fs. INIS-mf--5235 AU7904056

THE RECOMMISSIONING OF THE TREATMENT PLANT AT MARY KATHLEEN URANIUM LTD.

By

J. THOMAS[1]

ABSTRACT

The recommissioning of the plant at Mary Kathleen involved several distinct phases.

The previous plant process was modified significantly, the plant capacity was increased by the addition of new equipment and the existing equipment was in most cases overhauled. This equipment was either reused in its original duty or relocated.

Maintenance requirements after the plant was cmommissioned were high because of the amount of modified equipment and also because some old items of equipment were deliberately not overhauled during recommissioning.

The equipment that was overhauled has operated reliably. However some new equipment has not been as satisfactory.

INTRODUCTION

The Mary Kathleen mine was first discovered in July 1954 by a group of prospectors led by Mr Norm McConnachie and Mr Clem Walton.

Exploration work followed by metallurgical testing and then detailed plant design followed quickly with production beginning in mid 1958.

The plant operated for five years, finally shutting down in October 1963, when the sale contract with the United Kingdom Atomic Energy Authority (UKAEA) was completed.

The plant lay dormant on a care and maintenance basis until the decision was taken in late 1974 to recommission the plant and restart production, which began in January 1976.

PREVIOUS OPERATION

Shutdown

When the management of the initial operation realised that no further contracts could be successfully negotiated and the decision was taken to shutdown, a number of tasks were carried out to help with the expected restarting of the plant. In some parts of the plant however, the equipment was run flat out and maintenance work eased off as the final six months of the operation approached.

Crushing Plant

It was very evident that the crushing plant was worked hard during the last few months of the previous operation. The chutes in the sorting area were badly damaged and both crushers needed to be relined. Some mechanical damage was also evident in the crusher internals. Conveyor belts were removed, rolled up, and stored underneath the thickeners on hangers. Their condition was in general reasonable, although significant sections of belt were perished requiring replacement.

Wet Plant

The wet end of the plant beginning at the grinding section was generally cleaned right out of all pump and liquor, except for the thickeners in the washing circuit, which are left with beds of ground and leached ore.

1. Assistant Superintendent - Treatment Plant
Mary Kathleen Uranium Ltd
Mary Kathleen, Qld.

All rubber lined vessels which included the eight leach vessels, the wash thickeners and numerous storage vessels in the ion exchange circuit were kept full with water. This practise was generally successful and rubber repairs were minimal.

Acid Plant

Whenever acid plants are allowed to cool down during normal operation, corrosion sets in ducts and vessels where acidic condensate can rest.

When a plant is shutdown for a significant length of time this problem needs to be combatted. The management of the plant decided to put lime in both the absorber and drier towers, and both acid storage tanks. They also removed all the catalyst from the converter and stored it in air tight drums. In addition they removed all filter media from the hot gas filter. The boiler was stored in a dry condition.

Recommissioning of Plant

Recommissioning of the plant at Mary Kathleen involved three distinct aspects.

1. New process steps.
2. Increased capacity.
3. Overhaul of existing equipment.

The new process technology was decided on by Mary Kathleen staff. Its engineering implementation was carried out by Minenco, with the acid of other consultants.

Minenco also handled the engineering management of the project involving the installation of new equipment on expansion of plant capacity. Electric Power Transmission (EPT) was used to carry out the majority of the work in the plant. The exception was the acid plant which was handled entirely by Simon Carves (Australia).

Mary Kathleen personnel looked after and carried out all the overhaul of existing equipment and the cleaning out of various vessels.

New Process Steps

It was realised that during the care and maintenance period of Mary Kathleen new plants were built which incorporated new ideas which could be applied in a worthwhile fashion at Mary Kathleen.

Figures 1 and 2 illustrate the present flowsheet. As can be seen from the flowsheet the plant incorporates solvent extraction, sand clarification ammonia precipitation and high temperature calcination and drying.

Each of these areas represents a change from the original flowsheet. Each change was justified on the known economics of the original process steps versus the estimated costs of the new proposed steps. Estimates were based on existing plants overseas and testwork carried out both at Rum Jungle and Mary Kathleen. A number of production plants also were using the new technology successfully.

