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ARAB POTASH COMPANY
OPERATION AND WASTE MANAGEMENT SYSTEM

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L'Arab Potash Company (APC) a été fondée en 1956 par le gouvernement Jordanien pour utiliser les minéraux de la Mer Morte. En 1982 la production de potasse a commencé et en l'an 2000 la production estimée atteindra 2,1 millions de tonnes.

Généralement, l'industrie de la potasse génère des émissions aériennes ainsi que des déchets solides et liquides, tous étant des polluants importants. Au départ au cours des stades de conception des raffineries de potasse, toutes les mesures et tous les aspects environnemantaux ont été considérés pour limiter la pollution du voisinage conformément aux normes internationales les plus élevées.

L'Arab Potash Company a défini une stratégie à long terme pour traite des déchets de l'environnement en lançant un programme de contrôle des déchets dans le cadre légal de la Stratégie Nationale de l'Environnement (NES), en accord avec le Plan d'Action National de l'Environnement (NEAP) pour traiter des principaux polluants : émissions aériennes ainsi que déchets solides et liquides.

Cet exposé insiste sur les points suivants :

- Description du système de bassin solaire et raffineries de procédés
- Situation complexe et conditions climatiques
- Données historiques sur les déchets
- Mesures prises par APC pour contrôler la pollution
- Réhabilitation du système existant de collecte de la poussière
- Projet d'exploitation des queues
- Projet future sur l'environnement et ISO 14001

SUMMARY

The Arab Potash Company (APC) was founded in 1956 by the Jordanian Government to utilize the Dead Sea minerals. In 1982, production of potash first started and by the year 2000 the estimated production will reach 2.1million tons per year.

Generally, the potash industry generates air borne emission as well as liquid and solid wastes, all of which are major pollutants.
Originally, during the design stages of potash refineries, all environmental measures and aspects had been taken into consideration in order to limit pollution of surroundings in accordance with the highest international standards.

The Arab Potash Company set a long term strategy to deal with environmental waste by enforcing waste management program within the legal framework of the National

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Environment Strategy (NES), in accordance with the National Environmental Action Plan (NEAP) to deal with major pollutants: air borne emissions as well as both liquid and solid wastes.

This paper will focus and highlight on the following issues:

- Description of Solar Pond System and process refineries.
- Complex location and climatic condition.
- Historical data on waste.
- Measures taken by APC for pollution control
- Revamping of existing dust collection system.
- Tails management project
- Future environmental project and ISO 14001

1. INTRODUCTION

The Arab Potash Company (APC) was founded in 1956 by the Jordanian Government to utilize two of Jordan's most abundant natural resources: Solar energy and the mineral rich brine of the Dead Sea.
The location of the site complex is 110 km south of Amman and 200 km north of Aqaba. The Company operates one of the largest man-made solar pond system of an area of 131 km^2. It is built on the land which used to be part of the Dead Sea. It raw material known as carnallite mineral with the chemical formula ($KCl.MgCl_2. 6H_2O$). The system feeds three processing refineries to produce potash at an annual capacity of 2.1 mmt.
Commercial potash production started in 1983. It has since progressed with intensive development and expansion. The original design capacity of the plant was 1.2 mmtpy. This was later up-graded to 1.4 mmtpy by 1990 after a series of modifications in both refinery and solar pond system were undertaken.
The second plant based on different technology, which was developed in-house known as cold crystallization, was added to the system in 1994 with a design capacity of 0.4 mmtpy. And this made the total potash production capacity 1.8 mmtpy. Further expansion to both refineries and solar pond system are underway in order to bring the total capacity to 2.5 mmtpy.

APC produces three grades of muriate of potash: standard, fine, compacted material (granular) and recently has successfully produced industrial potash with a design capacity of 100,000 tpy.

1.1. DEAD SEA

The Dead Sea is world's saltiest natural lake and it is ten times more salty compared to the ocean. Its salinity is about 345gm/liter
The chemical content of the Dead Sea brine which has an average density of 1.235g/c.c. It holds a unique assemblage of salt minerals. It is rich in magnesium, sodium, calcium, potassium and bromine with an average salinity of 340 g/liter. The estimated total amount of these salts is over 43 billion tons. The following table shows the typical Dead Sea composition and quantity.

Dead Sea composition by weight and reserve in billion tons

Composition	% by wt	Reserve Billion Tons
Magnesium chloride $MgCl_2$	14.5	22
Sodium chloride NaCl	7.5	12
Calcium chloride $CaCl_2$	3.8	6
Potassium chloride KCl	1.2	2
Magnesium bromide $MgBr_2$	0.5	1

The origin of the salts is believed to be a leaching of soluble salts from the surrounding area through the ages.

1.2. SOLAR POND SYSTEM

The solar evaporation pond system is considered to be the key element in the potash recovery process. Its main function is primarily to prepare the raw material known as carnallite in order to feed the refineries (see diagram).
The Dead Sea brine is first delivered to the salt ponds the first part of the solar pond system at the yearly average rate of 300 millions tons. The brine then flows to the first of a series of salt ponds (SP-0B, SP-0A, SP-1, SP-2, SP-3) which has the highest evaporation rate in the system. In these ponds the initial concentration of Dead Sea brine which has a density of 1.235gm/cc; due to high evaporation and solubility of NaCl. Most of NaCl is deposited and the water content of the brine is reduced bringing the final density of the brine to a bout 1.3g/c.c.

At the end of the salt ponds, the brine is then transferred by gravity to another pond known pre-carnallite pond PC-2. The main function of this pond is to act as a control pond in order to make a proper composition of the brine feeding the carnallite ponds. The %KCl content of this stage is around 2%.

The controlled brine is then pumped through a series of 6 carnallite ponds. (C-3, C-2, C-1, C-5, C-6, C-7) by gravity where further evaporation occurs. The carnallite KCl. $MgCl_2.6H_2O$, salt is then crystallized at the ponds bottom with a thickness of 300-400mm. Brine from the last stage pond C-7, which contain less KCl content flows by gravity to flood channel and flow back to the Dead Sea. C-4 pond is fed by refinery return brine in order to improve the overall recovery of the pond system. The solar evaporation pond system is capable of producing 10-11 mmtpy carnallite.

1.3 HARVESTING

The average thickness of carnallite salt crystallized and depleted in the carnallite ponds is around 300-400mm, and the average chemical composition of the carnallite is 84% pure carnallite and 16% sodium chloride. The carnallite bed is harvested beneath the brine in slurry form and delivered to the process refineries via a series of pumps through steel pipes.

