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SALT IODIZATION PLANT - PAKISTAN 1977

by

Edwin Willoe

February 1977

A Report Prepared for:

Office of Nutrition
Technical Assistance Bureau
Agency for International Development
Washington, D.C. 20523

Carried out through Contract with:

Nutrition and Agribusiness Group
U.S. Department of Agriculture
Economic Research Service
Washington, D.C. 20250

CONTENTS

SALT IODIZATION PLANT - PAKISTAN 1977

GENERAL DESCRIPTION OF PROCESS FOR CRUSHING, IODIZING, AND PACKING OF SALT AT PLANT TO BE BUILT NEAR PESHAWAR, NORTH WEST FRONTIER PROVINCE, (N.W.F.P.)

Lump rock salt will be delivered at the proposed plant from Government mines in the area. Analysis of salt from the Jetta mine shows NaCl content of 90-93%. Salt from the Bahadar Khel mine shows NaCl content of 98%, the major impurity being CaO in both cases. These analyses were from records at the main mine office. The salt from both mines will be delivered in covered trucks of about 10 ton capacity.

A general covered storage area will be provided for the lump rock salt and the finished iodized bag salt. By adjustment of the percentage of each product stored and the height to which it is stored, we believe it will have sufficient storage area to compensate for the effect of weather on shipments to and from the plant.

The large lumps of rock salt 10" to 14" size will be crushed in a jaw crusheer to 1/2" size lumps and fines. A 14" rubber belt conveyor (inclined) will carry this primary crushed salt to bins over two chuckie mills.

The chuckie mills will be set to grind the salt a little coarser than normal product to try to reduce the amount of very fine salt (minus 120 mesh). The salt will then go over a 16 mesh scalping screen with the minus 16 mesh salt going to a final crushed salt bin and the plus 16 mesh returned for regrinding by the chuckie mills. There may have to be some adjustment of the size of this scalping screen depending on the performance of the chuckie mills which is not definitely known at this time.

The finished crushed salt will be fed from this bin by a small vibrating feeder (Eriez Manufacturing Company, U.S.A.) at an adjustable rate of 5 to 6 tons per hour. This feed rate is controlled by a rheostat which varies the amplitude of vibration. As the salt falls approximately 18" from the feeder to the mixing conveyor it will be sprayed with a potassium iodate solution in a spray chamber. By using an air atomizing nozzle (wide angle 50^{o}) a fine spray will impinge on the salt giving a fairly even distribution of the iodate solution. The amount of iodate solution fed is controlled by putting a constant air pressure on a small closed tank and regulating the flow with a needle valve through a visual flow meter. Necessary safeties will be installed to shut off iodate feed if salt flow accidently stops. It is planned to feed not less than 25 parts per million potassium iodate. Dr. Sardar Ali, Assistant Director of Health Department, N.W.F.P., suggested maximum amount fed be not more than 50 parts per million. Therefore control will be 25 to 50 parts per million. The iodated salt will then be mixed in a 12" diameter cut and folded flight mixing conveyor to provide a thoroughly homogeneous product.

The finished salt will be manually packed in 1-kilo polyethylene bags and manually heat sealed. The weight will be controlled by a volumetric manual measure and checked by a small scale at each station. There will be six packing stations each packing 15 to 16 bags per minute to give a total production of 100 bags per minute. Bag size to be used is 6" x 9" .002 mm thickness.

A 6" cotton belt will carry the 1-kilo packages to a manual packing station where twenty 1-kilo packages will be packed into a 16" x 24" .03 mm polyethylene bag and heat sealed for closing. Some fill and drop tests should be made before final bag sizes and thickness are determined. The packed bags will be trucked to storage by 2-wheel hand trucks and manually piled. The packed bags will be moved from storage to shipping trucks by 2-wheel hand trucks.

