Zonguldak and Çatalağzı Washeries Modernisation Project

Zonguldak ve Çatalağzı Lavvarları Modernizasyonu Projesi

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ABSTRACT

The paper oulines the background and subsequent stages associated with the feasibility studies and engineering undertaken for the modernisation of two coal washeries for TTK.

The paper indicates how the project was organised and the development of the project is explained. Topics covered include the initial coal sampling exercises, the process and engineering development and the financial and economic evaluations.

ÖZET

Bu bildiri T.T.K.'na ait iki lawann modernizasyonu için üstlenilen fizibilite ve mühendislik işlemleri ile ilgili aşamaların başlangıçtan itibaren gelişiminin bir taslağım sunmaktadır.

Bildiride projenin nasıl oluşturulduğu ve nasıl geliştirildiği açıklanmaktadır. Konunun kapsamı başlagıçtaki kömür örnekleri alımım, yöntem ve mühendislik işlemleri ile finansal ve ekonomik değerlendirmeleri de içine almaktadır.

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1. PROJECT CONCEPT DEVELOPMENT

1.1 Description of Existing Washeries

Zonguldak Coal Washery is located in Zonguldak city and was established in 1957. It treats the ROM coal production of Kozlu and Uzulmez mining areas.

Catalagzi Coal Washery, located some 15 km away from Zonguldak city, was established in 1956 and treats the coal mined from Karadon area.

1.1.1 Existing Coal Preparation Process

ROM Coal produced from Kozlu and üzülmez hard coal establishments is transported to the Zonguldak coal washery by railway and stocked in ROM bunkers. It is then conveyed by three different belt conveyors to the washery. ROM coal produced from Karadon hard coal establishment is transported to the Catalagzi coal washery by two belt conveyors.

ROM coal entering the coal preparation plant is screened at 100 mm. The undersize coal is stocked and sent to the coal washing units. In both washeries ROM screens are in two stages and 18 mm screens are placed under the 100 mm screens for preparing 0-18 mm ROM coal for the heavy media washing units.

After screening, the oversize (+100 mm) ROM coal is fed to a rotary crusher. Before entering the crusher pieces of timber, tramp iron etc are removed by hand sorting.

Only a small percentage of coal is found in the +100 mm range but due to the inefficiency of the crusher, coal has to be hand picked from the +100 mm belt, while a large percentage of -100 mm contains discard which upsets the balance of the subsequent washing systems.

1.1.2 Coal Washing Process

Zonguldak coal washery has three jig system washing units each having 250 ton/h capacity and 1 dense media washing unit with 250 ton/h capacity. The total washing capacity of Zonguldak washery is 1000 ton/h.

Catalagzi washery has two jig system washing units each having 250 ton/h capacity and 1 dense media washing unit with 250 ton/h capacity. The total capacity of Catalagzi coal washery is 750 t/h.

At the moment the capacity of one unit is İ75-180 ton/h and both washeries are working below their capacities.

The washeries work two shifts for production (coal preparation and washing) and one shift for maintenance, but because of the present undercapacity, the length of production shifts are increased. This causes extra operational costs as well as decreasing the level of maintenance.

ROM coal processed in the washing units includes excessive amounts of tailings and therefore balanced feeding of the jigs is not possible. This condition causes inefficiencies and therefore the desired production cannot be achieved and coal losses occur.

Because of the age of the existing equipment repairs are difficult because of the lack of spare parts.

1.1.3 Heavy Media Washing

Heavy media washing units were installed in 1973 at both Zonguldak and Catalagzi. At both washeries the 0.5-18 mm raw coal and the rejects in the jig circuits can be crushed to - 18 mm and rewashed.

The existing water clarification circuit produces insufficient water for the heavy media washing units and therefore these units at present do not work efficiently.

1.1.4 Froth Flotation

Froth flotation is done by Denver type flotation cells. The produced concentrate is filtered with drum type and disc type vacuum filters. The produced 0-0.5 mm clean coal is mixed with 0.5-6 mm coal and stored.

The recirculated water coming from washeries cannot be cleaned to the desired level and therefore a closed water circuit cannot be incorporated. Because of this, fresh water useage in the washeries is very high and at the flotation units the desired efficiency and quality of washing cannot be obtained.