APC has 6 tailored-made harvesters for such operation and these are floating type. Digital Global Positioning System. (DGPS) is utilized for a proper and precise harvesting guidance. This system has enhanced the navigation and has been translated into higher productivity.

1.4 PROCESSING PLANTS

1.4.1 Hot Leach Plant

The hot leach plant is now operating at a design production rate of 1.4 mmtpy. The hot leach process utilizes the conventional method to produce potash. The process described as follows:

- The carnallite slurry is delivered to refinery, then dewatered, and the cake decomposed with process water in two-stage decomposition. The resulting solid is a mixture of (NaCl & KCl) known as sylvinite. The sylvinite slurry is dewatered and washed. The de-watered cake is then introduced onto hot leach tanks in two stages: heated brine is used for leaching potassium chloride from the sylvinite. The potassium chloride (KCl) is leached and the hot brine is now saturated with KCl, while the NaCl salt stays in solid phase.

The saturated brine from hot thickener O/F is cooled successively in 6-stage draft tube baffle vacuum crystallizers system from 93C^{o} to 49C^{o}. Upon cooling KCl salt crystallized under control condition. The underflow from the last stage crystallizer is transferred to hydrocyclones then to centrifuges for final dewatering. Then the cake is dried in a rotary dryer in which fuel oil No. 6 is used for drying; product from dryer is introduced into a screening section where two types of product are produced : standard and fine. Also granular product is produced from compacted fine material.

While the effluent dust and gases are passed through number of high efficiency cyclones and bag filter and this will be discussed in more detailed later in the paper.
The anti-caking material is added for all products to reduce the caking tendency and maintaing free flowing properties.

1.4.2. Cold Crystallization Plant (see diagram)

The cold leach plant is now operating at a design production capacity of 0.4mmtpy. This plant utilized the APC innovation and runs independently of the hot leach refinery. It is operated at ambient conditions with less energy requirement. The process can be described as follows:

The carnallite salt delivered to the refinery is first beneficiated by wet screening to separate high-grade carnallite from the fine grade, which is characterized by low purity. This stream is directed onto flotation units where high-grade carnallite is obtained as sink and NaCl as float. Both streams which contain the high grade carnallite and the sink product after de-watering are transferred into two stage cold crystallizer. Water is being added where $MgCl_2$ goes into solution and KCl crystallized, leached in two stages, and dewatered. Centrifuges are utilized for the final dewatering and then the cake is dried in a rotary type dryer using fuel oil. The product is then classified into standard and fine material.

Effluent gas and dust are directed into a series of high efficiency cyclones.

2 REFINERIES SOLID AND DUST WASTES (see diagram)

Hot leach process and cold crystallization process produce the same wastes of solids and dust.

2.1. Solid Wastes

Only one solid waste is produced upon the application of potash – producing processes, this being sodium chloride. The total quantity of sodium chloride produced as solid wastes is around 1.8 million tonnes per annum, or equivalently one ton sodium chloride per ton potash produced.
Sodium chloride is pumped as a slurry mixture from both plants to a tails site situated 2-3 km from the refineries, just to the south of the plants. Tails area, sufficiently large to absorb all the solid wastes resulting from one hundred years' production period, constitutes salty soil (inconvenient for flora) that was part of the Dead Sea ground The topographical nature of this area assists the flow of the brine from the tails area to the Dead Sea through the truce channel.

Arab Potash Company used to sell limited quantities of the waste salt NaCl, but the sold quantities of this salt are comparatively very small in comparison with the total quantities of salt actually produced and accumulated through the production years. However, APC has recently utilized this salt material as a solid base layer covering the ground of the newly established carnallited pan, C-4. This pan has consumed approximately four million tons of salt, which made a thickness layer of its ground of about 22cm.

2.2 Potash Dust

Only one dry material is being treated or conveyed through production processes, this being potash product, KCl. Consequently, the quality of the produced dust will be chemically similar to that of the final product, therefore, the dust constitutes 90-95% KCl and 2-5% NaCl. This dust is essentially formed in product dryers, cooler units, screening units, and conveying and transport system in both plants, as well as in the compaction unit in the Hot Leach plant.
APC practical procedures and regulations relevant to reduction of various emissions, particularly dust, emerge from the company's attitude toward environment as to keep it as clean as possible in spite of the fact that neither KCl nor NaCl has any drastic effect on human body. On the contrary, these two materials are very essential ingredients of the electrolytes in the human body. Still KCl and NaCl are completely soluble in water even at normal temperatures. The U.S. Environmental Protection Agency (E.P.A) has thoroughly studied the influence of dust on nearby desert plants. The study has come to the conclusion that the plants near to potash production complex usually grow better and bloom better than the remote vegetation due to fertilizing effect of potash dust.

2.2.1- Dust collection system – hot leach plant

As the processes of potash crystallization and separation from the conjugate brine solution are finalized, the wet product, containing about 5% moisture is conveyed to a rotary dryer. Effected by induced draft fans, air is forced into the dryer after being heated up to 980C^{o} in the combustion chamber upon percolation of the hot air into potash crystals, potash is dried down to 0.2% moisture or less. Heavy fuel oil is used for combustion purposes.
In the drying stage gases are formed. The flue gas contains fine potash particles that are eventually emitted through existing stacks. In order to reduce the emission of dust to the atmosphere and to control air pollution, the emitted gas are first passed through the following dust collection system as illustrated by Annexe I.

2.2.2- Dryer and Cyclones

Gases and vapors resulting from drying process contain fine particulate material of potash, the quantity of which constitutes about 1.5-4.0% of total potash product. The contaminated gases and vapors are with drawn via induced draft (ID) fans and passed through three cyclones. As the dust (solid-contaminated gases) enters the cyclone tangentially, heavier particulate material is efficiently separated from the carrier gases by virtue of centrifugal effect and settles down. These particulate solids materials are then conveyed by means of a screw conveyer to compaction unit or to fine potash surge bin as illustrated by Annex I.

2.2.3- Electrostatic Precipitator (E.S.P)

The electrostatic pracipitator is composed of an assembly of parallel, vertical plates, to which many vertical rods are connected. The mechanism of operation of electrostatic precipitator can be briefly described as follows: " The plates and rods are charged via high differential voltage. As potash particles (dust) pass through those plates the particles gain an opposite charge and are thus attracted by the plates. When the plates to which solid particles have adhered, are automatically vibrated, the solid particles became free and hence settle down the precipitator. Next, a screw conveyor transfers these solid particles to the compaction unit. Another possible alternative is to add fresh water to these particles to be dissolved and consequently the water is reused for industrial purposes (now called process water). On the other hand the finest material that cannot be precipitated or separated by the electrostatic precipitator is withdrawn by means of ID fans to very high altitudes of atmosphere through 50-m high stacks.