Sand Clarification

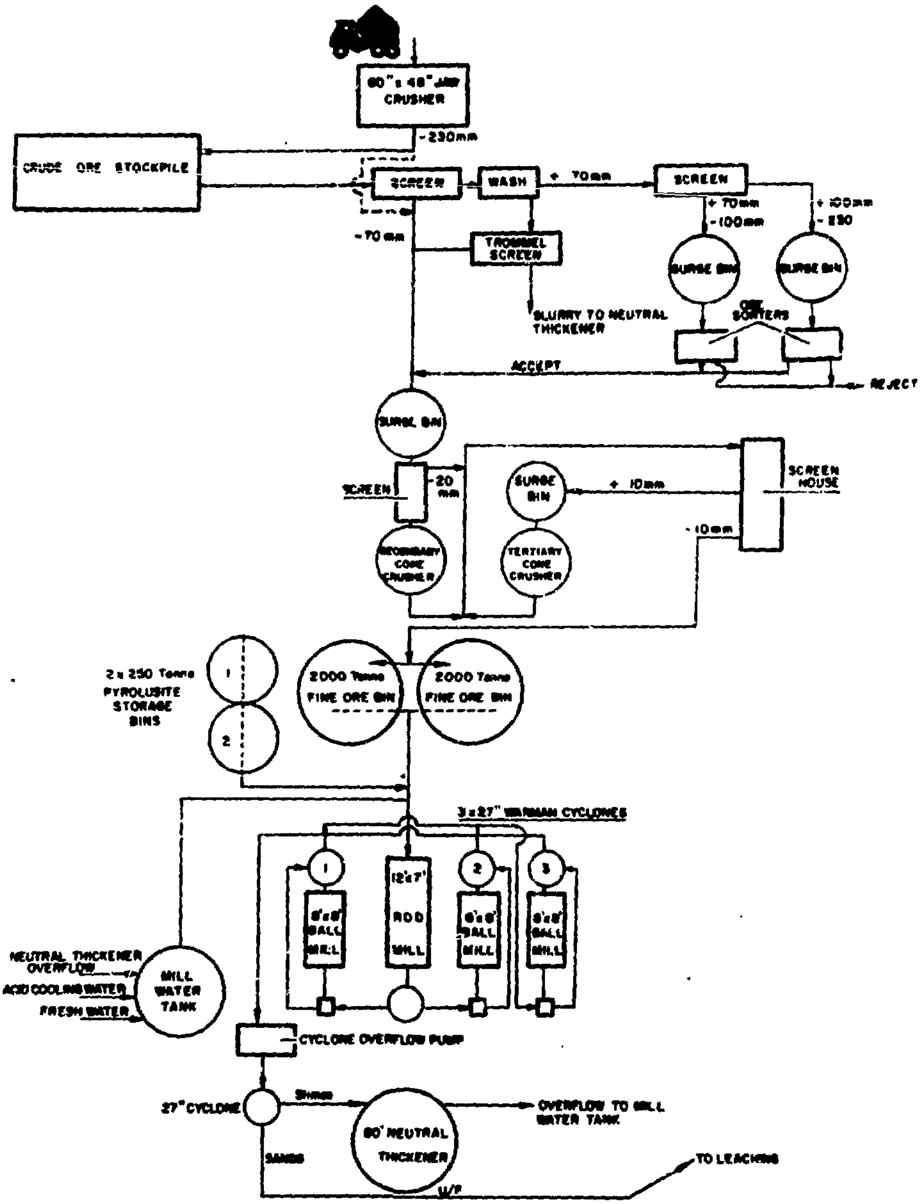
The pregnant liquor produced from the current counter washing step contains slimes up to 300-400 ppm and sometimes higher. This liquor must be clarified down to less than 50 ppm to ensure that the solvent extraction process proceeds without excessive crud formation.

The original process used precoat filters to clean the liquor up. This process was costly in terms of both reagents and labour and had limited capacity.

The vessels used in the sand clarification process are the old ion exchange columns. This meant a significant saving on capital for installation of new equipment.