1.1.5 Saleable Products

In both washeries after the washing process seven different sizes of clean coal are produced at present, these are:

0-0.5 mm, 0.5 - 6 mm, 6 - 10 mm, 10 - 18 mm, 18 - 50 mm, 50 - 100 mm and - 100 mm

These are stored separately and stocked in different stock areas, but often mixed to sizes 0 - 100 mm and sent to customers.

Discard is disposed in the following sizes:

+ 100 mm rock, 0.5 - 100 mm schist (coarse refuse) and 0 - 0.5 mm schist (tailing of froth flotation)

1.2 Scope of Work

In accordance with the terms of the contract, the project was divided into the following logical phases.

Phase 1 - Feasiblity studies, including coal sampling and analysis, to determine the process for implementation from three process options.

Phase II - Front End Basic Engineering and Detailed Engineering Study on the selected process to include selection of materials and equipment, preparation of Technical Specifications and preparation of draft contract documents.

Phase III - Provision of Training Services

1.3 Project Implementation Philosophy

For liaison and guidance purposes a TTK project committee was formed comprising various staff from TTK's Research and Project Planning Department and Washery Staff. This was supplemented when required by senior TTK personnel and technical staff from the washeries.

Bi-weekly progress meetings were instigated. Formal Monthly Progress reports were prepared. Project Offices were established in Zonguldak with a drawing office in Ankara. For each stage of the project intermediate reports were requested upon which progress payments would be based.

2. SAMPLING

2.1 Plant Details

At Zonguldak three streams of coal enter the preparation plant separately on their own conveyor belt and chutes between the end of each conveyor belt and ROM screen can be opened and closed in order to take each increment.

At Catalagzı sampling was done by stopping each of the conveyors carrying the ROM coal from Karadan mine. To take the samples from the stationary belts, two metal plates were made for each belt, each contoured to the shape of the belt so that when these were placed in position all the material lying between the plates could easily and accurately be removed to form the sample.

2.3 Sampling Procedure

It was estimated for an accurate float and sink analysis a total sample weight in the order of 1500 - 2000 kg would have to be obtained to give sufficient material in the 100 - 50 mm range (ie 300 - 350 kg).

Over each sampling shift four increments were taken and then thoroughly mixed and reduced in quantity by cone and quartering until an final increment weight of 50 - 60 kg was achieved for each coal per shift. Taking an average of 60 kg of coal per shift and 2 shifts per day over 15 days meant that a final tonnage in the order required for each coal was possible.

Äs each increment was taken it was first hand screened at 100 mm (round hole) before the quantity of -100 mm material was reduced by cone and quartering. The +100 mm material was classified by eye as being either coal or reject and the weights of each recorded.

2.4 Analysis of Samples

The following analyses were carried out:

Size Analysis.

Float and Sink Analysis.

Hardgrove Tests

Flotation

The results showed that a high proportion of fines (0.5 - 0 mm) were present in the ROM particularly at Zonguldak (approximately £5%) and there were indications that this was an increasing trend. It was also noted that the coal quality increased as the average material grain size decreases and there was a low quantity of near gravity material in the raw feed.

The characteristics of the coal could be variable and therefore any washing process had to be flexible and in the flotation bench cell tests extremely short residence times were observed which would make the control of ash levels in any flotation middlings very difficult.

3. FEASIBILITY STUDIES

3.1 Design Development

The three process alternatives required by the contract were generated from consideration of the following modules.

3.1.1 ROM and Raw Coal Handling

Following inspections at both Zonguldak and Catalagzi it was considered that the bulk of all future ROM and Raw Coal Handling facilities should be made from the existing equipment which would be refurbished.

3.1.2 Large Coal Washing

The following options were investigated:

Refurbishment of the existing rotary coal breaker
Heavy Medium Drum
LARCODEMS Separator
ROM Jig
Baum Jig

3.1.3 Small Coal Washing

In the process selection of the small coal washing facility two technologies were considered:

Dense medium technology - in the form of Dense Medium Cyclones.
Jig technology - in the form^of Improved Jigs.

The low content -*f* near gravity material in the raw feed to the small coal washery meant that both technologies are equally suitable.

The choice of process technology was made bearing in mind the relatively high discard content of the small coal washery feed and the required ability for the given process to handle variations in the raw coal's washability data.