As a consequence of increasing potash production from 1.2 up to 1.4 million tonnes annually for the year 1990, the quantity of gases emitted at the exit of potash dryer has also increased from 95m^3/hr. to 180m^3/hr.

Therefore, the electrostatic precipitator is no longer been capable of treating the additional quantities of dust resulting from increased quantities of gases at the dryer exit. Unfortunately, this has led to failure of the electrostatic precipitator due to overload. The manufacturer of the precipitator have then been contacted for repairs but without success. Hence, it was necessary to replace this system by a new more efficient unit.

3. DUST COLLECTION SYSTEM IN THE COLD CRYSTALLIZATION PLANT:

Environmental measures have been taken into consideration during the first stages of design and erection of the 400,000 tpy cold crystallization plant for minimization of dust accompanying gas emissions. For this purpose, a modern system had been installed to collect fine particulate from dust-producing zones in the plant, which include drying, cooling, screening and dispatching regions. Fine particles produced here are collected and passed through a high-efficiency cyclone wherein relatively large particles are separated and recycled to the circuit. Only a small fraction of very fine particles is emitted to the atmosphere along with the gas stream.

The dust collection system comprises the following parts:

1. Induced draft fans:

Two induced draft fans are located on the gas outlet of the dust collection cyclone. The fans, of centrifugal type, discharge the gases to the dust collection stack.

2. Cyclone:
The dust collection system is ducted to a high efficiency cyclone capable of treating 20,000m^3/hr. at an efficiency of 90% minimum. The fine particulates are removed whilst the solids discharge from the cyclone cone into an underflow solids hopper.
3. Rotary valve:
A rotary valve is provided for air lock on the cyclone.

3 (a) 1. GAS WASTES MEASUREMENT

Technical staff at APC performs periodic measurements of the quantities of gaseous wastes emitted to the atmosphere from the cold crystallization and the hot leach plants. Accordingly, APC decided to install a collection system that will be described later. Some of the results obtained by virtue of those measurements follow:

3 (a) 1- Measurements of emissions in hot leach plant:
The main objective of emissions measurement is to collect essential data about the quality and quantity of emissions for identification of the performance of the collection system as well as to collect data for purposes of design of the new system Table 1 reveals one typical measurement.

3 (a).2- Measurement of emissions in cold crystallization plant:
Measurement of gaseous emissions at the outlet of the dryer and cooler are periodically carried out so as to assess the performance of the existing system for purpose of modifying the operational manners of this system. A typical measurement is shown on Table 2.

3 (a) 2. NEW DUST COLLECTION SYSTEM IN HOT-LEACH PLANT

Due to failure of electrostatic precipitator and exposure of existing dust collection system, the amount of emitted dust has substantially increased. Subsequently, APC has studied the various options for installation of an alternative system. The technical specifications and conditions for the new system have been identified in such a manner as to include all dust-emitting areas in the plant and reduce dust emission to the least extent and give plant equipment the required protection from dust. The new dust collection system has recently been installed and by now it is functioning satisfactorily.

The major elements of this system are:

- Dust collection system at the outlet of the dryer:
  Based on technical measurements and design calculations the existing system has been modified as follows:

  - Utilization the existing cyclones as a first-stage separation.

  - Substitution of the electrostatic precipitator by a series of eight high-efficiency cyclones as illustrated by Fig 2. Installation and operation of this system has successfully been finalized and the quantity of emissions has been reduced from 1750mg/m^3 to 300-400mg/m^3.

- New dust collection system at screening and compaction area:
  Wet scrubber system was used for separation of dust emissions at the screening and compaction area. However, the performance of this system was not satisfactory for the following reasons:

  - Corrosion and erosion of the major parts of the system.
  - Inadequacy of system capacity relative to production capacity.
  - Bad condition of sewer system due to plugs, which necessitates complete replacement of this system.
  - High water consumption and low recovery.
  - In the new system readily installed at the beginning of 1999, all dust emitting equipment have been connected to a central collection network of jet bags type as illustrated by Fig.3 which is expected to have the capacity of treating 80000m3/h.
  - Negative pressure technique is utilized wherein emissions are collected via sleeve filters.

- Proposed dust collection system at cooler:
  Amounts of emissions at the outlet of the existing cyclones at the cooler discharge have been estimated to be 150-300mg/m^3. For reduction of such emissions it turned out to be necessary to install jet bags at the outlet of these cyclones. The new system should be able to treat 210,000m^3/h and to reduce the emissions down to 70mg/m^3. This proposal is now under study by concerned department.

3(b). WASTE MANAGMENT SYSTEM IN INDUSTRIAL POTASH PLANT

In 1996 APC had established a plant for the production of 100,000 tpy of high purity potash. Through design and erection stages, satisfactory treatment of solid, liquid and gases wastes has been taken into consideration in compliance with effective environmental regulation in Jordan. As such, high efficiency equipment has been selected. Following is a description of procedures taken for treatment of wastes according to their states:

- *Gas emissions:*

  - Design considerations had taken into account that gas emission out of the plant be as low as possible so as to be compliant with Jordanian environmental laws and regulations. For this purpose, a fluidized bed dryer/ cooler has been selected which reduces the quantity of emitted gases and conjugate particulate matter in addition a developed dust collection system has been installed comprising a 99% efficiency cyclone, throttling valve and a bag filter. Specifications of emitted gases out of the plant are as follows:

    - Dust content 65mg/m^3
    - Dust Composition Co_2 2.7% max.
    - SO 0.047% max.
    - NO 0.003% max.
    - Br_2, Cl_2 5mg/m^3 max.
    - Temperature 120C^o
    - Air volume 40,000m^3/h

- *Liquid effluents:*

After being treated, neutralized and cooled to ambient temperatures, the liquid effluents from the plant are directed to the solar pans through the existing sewer system in the plants :

- Crystallization Purge
- Flow rate 4.3m^3/h
- Composition: KCl 16.4% by wt
- NaCl 15% by wt
- $MgCl_2$ 1.7% by wt
- $CaCl_2$ 0.4% by wt
- $CaSO_4$ 0.1% by wt
- KBr 0.015 ppm
- Temperature 43C^o

- Debromination Purge
- Flow rate 2.6m^3/h
- Composition NaBr 0.8% by wt
- NaCl 0.7% by wt
- Na_2SO_4 1.5% by wt
- Na_2SO_3 200 ppm
- H_2O 96. 8% by wt
- Temperature 50C^o

- *Soiled Effluents*

  Solid effluents out of the plant are those materials, which have already been dissolved in the solution exiting the plant, and are treated as described in liquid effluents.