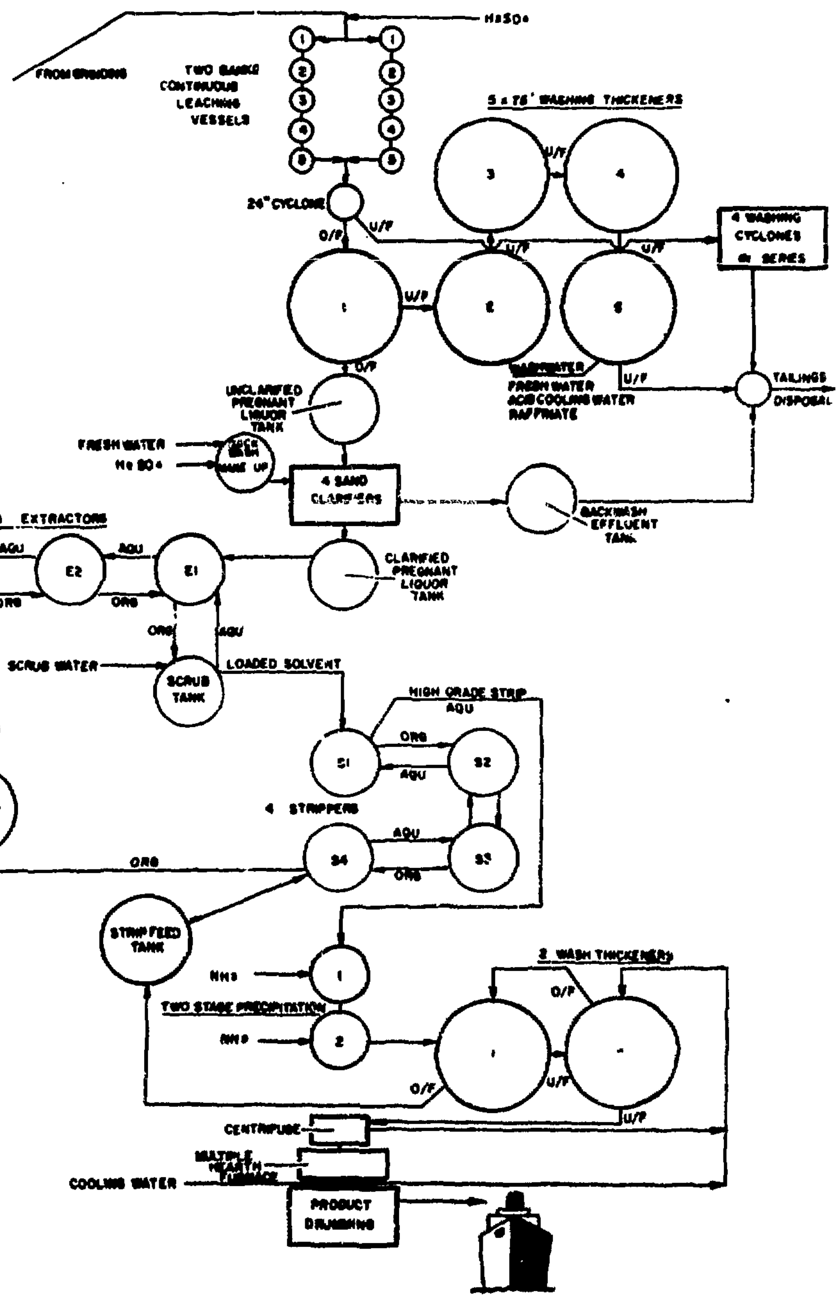
The automatic control valves and piping used on the ion exchange column for the elaborate loading, elution and resin regeneration steps were able to be reused after overhaul with only minor modifications to the pipework.

Permutit were consulted on the details of the back washing sequence required.



TREATMENT PLANT FLOW SHEET

Figure 1



TREATMENT PLANT FLOW SHEET

Figure 2

Sand clarification as installed at Mary Kathleen is far less costly and operates with excellent flexibility. Cleaning out of the sand beds is the major job which needs to be carried out once per year. Calcium sulphate in the liquor tends to cement the sand grains together and over a period of time clogs the bed up.

Solvent Extraction

The original plant used as its uranium recovery step ion exchange using resin in columns. Significant problems were encountered with silica which was dissolved in the acid leaching section. This silica was taken up by the resin, making it necessary to regenerate the resin using caustic soda.

The solvent extraction process uses liquid ion exchange in which the pregnant liquor containing the uranium is contacted in mixers stagewise with an organic phase which in Mary Kathleen's process is home heating oil with small additions of nonanol and tertiary amine.

It proved possible to reuse virtually all the old storage vessels for the new solvent extraction plant. All stages of extraction and stripping were relined with fibreglass reinforced plastic (FRP). A number of rubber lined vessels were merely covered over without removing the rubber. Subsequently these vessels have had to be relined.

