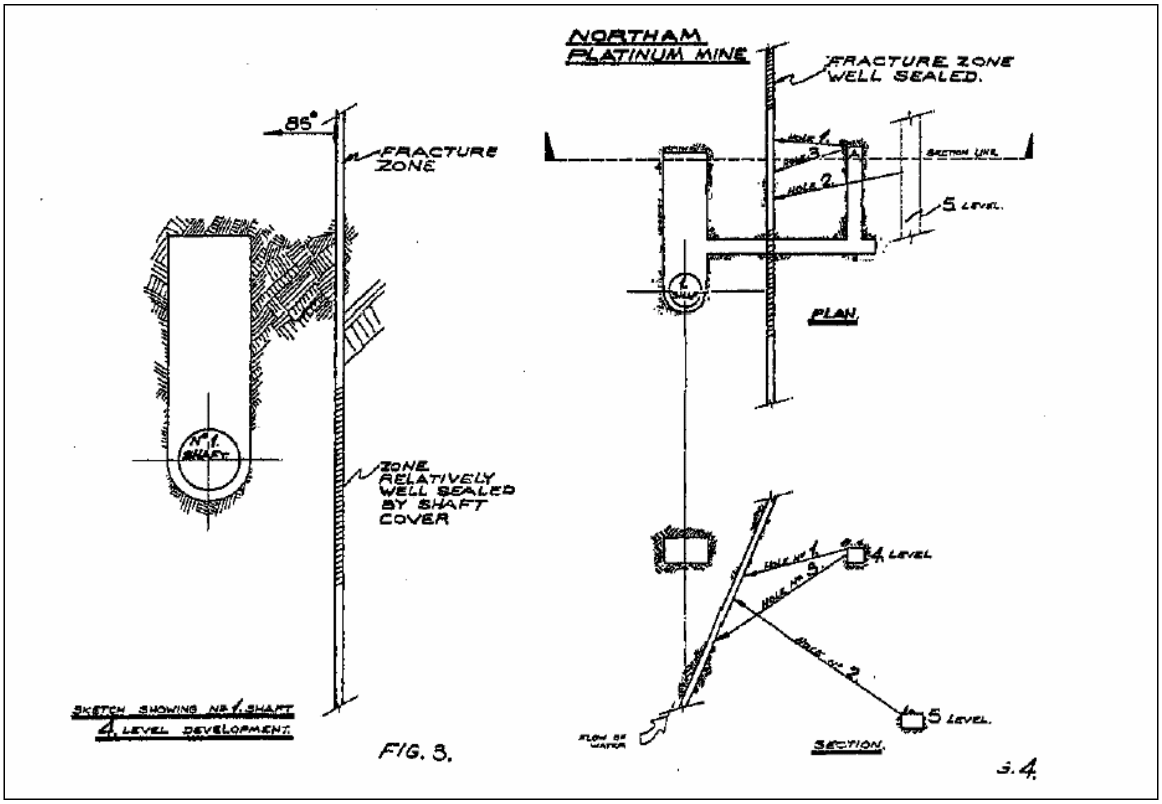
Hole 2 would intersect the fracture upstream of Hole 1.

Hole 3 would intersect the fracture upstream of both holes.

The sealing method required that *SCEM 66* be injected into Hole 1 until it reported to the face. Once the *SCEM 66* starts reporting to the face, activator would be injected into Hole 2 and the water would carry the activator to the *SCEM 66* causing coagulation within the fractures.

The holes were drilled as required and dye was used to confirm their relative positions in the stream of water. The dye was also used to ensure that all holes coupled to each other.

The sealing operation was achieved in a single 8 hour shift.



B Vaal Reefs No 9 Shaft

This shaft was sunk through 236m of Tranvaal water-bearing dolomite formation. No pre-cementation was undertaken from surface. Cover drilling and cement grouting from the shaft bottom during sinking did not achieve a dry shaft.

The rate of inflow from the dolomite formation when the shaft was nearing completion was 155 litres/min.

An in-shaft grouting programme from the sinking stage using *SCEM 66* reduced the water inflow to 17 litres/min, an improvement of 89%.

More time spent on grouting would have achieved further reduction, but would have caused unacceptable delays to the equipping programme.

C President Brand No 5 Shaft

The volume of water make in the shaft was affecting shaft sinking progress to such an extent that sinking was suspended for a period of 40 shifts. A *SCEM 66* grouting programme commenced from surface down to 1250m depth. Most of the water was sealed and a particularly bad zone of sandstone at 400m depth was contained, enabling shaft sinking to resume.

D Blyvooruitzicht Gold Mine – Fan Chamber

As part of a programme to improve the ventilation, Blyvooruitzicht Gold Mine established a fan chamber on 6 level. The roof of this excavation was supported by 12m long “Copi” ropes grouted into holes in the roof. Water was entering the chamber through some of these holes and also from random fractures present in the surrounding rock.