3.2.4 Middling Re-Treatment Facility

By designing suitable modifications and refurbishments to the existing Dense Medium Cyclones, already in position in the respective washeries, a facility existed to re-wash the improved jig middling. Such a facility is only required, if the level of misplaced clean coal within the middlings becomes unacceptable.

3.2.5 Fine Coal Washing

The existing froth flotation plants at both Zonguldak and Catalagzi are currently considered to be overloaded due to the high fines, (0.5 x 0) mm, content of the ROM coal feeds.

Given the high tonnage feeds to the proposed future flotation plants and the expected flotation behaviour of the raw coal fines it was concluded, after considerable consultations with flotation equipment manufacturers, that the existing flotation machines could not be utilised.

The designed flotation circuit envisages four parallel banks of five sub-aeration type flotation cells.

Clean coal concentrate will be dewatered using four rotary disc vacuum filters, each of which will be fitted with nine disc's of diameter 3.5 m.

3.2.6 Tailings and Clarified Water Treatment

It was decided that the bulk of all future tailings treatment facilities would be made up from existing but refurbished equipment which already exists at both of the coal preparation plants.

By carrying out modifications to the existing 38 m diameter thickeners they can be converted to a Hi-rate type, capable of handling far greater tonnage feeds.

3.3 Summary of Alternatives

As some of the modules remain unchanged for the three options Table 1 summarises the various schemes for the modules where alternatives are offered.

TABLE 1
Module Alternatives

	Scheme No 1	Scheme No 2	Scheme No 3
LARGE COAL WASHERY	Wemco Drum	ROM Jig	Baum Jig
SMALL COAL WASHERY	Medium Grain Improved Jig	Medium Grain Improved Jig	Fine Grain Improved Jig
PRODUCT HANDLING	(50 x 10) mm CC (10 x 0) mm CC Middlings	(50 x 10) mm CC (10 x 0) mm CC Middlings	(150 x 10) mm CC (10 x 0) mm CC Middlings

3.4 Comparison Between Schemes

Table 2 indicates the comparison between the three alternative schemes in terms of major parameters.

TABLE 2
Comparison of Major Parameters
Between Project Schemes

Scheme Number	1	2	3
Operating Labour	**51**	**49**	**53**
Maintenance Labour	**24**	**24**	**25**
Maintenance Materials		**E Q U A L**	
Yearly Power Consumption (MKW)	**25.5**	**26.0**	**29.6**
Make-up Water Consumption		E Q U A L	
Yearly Magnetite Consumption (Tonnes)	535.5	NOT	APPLICABLE
Flocculant Consumption		E Q U A L	
Flotation Reagent Consumption		E Q U A L	
Lubricant Consumption		E Q U A L	
Capital Cost	Medium	Lowest	Highest

3.5 Recommendation of Preferred Process Alternative

Of the three schemes investigated. Scheme No 2 was considered to be the most suitable for the proposed future duties at Zonguldak and Catalagzi.

The ROM and Raw coal handling requirements can easily be met by simple refurbishment and modernisation of the already existing facilities at both washeries with the addition of only a few items of new equipment.

Large coal washing in Scheme No 2 will be conducted in a ROM jig-

It can cater for large variations in the quantity of discard in its raw coal feed. It also gives good overall coal and discard separations and it requires an extremely small closed wash water circuit which will vastly reduce its associated ancillary equipment. Any requirement for. hand picking of the raw coal feed will be removed.

In scheme No 2 washing of small and crushed large deshaled coal will be conducted in two Medium Grain Improved Jigs which can cope with great variations in the quantity of discard in their raw coal feed. Additionally, a compact "straight through flow" layout concept will be achievable, enabling a comparatively easy retrofit into the existing buildings. The proposed Improved Jig plant will have reduced operating costs.

The proposed fines treatment facilities incorporated into scheme No 2 will allow the high quantity of raw fines be treated far more effectively than in the presently overloaded fines circuits operating at both Zonguldak and Catalagzi.

The proposed tailings thickening circuits in Scheme No 2 will make the best use of existing thickeners presently operating Zonguldak and Catalagzi, while suitable modernisation with the most up to date thickener rake mechanisms will make their future operation more efficient.

The selected scheme is outlined in Figure 1.