NOTE: By adding a small amount of yellow prussiate of soda (sodium ferrocyanide) to the iodate solution tank, a tendency of the fine salt to become lumpy can be minimized. We are suggesting 5 parts per million in the finished product. American standards allow 13 parts per million of sodium ferrocyanide in table salt. (Sodium chloride food chemical Codec). There would be no extra cost of equipment--only the very small cost of the chemical.

During one of our discussions with Pakistan Engineering and Design Company in Lahore, we learned that a company there was considering a plant to add magnesium carbonate to the crushed salt to provide a free running salt. With the equipment as proposed, if in the future it was decided to make a competitive product, this could be accomplished by the addition of a small dry powder feeder 5 feet along on the cut and folded flight mixing conveyor. This feeder should not cost more than 200-300 dollars and could be used where a free flowing salt was desired and not used where a conventional crushed salt was desired. A better product than magnesium carbonate for making salt free flowing is sodium alimino silicate.

EQUIPMENT FOR SALT CRUSHING AND IODIZATION PLANT

Item 1 One Jaw Crusher as manufactured by Moghal Engineering Works, 90 Railway Road, Lahore. To crush 24" x 10" chunks of rock salt to 1/2" size. Capacity 10 tons/hour. Complete with 40 h.p. motor and gear reduction drive. Hopper mounted under crusher to convert discharge to 4" wide to discharge in center of 14" conveyor belt.

Item 2 One 14" Flat Rubber Belt Conveyor 25' approximately in length with gear reducer V-belt pulley and motor. 12" diameter head and tail pulley for maintaining correct belt tension. Belt conveyor is inclined to a height of 11'-10". General engineering firm (contractor) to design and order supporting steel structure for conveyor and drive. Belt may require ribs across surface to prevent lumps from rolling back.

Item 3 One 9" Diameter Screw Conveyor to distribute salt to 4 feed bins for chuckie feed. Galvanized iron for screw and box. Length of conveyor about 20 feet.

Item 4 Four Bins Over Chuckie Mills as per drawing sketch. Details of bin structure and supports to be furnished by general design contract engineering firm. Material in contact with salt to be aluminum, E.L.C. stainless steel 316. If 316 not available, 304 can be used if necessary. Black iron may be used if it can be sand blasted, painted and baked to form a hard finish.

Item 5 Four 30" Horizontal Chuckie Mills complete with 15 h.p. motor, gear reduction and belt drive. Capacity 35 maunds per hour or 2740 lbs./hr. Moghal Engineering Works, 90 Railway Road, Lahore, Rupees 15,500 each, FOB Lahore.

Item 6 One Scalping Screen approximately 12" by 3' 6" long equipped with 16 mesh 316 stainless steel screen. Product through screen to be carried in through and discharged to fine crushed salt bin. Coarse product over screen to go to overflow bin for regrinding. Scalping screen to be vibrator operated either with electric vibrating unit or excentric rotating shaft.

Item 7 One 14" Flat Rubber Belt Conveyor same details as Item 2 but a length of 25 feet. No cross ribs on surface required.

Item 8 One Bucket Elevator Belt Type. Use 8" rubber elevator belt with galvanized steel buckets. Size of buckets and speed of operation to be such that elevator has a capacity of 12 tons of crushed salt per hour. Height of elevator approximately 22 feet. Elevator to be equipped with gear reducer, V-belt drive and motor. Elevator housing to be galvanized steel (iron).

Item 9 One Crushed Salt Storage Bin. Aluminum, stainless steel, or fiberglass, where material comes in contact with salt. Superstructure may be mild steel to reinforce bin so a lighter skin material may be used. Bin to have swing gate shut off on bottom.

Item 10 One Vibrating Feeder Conveyor. Approximately 8" wide by 18" long, 316 stainless steel. Equipped with electric vibrator control mechanism to feed. If possible should be rheostat adjustable to vary feed from 6 tons per hour to 12 tons per hour. Crushed rock salt minus 16 mesh to be fed. Eriez Manufacturing Company, USA.