3 (c) FUTURE PLANS FOR RENEWAL OF COLLECTION SYSTEM IN COLD CRYSTALLIZATION PLANT

Technical staff in the Arab Potash Company is conducting studies necessary for renewal and updating of the collection system of waste matter wherever necessary.

4. SOILD WASTE MANAGEMENT FUTURE PROJECT

The production of potash generates salt tails, of equal quantity to the potash production. Production has increased over recent years and production of salt tailings is projected to reach around 2.5 millions tonnes per year.

At present, these are deposited outside the refinery on land, which forms part of the APC concession. Over the years the salt tails have covered the area to a depth of many meters and effluent is now reaching the limits of the APC site. Which is now within the proximity of the agricultural land to the waste disposal area. The uncontrolled placing of the salt waste is not sustainable as it is not only threatening the adjacent farmland through contamination and despoliation but it is steadily reducing the capacity of the storm flood channel which directs major surface run-off from the surrounding Wadi’s towards the truce channel and the Dead Sea.

The future solid waste management addresses the sustainable disposal of salt tails from the refineries, the available space for deposition of salt waste using the current disposal method is nearly exhausted. The proposed system will provide a dedicated, engineering facility with a life of a round twenty years without causing further impact on the local environment. By using local and waste materials for the proposed system, the system will minimize waste and construction cost.

The project will enhance the local environment in the medium and long term by managing the deposition of waste and avoiding un-controlled leakage and spillage onto neighboring land. This will have environmental benefits to the area through reduced ground water contamination (damaging farmland), enhanced visual appearance, reduced risk of flood damage.

The project will include the excavation work and placement and compaction of the marl-cut off and salt dike around the southern perimeter of the site, the effluent pipelines will be extended further at about 500 meters, and the existing tailing pumps may require modification or replacement with more powerful ones.
The project will be managed and implemented by APC using its own resources and may a consultant if needed to supervise certain stages of the project, sub-contractor may be hired to do part of the job. The detailed construction program of the project is 24 months.

The proposed project will utilize standard construction method to design and construct a perimeter bound with marl cut off and starter dam. The starter dam will form the base for a much larger tailing dam to be constructed over the life of the project. The perimeter bund serves two purposes; the bound will protect the cut off.
In-out-fall structure and effluent channel will be constructed at the lowest point of the perimeter bund, to direct any residual overflow safety to either storm flood channel or / it could be pumped to carnallite pond C-4 for further KCl utilization.

The starter dam will be constructed from salt waste. The starter dam will be designed to be free draining, such that slurry waste pumped onto the up-stream side will form a natural beach on which heavy equipments may work safely.
The present pumps and pipeline system will be extended to reach the new area, and a high power pump will be required.

4 (a) ADVANTAGE OF THE PROJECT

1. A long-term sustainable solution to the problem of solid waste disposal from potash refineries will be developed and proven through practical application.
2. The project will lead to an integrated waste management system.
3. The project will prevent contamination to the adjacent land.
4. The project will utilize the tailing area in a more effective way.
5. The project will demonstrate a unique technical solution for the disposal of salt waste.
6. The project will reduce the risk of contamination and loss of agricultural land.
7. The project will protect and maintain the flood channel from possible flood over the life of the project.
8. The project will protect the local environment from despoliation and loss of natural habitats.

4 (b) LIQUID WASTE MANAGEMENT SYSTEM:

- SOLAR POND:

In the Solar Pond operation as described earlier, there is only one discharge stream from carnallite pond C-7 into the truce channel and flows by gravity back to the Dead Sea. The chemical and physical specification of this brine are as follows:

C-7 discharge brine

Chemical and physical specification

Quantity flow rate		250- 300 million tons /year			
Brine Temp		20- 40 C^o			
Brine Density		1.33 –1.341 g/Cm^3			
Compo nents	KCl	$MgCl_2$	$CaCl_2$	NaCl	H_2O
Wt %	0.25-0.35	26-29	6.5-7.0	0.5 –0.7	

Yearly Solar Ponds Input & Output

Year	Intake Pumps Discharge (Million Tons)	C-7 Discharge (Million Tons)	Evaporation (MillionTons)
1995	260	122	86
1996	305	110	83
1997	227	107	82
1998	309	123	113
1999	314	167	106
2000	330	195	125

- REFINERIES:

The principal liquid waste generated by APC refineries is brine from solar pond. This brine is discharged back to the truce channel and flows back into the Dead Sea. At the same time the refineries storm sewer drain is also directed back to the Dead Sea.
There is a variable composition of salt contents but mainly consist of rainwater, together with water used for plant clean up. The wastewater mainly contains salt in variable composition.

- POWER STATION

Fuel oil additives is being added to the fuel oil in-order to decrease the unburned carbon.
Flue gases from power station are discharged to atmosphere through three stacks. Chemical and physical specification of flue gases is tabulated below:

Flue Gas Specification

Flow rate	183.000 m^3/hr.
Temp	419 C^o
CO_2	15% by wt
SO_x	709 PPM
NO_x	505 PPM

CONCLUSION

Originally, during the design stages of potash refineries, all environmental measures and aspects had been taken into consideration in order to limit pollution of surroundings in accordance with highest international standards.
The Arab Potash Company set a long term strategy to deal with environmental waste by enforcing waste management program within the legal framework of National Environment strategy (NES), in accordance with the National Environmental Action plan (NEAP) to deal with major polluants : air borne emission as well as both liquid and solid wastes.