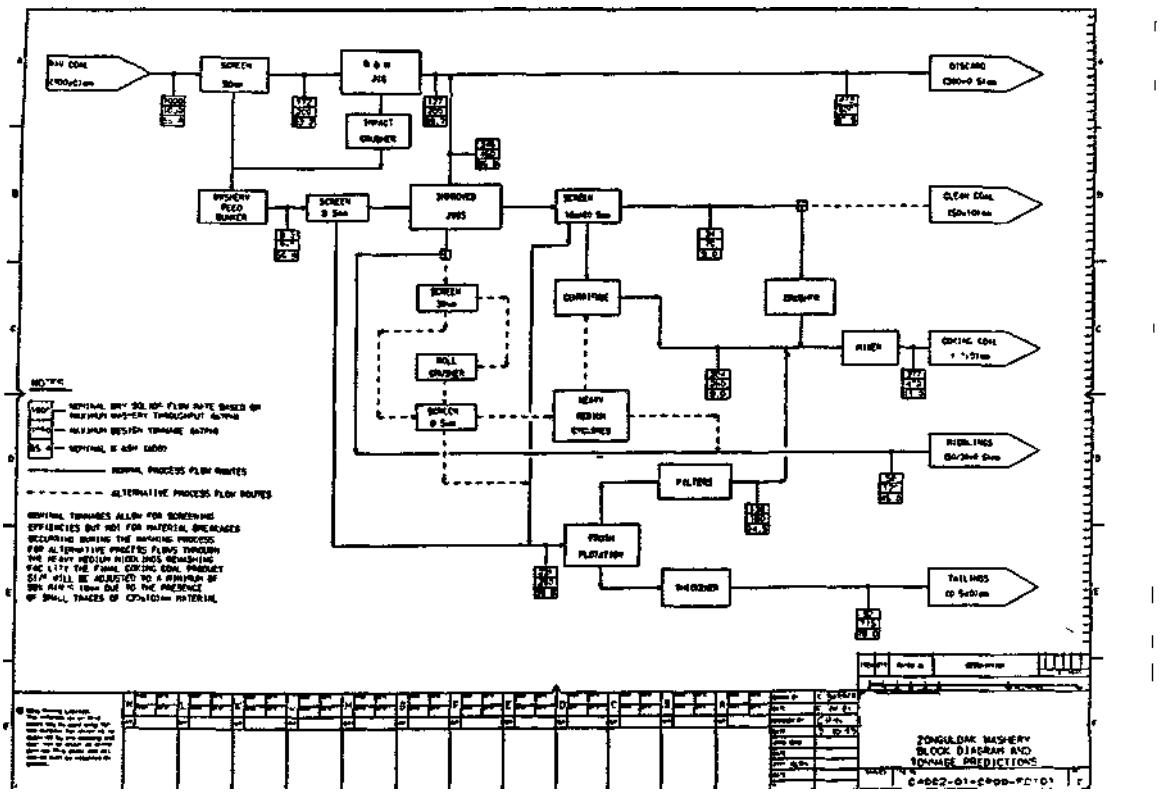
4. CONVERSION OF EXISTING WASHERIES

4.1 Existing Site Description and Mechanical Design Implications

Following extensive site visits and surveys it was decided that in order to modernise the washing process and reach the required capacity of 1000 tph, the Large and Small Coal Washing modules and

FIGURE 1

Outline of Selected Scheme



PBODCCTS	I0IGUDAI			ÇİİİLACH		
	IIILS (TPi)	X ASK	SI «ISIm1	mu (TPI)	*X* İSI	*X* ttlSItll
COUKG GOàl (1010) ma	577	11.0	15.4	594	10.2	12.1
Il DOLI(GS (9010.9) ıra	98	49.0	10.0	84	49.0	10.0
DISCARD (50010.9) un	475	87.7	6.5	458	87.6	1.0
TİILIIGS (0.910) u	92	78.0	71.0	66	80.0	71.0

the Fine Coal Treatment module would require almost complete replacement. The Raw Coal handling, Product Outloading and Heavy Medium Washing modules would, however, be capable of being refurbished.

A series of preliminary layout drawing were prepared to prove the feasibility of the method selected. These were then replaced by final layout design drawing during the final phase of the project. A total of 80 mechanical layout drawings were eventually produced for both plants.

4.2 Electrical

The original equipment has given good service but is now reaching the end of its useful life. With the supply of spare parts becoming difficult it was not possible to recommend that such equipment be used again in the modernisation project. Main incoming 15000 V and 3300 V switchgear are in good order, together with transformers 15000/3300 V, and these will be retained but the existing 3300/550 V transformers will be replaced.