Item 10a If manufacturer of Item 10 feels the unsteady voltage and the 50 cycle 220 volt current of the N.W.F.P. would adversely affect the accuracy of the feeder, a volumetric rotary feeder may be substituted. Such a feeder is called a DRAVO FEEDER as manufactured by B.F. Cump Company, USA.

Item 11 Spray Chamber for Adding Liquid Iodate Solution. Material 316 stainless or monel, equipped with wide angle air atomized spray nozzle. (Wide angle to be 50° or better). Nozzle to be purchased from Spraying Systems Company, Bellwood, Illinois. Use an F4B assembly unit with fluid nozzle #40100 capacity 7.5 lb./hr and 20 P.S.I.G. on air nozzle #122440.

Item 12 One 12" Mixing Conveyor. Cut and folded flight approximately 20' long. Provide four 2" x 2" cuts per 3 feet of flight. Made of two 10 feet sections with bearing between sections. Complete with box end reducing gear, V-belt drive and motor. Conveyor to have minimum capacity of 6 tons/hour, maximum capacity of 12 tons/hour. Conveyor and box to be galvanized iron, stainless steel, or monel. Jeffery Manufacturing Company, USA, or equivalent. Size of motor and gear reducer dependent on design of conveyor.

Item 13 One Bin for Hand Packing Station as per drawing, material to be fiberglass, aluminum, 304 stainless steel, or monel. Superstructure may be of mild steel so as to provide strength so thinner noble metals may be used.

Item 14 Six Small Bag Holders for manual filling of 1-kilo bags. Material stainless steel as per detail. (Check scale mounted under each manual filling station for checking weight). Use manual volumetric hand filling. Fill container to be about 4" in diameter and of a height about 5 inches to hold 1 kilo when struck off level at the top. Suggest several containers varying in height by 1/16", as specific weight of salt may vary from day to day.

Item 15 Four Manual Type Heat Sealers for closing 1-kilo polyethylene bags (6" x 9") 6" seam. Mounted on packing table for maximum ease of operation.

Item 16 One Slide Board Packing Station and sealing station bags, to be transferred manually.

Item 17 Two Hand Packing Stations for packing 1-kilo bags into a 16" x 24" ployethylene bag. Provide 2 simple bag holders for holding 16" x 24" bag so that 1-kilo bags may be placed inside.

Item 18 Two Heat Sealers for sealing 16" seam on bags.

Item 19 Eight 2-Wheel Hand Trucks for moving raw salt from trucks to storage and from storage to jaw crusher. Also used to move finished salt from packing station to storage and from storage to shipping trucks.

Item 20 Spray System Assembly comprised of one 50-gallon stainless steel or fiberglass tank (open). One 10-gallon closed tank tested and approved for 20 pounds per square inch bursting pressure. Two air pressure reducing valves, one 60 to 25 pounds, and one 60 to 10 pounds. One visual flow meter for measuring flow of iodate solution (Fisher Porter Moto Meter, USA). One air safety valve set at 15 pounds per square inch. Two solenoid valves 3/8" for automatic shut off of air and liquid flow. Three-eighths-inch miscellaneous tubing (copper for air, 316 stainless for iodate solution) as per detail. Miscellaneous 3/8" valves for manual control as per detail. One side tank mounted electric mixer for disolving iodate in solution. One air atomizing spray nozzle with changeable nozzles.

Item 21 One Air Compressure Unit complete with motor, air tank, automatic unloader, etc. Capacity 5 cu. ft. per minute; 60 pounds per square inch pressure.

Item 22 Miscellaneous High Level and Low Level Alarms for control of bin level on overflow bin and finished crushed salt storage bin. Provide a no salt flow alarm for vibrating feeder (or Dravo volumetric feeder) to activate shut off valves on iodate solution feed.