Table 1

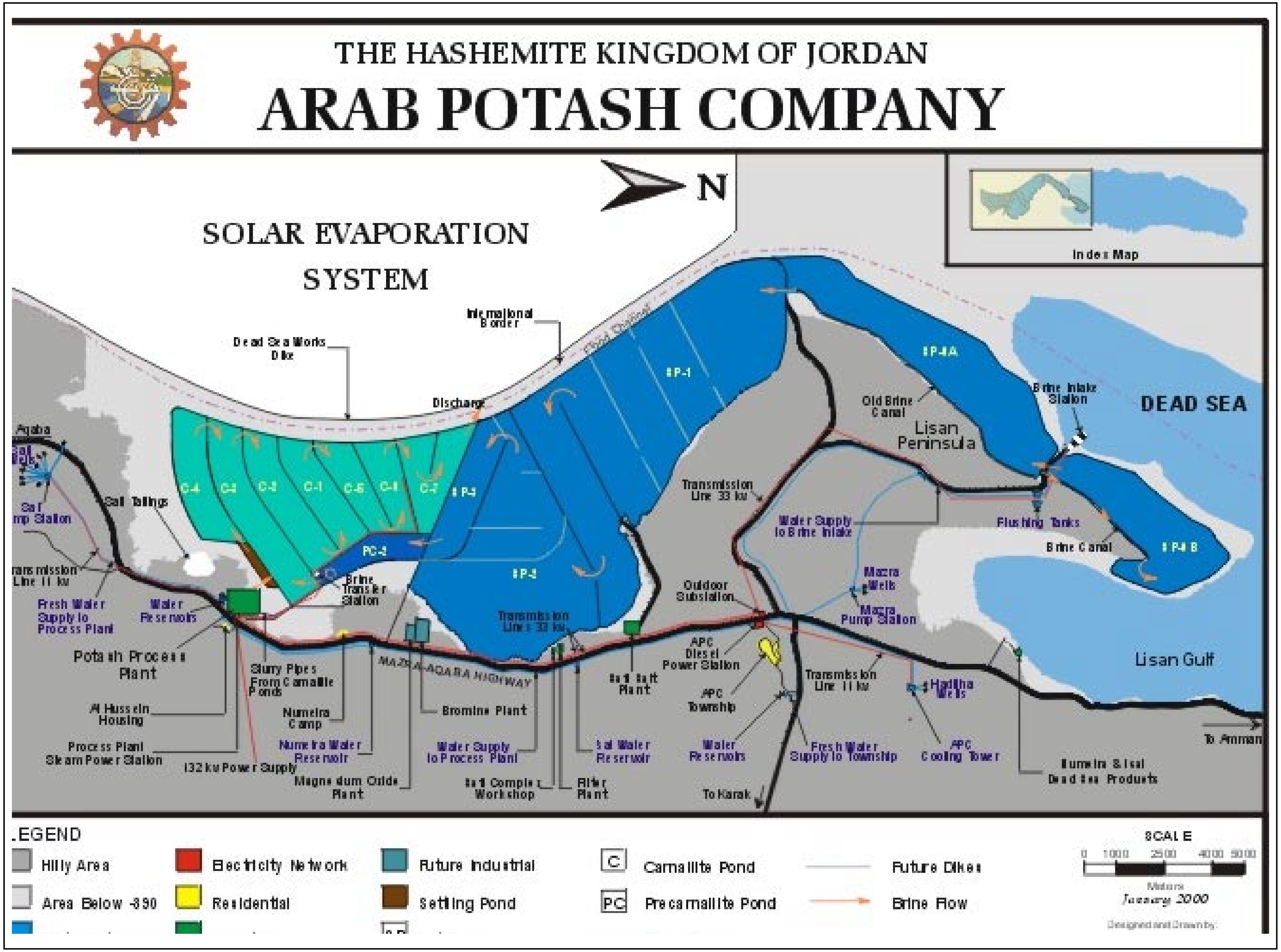
Emitted gases from Hot Leach Plant Stacks