Ammonia Precipitation and Calcination

The previous process used caustic magnesia as the precipitant. The precipitation step involved a two stage operation in which iron was precipitated first then uranium. The process was involved because the ion exchange resin was not selective enough.

With the introduction of solvent extraction caustic magnesia precipitation would have been more straight forward than previously since there would have been virtually no iron present in the high grade strip. However, in order that maximum benefit be gained from the solvent extraction process anhydrous ammonia was proposed as the best precipitant.

Examination of the economics which took into account the potentially high grade product available after high temperature calcination showed that anhydrous ammonia should be used.

A high temperature multiple hearth furnace was also installed in place of the original low temperature stainless steel conveyor type drier.

Both these changes in process technology have proved to be successful and little change has been necessary to the plant commissioned. A screw conveyor has been installed to feed the centrifuge discharge into the drier. At first this was pumped by diaphragm pump rather unsuccessfully.

Increased Capacity

From plant records which were available and from statistics kept during the previous operation the grinding capacity of the plant was reasonably well known.

Based on this knowledge and a knowledge of the grade of the orebody projections were made of the likely plant production rate in terms of uranium oxide. After considering the contracts which had been written for supply of uranium oxide it was decided to boost the plant grinding capacity by approximately thirty percent. The leaching section, the liquid solids separation area and the acid plant were also increased in capacity to match the grinding plant increase.

Sorting

In order that the sorting plant should keep up with the grinding plant it was decided to install a new fifty sorter with electronic solid state components. At the same time as this was done a change was made to the ore presentation system. The ore originally was screened at +75 mm. In the recommissioned plant the +75 mm ore was screened a second time at 100 mm. However the variation in the overall primary crusher discharge size led to significant variations in feed rate to the two sets of sorters handling each size. This in turn cut back on production capacity and starved the secondary and tertiary crushers. Commissioning of the sorters did not occur at the beginning of 1976 as for the rest of the plant. This occurred several months later but because of the problems just described the sorters could not be effectively utilised.

The removal of the second screening operation occurred last year in August. Since then the crushing plant has operated significantly better, although final improvement was only brought about by increasing the reclaim capacity from the primary crushed ore stockpile.

As a result of the experience with No.5 sorter which had solid state circuitry, all four old sorters were also converted to solid state in August last year.

Primary Crushed Ore Stockpile

The original crushing plant was designed with little flexibility. The various units in the crushing plant area were interlinked and downtime in the primary crusher caused downtime in the sorters.

As part of the philosophy of boosting plant capacity it was decided to build a primary crushed ore stockpile which would feed the sorting plant at a steady rate.

The reclaim system underneath the stockpile has performed reasonably well but as part of the present scheme of upgrading and increasing plant performance new feeders will be fitted.

The concept of a crushed ore stockpile has however proved correct and without it the problems of plant commissioning would have been compounded.

Grinding

By installing a third ball mill, identical to the two existing ball mills the grinding capacity should have been increased by about thirty percent. The capacity of the plant was estimated to be 1720 tonne per day with 94 percent availability. However it has now been shown from experience over the last two years of plant operation that the capacity of the grinding section is less than this.

Initially the circuit was commissioned as a two stage grinding circuit, the one rod mill supplying feed to the three ball mills via a rotary distributor. Each ball mill operates in closed circuit with a cyclone.

This circuit was changed after twelve months operation to a three stage grinding circuit with the one rod mill feeding two ball mills and they in turn feeding the third ball mill. The ball mills are still in closed circuit with cyclones.

No significant improvement in performance has been associated with this circuit change, although grinding circuit simulations have indicated that capacity increases should be possible.

A further modification in the quest for increased throughput has been to increase the rod mill speed from 68 percent of critical to 76 percent of critical. This has given some improved performance although because of other factors it has been difficult to estimate this accurately.

The rod mill is one area where the capacity was initially overestimated. The breakage capacity of the mill drops off quickly with increased throughput and is affected by variations in ore hardness which can be significant.

Finally, at the present time a new rod mill is being installed to provide two rod mill, ball mill circuits each feeding to the third ball mill.

Significant capacity increases in the range 15 to 20 percent are expected.