PROCEDURE FOR FEEDING IODATE SOLUTION

The iodate solution is to be mixed in the 50-gallon solution tank. Since the tank as manufactured may not be completely true, it should be calibrated in the field in kilo-gram units (liters) of height.

The solubility of potassium iodate is as follows:

Temperature C°	% Solution	KIO_3 grams/100 gms	KIO_3 Water grams/per kilogram
0°	4.73	4.73	47.3
20°	8.13	8.13	81.3
40°	12.80	12.8	128.0
60°	18.50	18.5	185.0

Therefore using the solubility at 0° to have 30p.p.m. in the salt would feed 0.634 kilograms (liters) of solution per 1000 kilograms of salt. Or at a production rate of 5 metric tons per hour would feed 3.17 kilograms of solution per hour.

If this rate of feed adds too much moisture to the salt, one could reduce the moisture by adding a small electric heater to the tanks and increase the solubility as per the table above.

The 50-gallon mixing tank should be mounted 6" to 1' above the top of the small tanks (10 gallon) so they will fill by gravity.

To fill 10-gallon tanks shut off valve A, close air valve C and open vent valve B. By then opening valve D solution will fill 10-gallon tank by gravity. To put in service close vent valve B, close fill valve D, open air valve C, and open discharge valve A. Adjust rate of flow by needle valve on visual flow meter. Flow meter should have a capacity of

3 to 7 liters per hour. In this description I have used liters and kilograms as equal which is sufficiently accurate when the tank is calibrated volumetrically.

By the use of two 10-gallon feed tanks it is not necessary to stop the operation to recharge feed tanks. Since one tank should last more than 8 hours of operation for first year operation, only one 10-gallon tank is needed.

SUGGESTED EMPLOYEES AND JOB DESCRIPTIONS FOR OPERATION OF CRUSHING, IODIZING, AND PACKAGING OF SALT AT PESHAWAR, N.W.F.P.

One-Plant Superintendent and Laboratory Supervisor

Generally responsible for complete operation of plant, material storage, and laboratory.

One-Assistant Plant Superintendent

Responsible to take over plant superintendent job when plant superintendent absent. Operates laboratory, making chemical tests as required, checks weights of packages, and monitors quality of workmanship.

One-Mixer Operator

Makes up iodate solution.

Adjusts feeding for correct feed.

Observes that feeders are feeding correctly.

Starts and stops equipment from crushed salt storage bin to finished salt storage bin.

Three-Chuckie Mill Operators

1 each operates feed to mill (feeder), one operator for 2 mills. 1 available to relieve feeder. Starts and stops conveyor from jaw crusher to chuckie mills and observes operation, starting and stopping of vibrating scalpers and elevator to fine crushed salt bin. Above group rotate job on regular schedule.

Two-Operate and Feed Jaw Crushers

Observe high level and low level signal on primary crushed salt bin so as not to overflow bin or have chuckie mills run out.

One-Packer, Sealer, Supervisor, and Relief Man

He is a leader who relieves regular packer sealers and sees that group operates efficiently. Checks weights and quality of workmanship of sealing.

Packer and Sealers

Six-pack 1-kilo of salt into 6" x 9" polyethylene bag Four-seal polyethylene bag	should rotate jobs
Two-pack twenty 1-kilo bags into 16" x 24" polyethylene bag Two-seal 16" x 24" polyethylene bags and places on hand truck	should rotate jobs

Three-Storage Men

Hand trucks 20-kilo bag of salt to storage and tips up truck to store. If storing higher than 1 tier, two extra men to lift bags to second tier.

Four-Raw and Finished Salt Handlers.

Move raw salt from incoming trucks to storage. Move raw salt from storage to jaw crusher. May be used in finished salt storage and handling as needed.

One-Mechanic

Does all mechanical repair normally done in field. May use laborer as helper when 2 people are needed. Should be able to weld, replace machine parts (simple repairs) and fix simple electrical problems.