New MCC's and switchboards for 3300 V and 550 V will be built. A new control room and electrical substation will also be provided. To control and sequence the plant a Programmable Controller (PC) will be used. Audio Communication equipment and Closed Circuit Television will help to reduce plant manning levels.

4.3 structural Design

A series of design sketches were prepared to further develop the structural steelwork system for the equipment supports which was shown on the detailed mechanical layout drawings. Prom these a full design was carried out to assess the individual member sizes of the steel structures.

The major equipment within the washeries at both Zonguldak and Catalagzi is supported on structural steel supports. The lightly loaded new supports are carried onto the existing reinforced concrete structure of the existing washery building. The new heavier loads, however, are taken to ground level with newly prepared foundations.

4.4 Civil Design

A series of design sketches were prepared to develop the foundation design and calculate the required quantities.

The main design philosophy for Zonguldak envisages that all major new loads will be carried by new foundations. New piles will therefore be installed remote from existing piles. At Catalagzi the new foundations will be based on existing footing and the area between filled with lean concrete. A mat foundation will be laid, the dimensions of which will be kept large enough to minimise soil bearing pressure.

4.5 Equipment Installation and Construction

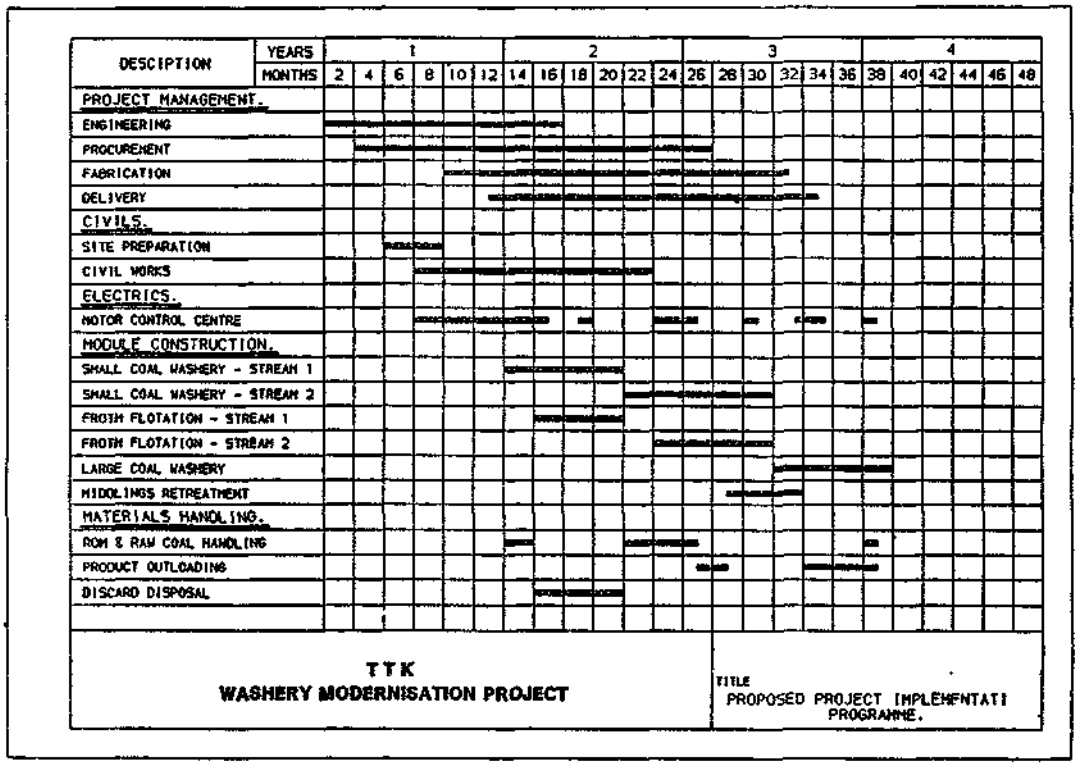
The principal constraint in the modernisation process was the requirement that the operation should not be interrupted. Many parts of the plant, for example, buildings, flooring, ROM and Product Outloading, can be refurbished or constructed at any time without interfering with the efficient running of the existing plant or with the proposed new installations.