A cover of fiberglass sheeting had been constructed to protect the fan and electrical equipment already installed in the chamber. This had to be removed to provide access to the roof and the equipment already in place was shrouded with plastic sheeting. A scaffold to work from was erected and holes were drilled to intersect the Copi rope supports at between one and two metres above the hanging wall. These holes were injected with *SCEM 66* and the water access channels were sealed off.

The operation was carried out systematically until all the obvious leaks were sealed. Work then commenced on the fractures, particularly those on the side walls. Holes were drilled to intersect the fissures at between 1.5 and 2m beyond the excavation. The *SCEM 66* injected into these fractures coagulated and blocked off each void ensuring that no further water could flow through.

Once all the obvious leaks had been sealed, the whole area was sprayed with a resin based gunite that included strands of fiberglass to increase the strength. After guniting, some small leaks were apparent and each one was drilled and sealed until no further leaks were present.

E Durban Roodepoort Deep Gold Mine – Underground Dam

A leaking dam on 42 level at No 5 Shaft was sealed using *SCEM 66*.

The method employed was one in which the dam was flooded with water into which *SCEM 66* sealant had been added to form an emulsion. The movement of water and chemical through the leaks caused the sealant to coagulate in these leaks and plug them.

At the end of the operation, the dam was filled and allowed to stand for 36 hours, a drop in water level of only 4cm was noted.

A short while after the successful sealing of the dam leaking recurred. On draining the dam, it was found that the area had been subjected to a rock burst and two metres of the central portion of the dam had collapsed. Cracks had formed between the concrete inner lining and the rock wall. Previously sealed cracks had opened, to the extent that stringers of rubber were stretched up to 5mm between the two sides of a crack.

Repairs were carried out by injecting *SCEM 66* into all the newly formed openings. Holes some 2m long were drilled into the area surrounding the dam wall and *SCEM 66* was injected into these with the object of sealing all the fractures that could possibly leak water out of the dam.

The dam was then refilled with water and again allowed to stand for 36 hours. The drop in water level was minimal and the dam was returned to use

F Dewatering of the Intake Hoppers at Odendaalsrust Grain Silo

It was the beginning of the wheat harvesting season in the Orange Free State but the intake hoppers at the Odendaalsrust silo were filled with water which had percolated through the concrete lining from the surrounding countryside.

The chain conveyors and steel framework were removed by staff from the Sentrale West Co-op, the silo managers, and a *SCEM 66* grouting programme was commenced.

Each of the four hoppers were 11m long and 2m wide at the top. The sides taper down to 6m by 0.5m, 2 metres below surface, with a trough at the base in which the conveyor operates. The chain conveyors were covered in water and had they been used, a great deal of wheat passing along them would have become wet. This water was running out of the hoppers at the outlet end and into a drain in the conveyor tunnel that lies below the silos themselves.

Sealing was carried out by drilling through the hoppers concrete lining and into the underlying ground. After a hole was drilled a hydraulic injector was placed into the hole and *SCEM 66* was injected into the formation through the hole. The *SCEM 66* emulsified in water and the ground water carried it into the leak areas. Once in the leak area, the *SCEM 66* is activated and a rubber plug formed within a leak and flow ceases.

SCEM 66 was injected at as low a pressure possible to ensure that the concrete would not be damaged. Generally, the seal formed under low pressure conditions requires time before the leak area becomes dry but in the case of these hoppers, the drying effect was almost immediate which is in all probability due to the pressure of the ground water itself. This was reasonably high because although the hoppers are not more than 3m deep, water spurted some 20cm into the air from one of the holes. A flow of this nature would certainly force the chemical back into the concrete and create a very good seal.

The operation was completed within 5 working days and after the steelwork had been replaced, the farmers were able to deliver their wheat.

G Multi-Story Building – Leaking Down pipes

The drain pipes from a multi-story building in Durban were cast into the vertical concrete columns. When the pipes corroded it allowed water to enter the concrete structure causing corrosion to reinforcing.

The bottom outlet was blocked off and the column was filled with *SCEM 66*. The column was then pressurized to force the *SCEM 66* into the cracks in the concrete structure. When pressure was static for an hour the plug was removed and the *SCEM 66* was drained out. The same procedure was followed with the other downpipes

H Cable Conduit in Tunnel Walls

Steel conduits for electric cables were cast into tunnel walls. After some years, ground water percolated through the concrete and corroded holes into the conduit, allowing water to flow through. One end was plugged and *SCEM 66* was injected into the conduit and pressurized for an hour to force our product into the cracks in the concrete. The *SCEM 66* was then drained from the conduit. All water leakage was stopped.

Conclusions

- These case histories represent only a small example of the many works that have been carried out in the United Kingdom, Australia and South Africa since the *SCEM 66* system was introduced in April 1979.
- The application of the system applies to a wide range of water flow problems as can be seen from the case histories.
- There is no doubt that this is a superior system which has proved time and time again that success can be achieved when other methods have failed.
- Although the cost may initially seem high, proper analysis and results proved that the system is cost effective.

References:

"Monktonhall Colliery – Control of Shaft Water" By D Seath and C A Pollard, "The Mining Engineer" Vol 150 July 1990 pp 34-38.