One-Material Supply Man

Responsible for receiving supplies of polyethylene and chemical and issuing same for usage.

Two-Laborers

To return over run of scalping screens for regrinding and for temporary assignment elsewhere if needed when work is slack.

Total Supervisory Employees	Two
Total Production Employees	Thirty-two

OPERATING COSTS FOR 6428 M.T. (PLANT COSTS ONLY)

Plant labor per year =	52,840 Rs.
Honoraria	60,312 Rs.
Plant labor	113,152 Rs. + Office
Electricity 150 H + 150 KW/Hr. for 2000 hours	
300 KW/Hr. @ 0,30 Rs. =	90,000 Rs.
Iodate 14,141,600 lb. salt @ 30 p.p.m. = 424 pound iodate	
424 x 40 Rs. per lb. =	16,960 Rs.
Bags = 6,427,000 1-kilo bags @ 066 Rs. =	424,180 Rs.
321,000 20-kilo bags @ 0,5 Rs. =	160,500 Rs.
Total Plant Cost =	804,782 Rs.

For 6,427,000 1-kilo packages = 0.125 Rs. each.

COST ESTIMATE OF EQUIPMENT

Item # 1	92,000
2	50,000
3	20,000
4	20,000
5	62,000
6	25,000
7	40,000
8	63,000
9	30,000
10	40,000
11	20,000
12	200,000
13	30,000
14	6,000
15	6,000
16	10,000
17	10,000
18	10,000
19	16,000
20	150,000
21	10,000
22	10,000
TOTAL	920,000 Rs.

Engineer Drawing	125,000	@ 15 Hr. 3 mos. x 40 Hrs.
Freight	20,000	
Installation supervision	45,000	
Local labor	45,000	
	235,000	
Contingencies	200,000	
	435,000	

920,000
435,000
1,355,000 Rs.

LABORATORY EQUIPMENT

1. 1 - Analytical Balance
   Fisher Scientific Co., USA

2. 3 - 100 ml. pipettes
   3 - 10 ml. pipettes
   3 - 1 ml. pipettes

3. 12 - 100 ml. glass stoppered graduates for Y.P.S. control
   12 - 600 ml. beakers

4. 24 - 250 ml. beakers
   2 - 3 liter beakers
   3 - 2 liter beakers
   2 - 1 liter beakers

5. 3 - rubber stoppered bottles/liter

6. 6 - 500 ml. volumetric flask

7. 2 - 6" diameter glass funnels
   3 - 3" diameter glass funnels

8. 3 - 100 ml. burettes
   2 - 250 ml. burettes

9. Small torsion balance 5 lb. for check weighing.

10. Chemicals for checking iodate content phosphoric acid, ortho 85% AR
    Sodium thiosulphate, C.P. Crystals
    Potassium iodate, C.P. Crystals
    Choloroform A.R.
    Soluble starch
    Methyl Orange Indicator

11. If U.P.S. (yellow prussiate of soda) is added to iodate solution tank, a check for Y.P.S. is a good field check on the iodate content.

    Equipment and chemicals required for Y.P.S. content.

    Colorimeter - Klett Summerson or equivalent with 40 mm cell and red filter (610-640 mu.) Klett No. 64 USA.

    Sulphuric Acid A.R.
    Hydrochloric Acid A.R.
    Sodium Hydroxide pellets A.R.
    Sodium ferrocyanide decahydrate A.R.
    Sodium chloride A.R.
    Filter paper, Whatman No. 42 or equivalent

12. Sink with hot and cold running water

13. Apparatus for making distilled water (evaporator, condenser, and larger stoppered bottles (1 gallon) for collecting).

14. Work benches and cupboards for chemicals and glassware.

15. Miscellaneous rubber tubing 1/4 " and glass tubing.

16. Hot plate (four heater capacity)

Above equipment and supplies can be purchased from Fisher Scientific Company, U.S.A. if not available locally.