Leaching and LSS

The leaching plant was expanded by the addition of two vessels each about 50 percent larger than the old vessels. This maintained a residence time of about 8 hours through the train. However these two new vessels had agitators of insufficient agitating power for the pulps encountered. Presently new agitators are to be fitted to these vessels.

At the same time as building the new vessels a change was made to the use of 98.5 percent concentrated sulphuric acid in place of 50 percent acid. This move significantly reduced the residence time required for the same leach efficiency as the previous operation. This in turn meant that the poor performance of the two new vessels was not as important as it might otherwise have been.

The thickening and washing circuit was expanded in capacity by installing in parallel with the thickeners a set of five 69 cm cyclones. This circuit has run well since being first commissioned although it is now necessary to run the thickener underflow densities around 50 percent solids - somewhat less than previously - in order that relatively clean pregnant liquor is produced.

Acid Plant

The original acid plant had a capacity of 110 tonne per day of 98.5 percent acid. This was not sufficient however, to meet the useage of acid in leaching, LSS and solvent extraction which was estimated to be 72 kg per tonne of ore.

Expansion of the plant was carried out by installing a new blower, modifying the acid distribution system in both absorber and drying towers and installing a new acid circulation pump. At the same time as these changes were carried out the sulphur melting area was replaced, a sulphur filter was installed, a new economizer was erected and new Alfa Laval plate type acid coolers installed.

The plant capacity was increased to 140 tonne per day.

Overhaul of Existing Equipment

The general philosophy followed in recommissioning the existing plant was to make maximum use of the existing equipment in the new plant. This was done to save on capital for new equipment.

In actual fact very little equipment or piping from the plant was not reused.

The job of overhauling and bringing up to scratch the existing equipment fell to Mary Kathleen personnel. Installation of new equipment such as No.3 ball mill was performed in the main by Electric Power Transmission (EPT). The acid plant new work was handled by Simon Carves.

The recommissioning of existing equipment was not open ended because it was felt that certain jobs were not necessary and could be left to later during plant operation if it proved necessary. It was a calculated risk.

An appreciation of the range of tasks carried out by MKU follows.

CRUSHING PLANT

Secondary Tertiary Crushing

As clean up of the crushing plant got under way it was suddenly realised that the crusher foundations were in bad condition. Subsidence had been bad enough to cause substantial misalignment between the motor and crusher counter shaft. The crushers were dismantled and the foundations removed. New foundations were poured and the crushers re-installed. No further problems have been encountered since. This job was a major one and was well handled by MKU personnel.

Primary Crusher

One significant problem area during the previous operation was the white metal bearings on the Allis Chalmers 152 x 122 cm primary crusher. Therefore new roller bearings were installed by MKU to the recommendations of Allis Chalmers, Canada. This conversion has been very successful.

Conveyors

All conveyors had to be refitted with belts as they had been removed by the previous operation. As had been previously mentioned some belts were not in good condition and had perished in a number of places. These sections were replaced.

All conveyor gearboxes were overhauled and filled with new lubricant. Higher grade lubricant was chosen for this duty to provide some added guarantee during commissioning of the plant.

Significant spillage from conveyors was encountered during the previous operation. In order to improve this aspect of plant operation the idler trough angle on a number of the steep conveyors was increased. This was done by modifying the existing idler frames to 35^{o} angle. The cost to do so was significantly less than buying new idlers.

The general labouring gang working on cleanup was reduced in anticipation of reducing spillage. However the crushing plant was still an area of spillage and until small mechanical loading equipment was introduced problems were encountered. Further plant modification was required to enable this equipment to be used.

Screens

Two large 3.7m x 1.5m Jacques screens which were used in the original plant were removed and overhauled with new bearings being fitted. These screens were relocated by Electric Power Transmission (EPT).

Sorting

The sorting plant was probably the area which required most extensive overhaul. All sorters were completly stripped and reassembled.

The discharge chutes at the sorters were in bad state of repair and in actual fact these chutes were replaced. However lining of these chutes proved to be inadequate and it was not till well into 1976 that these chutes were properly lined with wear plate.

A small modification which proved to be extremely worthwhile was the installation of a common chip conveyor for all five sorters. Previously separate chip conveyors were used.

Grinding

A significant amount of work was performed in this area during the recommissioning programme.

Mills

All trunnion bearings were inspected and the bearings on the rod mill feed end and No.2 ball mill were scraped and refitted. These bearing surfaces were quite rough indicating that during the previous operation some overheating of bearings may have occurred.