MEASUREMENT	VALUE
SO2	231 PPM
Nox	5210 PPM
Dust emission from Stack	325 mg/m3

Table 2

Dust Emission from Cold Crystallization Plant Stack

MEASUREMENT	VALUE
Cold Crystallization Plant Stack	275 mg/m3


THE HASHEMITE KINGDOM OF JORDAN
ARAB POTASH COMPANY
N
SOLAR EVAPORATION SYSTEM
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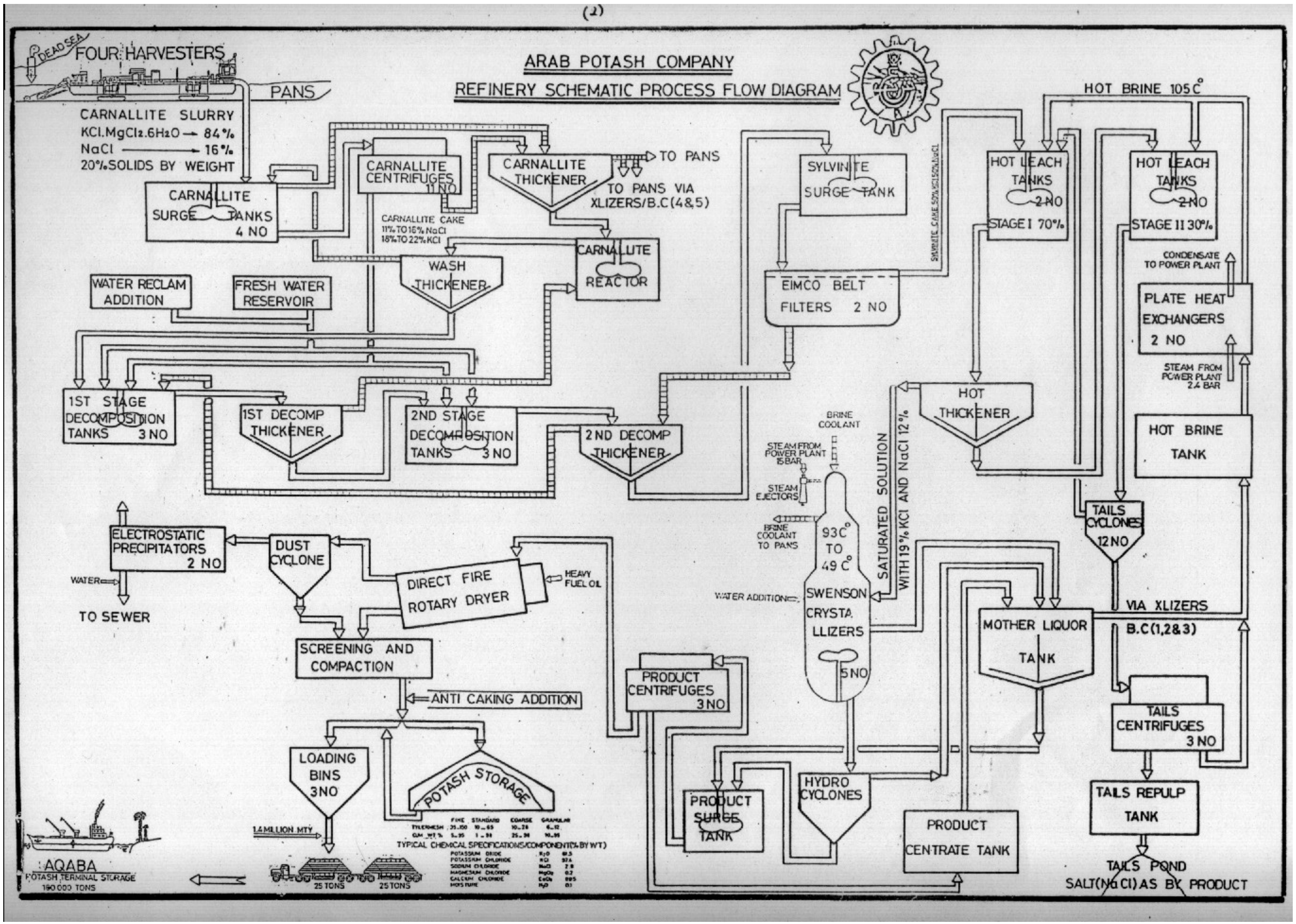
International Border
Dead Sea Works Dike
Discharge
DEAD SEA
Lisan Peninsula
Lisan Gulf
Old Brine Canal
Brine Intake Station
Brine Canal
Flushing Tanks
SP-4A
SP-4B
SP-1
SP-2
SP-3
PC-2
C-4
C-3
C-2
C-1
C-6
C-8
C-7
Aqaba
Salt Tailings
Brine Transfer Station
Transmission Line 33 kv
Transmission Line 11 kv
Water Supply to Brine Intake
Mazra Wells
Mazra Pump Station
Outdoor Substation
APC Diesel Power Station
APC Township
Water Reservoirs
Fresh Water Supply to Township
Haditha Wells
APC Cooling Tower
Sumeira & Isal Dead Sea Products
To Amman
To Karak
Salt Salt Plant
Salt Water Reservoir
Filter Plant
Salt Complex Workshop
Water Supply to Process Plant
Bromine Plant
MAZRA-AQABA HIGHWAY
Magnesium Oxide Plant
Numeira Water Reservoir
Numeira Camp
Slurry Pipes From Carnallite Ponds
132 kv Power Supply
Process Plant Steam Power Station
Al Hussein Housing
Potash Process Plant
Water Reservoirs
Fresh Water Supply to Process Plant
LEGEND
Hilly Area
Area Below -390
Electricity Network
Residential
Future Industrial
Settling Pond
C Carnallite Pond
PC Precarnallite Pond
Future Dikes
Brine Flow
SCALE
0 1000 2500 4000 5000
Meters
January 2000
Designed and Drawn by: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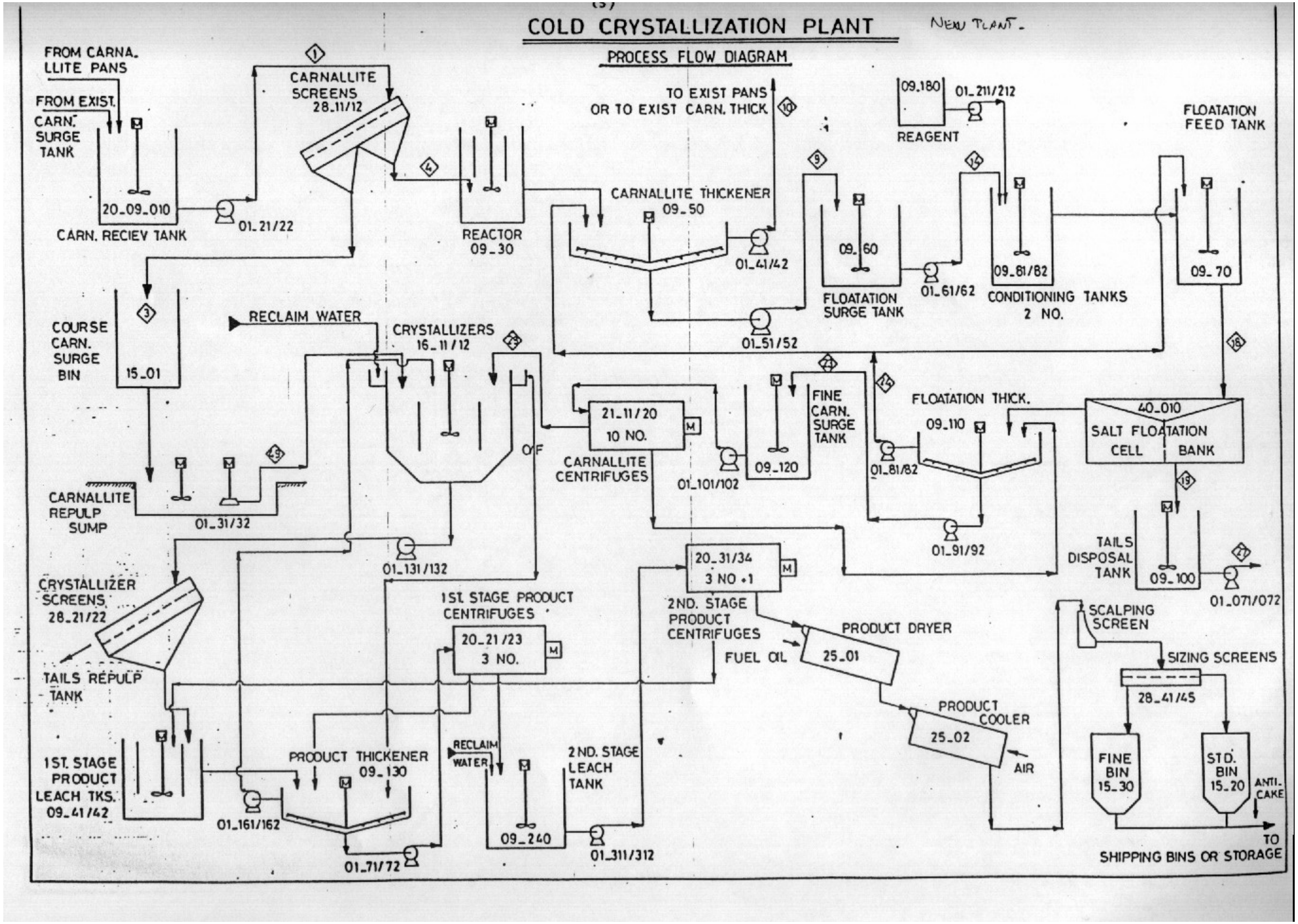
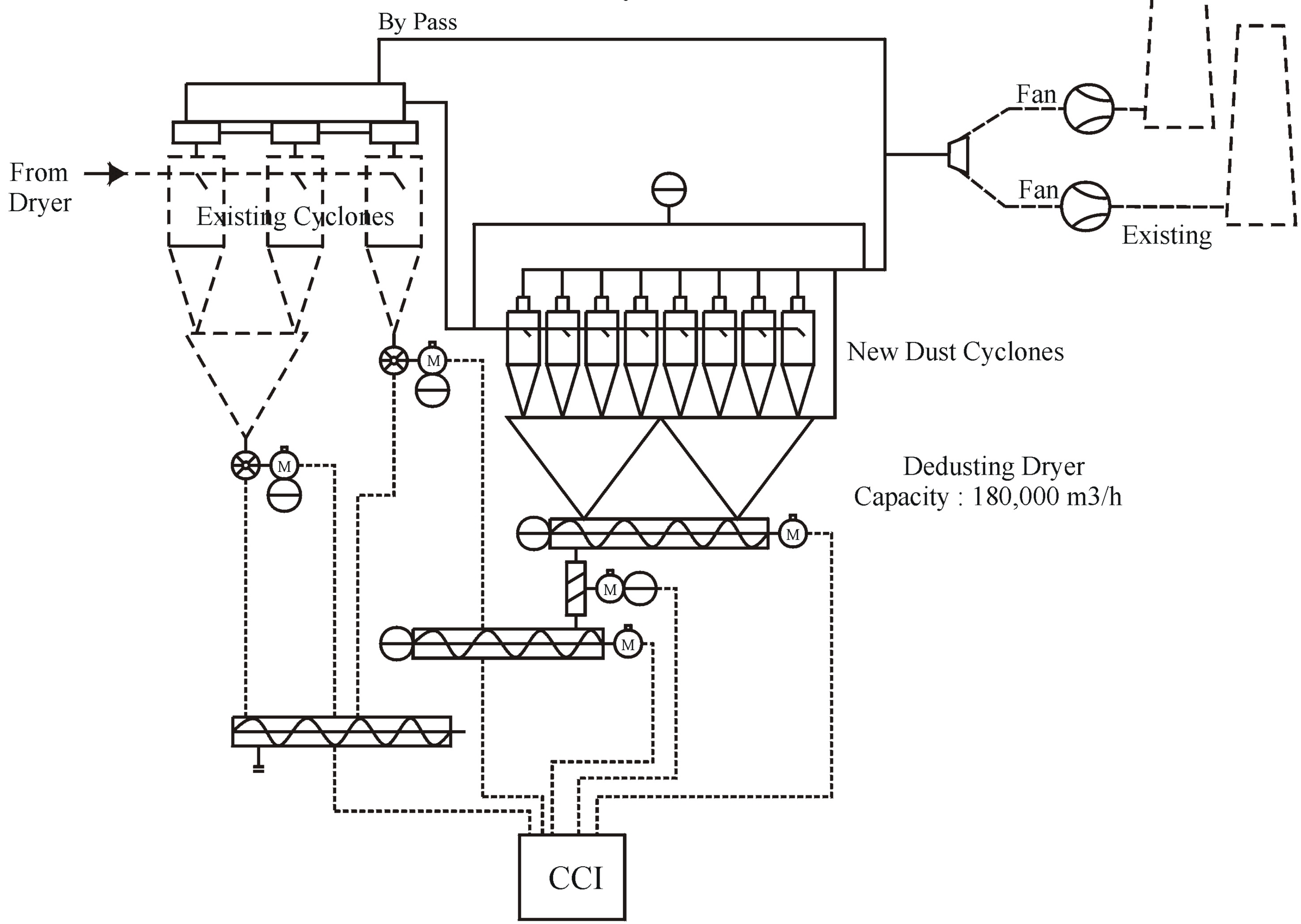
ARAB POTASH COMPANY
REFINERY SCHEMATIC PROCESS FLOW DIAGRAM
DEAD SEA
FOUR HARVESTERS
PANS
CARNALLITE SLURRY
KCl.MgCl2.6H2O → 84%
NaCl → 16%
20% SOLIDS BY WEIGHT
CARNALLITE SURGE TANKS 4 NO
CARNALLITE CENTRIFUGES 11 NO
CARNALLITE CAKE 11% TO 16% NaCl 18% TO 22% KCl
CARNALLITE THICKENER
TO PANS
TO PANS VIA XLIZERS/B.C(4&5)
CARNALLITE REACTOR
WASH THICKENER
WATER RECLAM ADDITION
FRESH WATER RESERVOIR
1ST STAGE DECOMPOSITION TANKS 3 NO
1ST DECOMP THICKENER
2ND STAGE DECOMPOSITION TANKS 3 NO
2ND DECOMP THICKENER
SYLVINITE SURGE TANK
EIMCO BELT FILTERS 2 NO
SYLVINITE CAKE 50% KCl 50% NaCl
HOT BRINE 105°C
HOT LEACH TANKS 2 NO STAGE I 70%
HOT LEACH TANKS 2 NO STAGE II 30%
CONDENSATE TO POWER PLANT
PLATE HEAT EXCHANGERS 2 NO
STEAM FROM POWER PLANT 2.4 BAR
HOT BRINE TANK
HOT THICKENER
SATURATED SOLUTION WITH 19% KCl AND NaCl 12%
BRINE COOLANT
STEAM FROM POWER PLANT 15 BAR
STEAM EJECTORS
BRINE COOLANT TO PANS
93°C TO 49°C
WATER ADDITION
SWENSON CRYSTALLIZERS 5 NO
TAILS CYCLONES 12 NO
VIA XLIZERS B.C(1,2&3)
MOTHER LIQUOR TANK
TAILS CENTRIFUGES 3 NO
TAILS REPULP TANK
TAILS POND
SALT(NaCl) AS BY PRODUCT
ELECTROSTATIC PRECIPITATORS 2 NO
WATER
TO SEWER
DUST CYCLONE
DIRECT FIRE ROTARY DRYER
HEAVY FUEL OIL
SCREENING AND COMPACTION
ANTI CAKING ADDITION
PRODUCT CENTRIFUGES 3 NO
LOADING BINS 3 NO
POTASH STORAGE
TYPICAL CHEMICAL SPECIFICATIONS/COMPONENTS(% BY WT)
1.4 MILLION MTY
25 TONS
25 TONS
PRODUCT SURGE TANK
HYDRO CYCLONES
PRODUCT CENTRATE TANK
AQABA
POTASH TERMINAL STORAGE
160 000 TONS