At present in the small coal washery module there are three streams at Zonguldak and two at Catalagzi their replacement can be tackled sequentially. This means that the Zonguldak plant will be operating at 66% capacity while Catalagzi will be 50% capacity. In accordance with the Proposed Project Implementation Programme this will be four months for Streams 1 and five months for Stream 2. (See Figure 3).

After commissioning of the second Improved Jig, the ROM Jig (Large Coal Washery) can then be installed.

FIGPRE 2

Proposed Project Implementation Programme



As the existing Froth Flotation cells are not capable of being uprated they must be replaced by four new banks of flotation cells which will be positioned in the same orientation as the existing cells. Their installation will be phased to run concurrently with the Large Coal Washery module and will mean that for some periods they will operate at 60% capacity.

The existing vacuum filters, which are a mixture of drum and disc type will be replaced by a series of disc filters situated in the same area as at present.

Due to the overall size and height of the existing washery buildings and the restricted access on the sites at Zonguldak and Catalagzi normal construction type, mobile jib, cranes cannot be used. In order to provide the required lifting facilities for both removal and installation of equipment the most practical solution is to use two tower cranes. A section of the roof will be dismantled over the areas of greatest lifts so that equipment can be removed and installed directly without double lifting within the building.

5. ECONOMICS

Table 3 shows the Fixed Investment Cost in terms of Suppliers Credit loan financing sources which may be considered to offer interest rates which are pessimistic.

The annual operating costs of Zonguldak and Catalagzi washeries is also shown.

If Supplier's Credit is used for financing, the total project profit increases from 15,243 m TL in year 2, to 28,514 m TL in the 6th year due to the interest payments terminating in the 5th year and remains constant until the 17th year. Due to decreases in depreciation total project profit then increases further.

The measures of financial viability for the project, NPV, IRR and the pay-back period are also shown.

TABLE 3

Major Economical Parameters

		Zonguldak	Catalagzi	Total
Fixed Investment Cost	(M TL)	77,263	68,946	146,209
Annual Operating Cost	(M TL)	18,746	16,813	
NPV	(M TL)	72,708	6,443	
IRR	(%)	25.21	12.80	
Pay Back Period	(Years)	3.5	7	4.5

6. CONCLUSION

As can be seen from the economic evaluations all indications show the project as being viable.

The project is now in a position to move forward to the next stage of development, that of project implementation.

As part of the contract, Davy McKee have already provided TTK with draft contract documentation for the construction phase and have recently recommended a project implementation method which TTK are considering. Once financial arrangements have been made the project can proceed.

It should be understood, that although indications are positive, the project will not be easy in terms of construction. At project completion two of the largest coal preparation plants in the world, in terms of plant throughput, will be available to TTK and therefore the best management, engineering and construction expertise will have to be applied to the project.

It should be remembered, however, that the exiPting plants are now nearly 40 years old and the question is not whether the coal industry of Turkey can afford to build these plants but whether they can afford not to.

7.0 ACKNOWLEDGEMENTS

The authorities would like to thank the Senior Management of TTK for their assistance during the project and for permission to present this paper.

YURT MADENCİLİĞİNİ GELİŞTİRME VAKFI

Türkiye 7. Kömür Kongresine başarılar diler ve tüm madencileri 18-19 Haziran 1990 tarihinde İstanbul'da yapılacak I. Mad en Şurası'na katılmaya davet eder.

Kömür bütün Türkiye'yi ihya edecek bir servettir.
K. Atatürk

T.T.K.

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ARMUTÇUK TAŞKÖMÜRÜ İŞLETME MÜESSESESİ (ARMUTÇUK LAVUARI)

KRİBLE
18—50
10—18
0—10
ŞLAM

KOZLU VE ÜZÜLMEZ TAŞKÖMÜRÜ İŞLETME MÜESSESESİ (ZONGULDAK LAVUARI)

KRİBLE
18—50
10—18
0—10
6—10
MİKST
ŞLAM

KARADON TAŞKÖMÜRÜ İŞLETME MÜESSESESİ (ÇATALAĞZI LAVUARI)

KRİBLE
18—50
10—18
0—10
MİKST
ŞLAM

AMASRA TAŞKÖMÜRÜ İŞLETME MÜESSESESİ (AMASRA LAVUARI)

KRİBLE
18—50
10—18
0—10
TUVÖNAN

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TESHİN VE SANAYİ İHTİYAÇLARI İLE
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