No.1 mill was relined with manganese steel liners and the rod mill lifters were replaced with manganese steel.

The new No.3 ball mill installed by EPT was fitted with rubber liners and though their life was relatively short (8 months), further experience with rubber liners has led MKU to standardize on this material in the ball mills.

Pyrolusite Mill

Pyrolusite is used in the leaching operation to control the redox potential of the leach pulp. The previous operation ground the pyrolusite in a separate 1.5m x 1.5m ball mill using 76 mm grinding balls. This grinding system was overhauled and commissioned with the grinding plant. Since then, however, the system has been modified and the pyrolusite is now ground with the ore.

Rod Mill

The rod mill discharge end foundation was found to have significant cracks. These would have endangered the mill once it was restarted. The foundation was drilled, rock bolted and grouted to restore its strength, the repair has proved satisfactory.

Cyclones

All four 69 cm Warman cyclones were removed, rerubbered and replaced.

LEACHING AND LSS

All the vessels in this area of the plant had heavy buildups of calcium sulphate. The first leach vessels in the train were especially bad. The thickeners also had thick accumulations on both the walls and other rakes, No.1 being the worst.

All thickeners were cleaned back to bare rubber using a high pressure water spray and the majority of the buildup was removed from the leach vessels. However it was found that in removing the highly adherent buildup signifcant damage was being done to the rubber. If the buildup could not be removed readily the material was then left. All vessels were spark tested and repairs carried out.

The flexible couplings on the leach agitator mechanisms were all overhauled and in cases where they required replacement new fluid couplings were fitted.

SAND CLARIFICATION

The sand clarification process was installed using the existing ion exchange columns. These columns had to be cleaned out of old resin and support media. All Saunders diaphragm control valves were overhauled for installation by EPT.

SOLVENT EXTRACTION

Preparation work in this area was mainly required for subsequent work by contractors. All vessels which were in the main rubber line were cleaned back to bare rubber and where this was of doubtful quality it was removed. Spark testing and repair followed. Vessels in the solvent extraction area were lined with fibreglass reinforced plastic (FRP) by Ceilcote. Where this was applied over rubber which was the majority of cases it has subsequently been necessary to replace it. On plain steel minimal problems have been encountered.

ACID PLANT

Work by MKU in this area was largely limited to preparation work for the main contractors. All the old steam valves and piping were removed and when possible overhauled. The small bore piping was in a lot of cases badly corroded.

The original sulphur melting area was demolished and the area prepared for the new sulphur melting equipment.

The old economiser and sulphur dioxide cooler air preheater were removed and put on the scrap heap. New equipment was installed in their place.

Both the converter and the hot gas filter were cleaned completely with all traces of dust and scale being removed. Both vessels were refilled with charges. In the case of the converter the catalyst taken out by the previous operation was replaced, with additional new catalyst being added.

PUMPS

All original Warman pumps were overhauled and virtually all have been reused in the existing plant. Some Worthington Simpson pumps used in the old ion exchange process have been reused.

ELECTRICS

Electrical work was extensive, involving the cleaning out of all switch rooms, cabling and all electric motors. The bearings on a number of electric motors required replacement. This was carried out in the shop.

INSTRUMENTS

The existing instrumentation was in bad state of repair and required significant overhaul. The problems were compounded by spares availability. At the present time the plant instrumentation is undergoing a major replacement and upgrading.

CONCLUSION

In general the recommissioning of existing equipment has proved to be successful. No significant problems have been encountered with this gear.

However several items of equipment for example the apron feeder feeding the Allis Chalmers primary crusher and the LSS thickener rake mechanisms were not overhauled because it was thought from general inspection, they were satisfactory. These items have caused problems.

A considerable amount of modification work was carried out during recommissioning. In addition, old equipment was married with new equipment.

During the first 12 months of operation the amount of maintenance caused by these factors was unexpected and the workforce was insufficient to cope adequately.

The general workforce was reduced on the basis that the plant was being improved by modifications and process changes. This meant that there was insufficient labour available for cleanup. Mechanical cleanup equipment was not introduced until the plant had been running for some time.

Because of tight capital expenditure allowances some areas of the plant were not brought up to a high standard during recommissioning. This was true of the crushing and sorting plant.

At the present time, plant availability is high and with the installation of an additional rod mill plant capacity should be appreciably improved.