COLD CRYSTALLIZATION PLANT
New Plant -
PROCESS FLOW DIAGRAM
FROM CARNA-LLITE PANS
FROM EXIST. CARN. SURGE TANK
20_09_010
CARN. RECIEV TANK
01_21/22
CARNALLITE SCREENS 28_11/12
REACTOR 09_30
TO EXIST PANS OR TO EXIST CARN. THICK
CARNALLITE THICKENER 09_50
01_41/42
01_51/52
09.180
REAGENT
01_211/212
09_60
FLOATATION SURGE TANK
01_61/62
09_81/82
CONDITIONING TANKS 2 NO.
FLOATATION FEED TANK
09_70
COURSE CARN. SURGE BIN
15_01
RECLAIM WATER
CRYSTALLIZERS 16_11/12
O/F
21_11/20 10 NO.
CARNALLITE CENTRIFUGES
01_101/102
09_120
FINE CARN. SURGE TANK
FLOATATION THICK.
09_110
01_81/82
01_91/92
40_010 SALT FLOATATION CELL BANK
CARNALLITE REPULP SUMP
01_31/32
01_131/132
TAILS DISPOSAL TANK
09_100
01_071/072
CRYSTALLIZER SCREENS 28_21/22
TAILS REPULP TANK
1ST. STAGE PRODUCT CENTRIFUGES
20_21/23 3 NO.
20_31/34 3 NO +1
2ND. STAGE PRODUCT CENTRIFUGES
FUEL OIL
PRODUCT DRYER
25_01
SCALPING SCREEN
SIZING SCREENS
28_41/45
PRODUCT COOLER
25_02
AIR
1ST. STAGE PRODUCT LEACH TKS. 09_41/42
01_161/162
PRODUCT THICKENER 09_130
01_71/72
RECLAIM WATER
09_240
2ND. STAGE LEACH TANK
01_311/312
FINE BIN 15_30
STD. BIN 15_20
ANTI-CAKE
TO SHIPPING BINS OR STORAGE

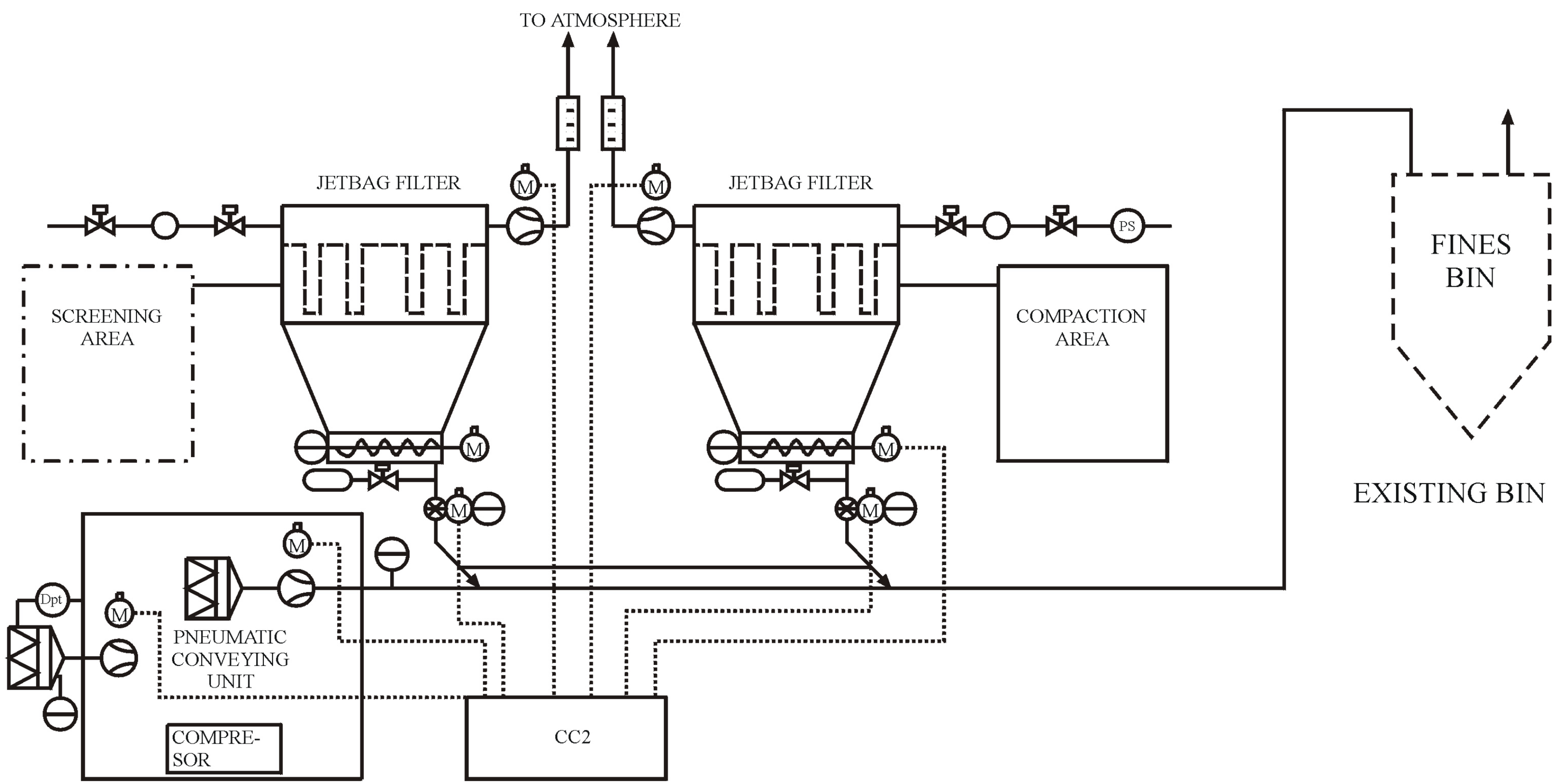
Annex 1

Dust Collection System Hot Leach Plant



ANNEX 2

DEDUSTING SCREENING AND COMPACTION



CAPACITY: 40,000 Am^3/h - each
EMISSION LEVEL: < 10mg $/Nm^3$