POTASSIUM IODATE DETERMINATION

This method is to be used for determining the iodine in an iodized salt.

I. Chemicals and Reagents Required

Phosphoric acid, ortho 85% AR

Sodium thiosulfate, CP, crystals

Potassium iodate, CP, crystals

Chloroform, AR

Soluble starch

Methyl orange indicator

II. Solution Preparation

Solution A - Sodium thiosulfate solution

Weigh out approximately 2.50 grams sodium thiosulfate and dissolve in 2 liters of distilled water. Add 0.2 grams sodium carbonate and 4 drops of chloroform. Keep in a rubber stoppered bottle. The rubber stopper should be free from sulphur contamination. Sodium thiosulfate solution is quite stable and maintains its normality (within a reasonable factor) for several weeks. It is advisable to check this solution frequently to determine the exact period of stability.

Solution B - Starch Solution

Add 2.50 grams of soluble starch to a few ml. of cold distilled water and rub to a paste. Add this, without stirring, to 1 liter of boiling distilled water so slowly that boiling never ceases. Boil for an additional 2 minutes and then allow to cool. Preserve by addition of 1 ml. of chloroform and keep in a glass stoppered bottle. Discard and make up a new solution when mold appears or if a good strong color is not developed with a very diluted iodine solution.

III. Standardization

Dissolve exactly 0.1686 grams of potassim iodate in distilled water and make up to 1 liter quantitatively. Using a pipette, measure into a 600 ml. beaker exactly 25.0 ml. of the above solution. This represents 0.00422 grams of potassium iodate. Add 250 ml. of distilled water, a few drops of methyl orange indicator and neutralize with 85% phosphoric acid. Then add 2 ml. excess acid and about 0.5 grams potassium iodide crystals. Titrate the liberated iodine with the sodium thiosulfate solution using starch solution as an indicator. Record ml. used.

IV. Procedure

Weigh out a 100 gram sample of iodized salt. Introduce it into a 500 ml. volumetric flask by means of a small funnel. Dissolve the salt in distilled water and make up to 500 ml. mark. Transfer a 50 ml. aliquot of this solution by means of a pipette to a 600 ml. beaker and add 250 ml. distilled water. To this sample (represents 10 grams of the original) add a few drops of methyl orange indicator and neutralize with 85% phosphoric acid; then add 2 ml. excess of acid. Add about 0.5 grams of potassium iodide crystals. Titrate the liberated iodine with standardized sodium thiosulfate solution of about 0.005N, using a standard burette. When the iodine color of the solution turns pale yellow add about 5 ml. of starch solution and continue until the solution is just colorless. The reaction is:

$$KIO_3 + 5KI + 2H_3PO_4 \rightarrow 2K_3PO_4 + 3H_2O + 3I_2$$

NOTE: This method is not applicable to an iodized salt which has been stabilized with calcium stearate, a fatty acid.

V. <u>Calculations</u>

0.00422 grams potassium iodate divided by the number of ml. sodium thiosulfate solution equals grams potassium iodate equivalent to 1 ml. of solution (Factor)

Factor x ml. sodium thiosulfate used to titrate unknown x 100 ÷ 10 = % potassium iodate in sample.

FERROCYANIDE IN SALT

This is a colorimetric method for the determination of total ferrocyanide in various ferrocyanide treated salts, e.g. TFC Treated Salt, Dendritic and Safe-T-Salt. This is based on the development and measurement of the ferro-ferrocyanide blue color. In this method it is necessary to have two standard curves for high and low levels of ferrocyanide in the salt.

I. Chemicals and Apparatus

Colorimeter - Klett Summerson or equivalent with 40 mm cell and red filter (610 - 640 mu.), Klett No. 64.

Sulfuric acid - A.R.

Hydrochloric acid - A.R.

Sodium hydroxide pellets - A.R.

Ferrous sulfate heptahydrate - A.R.

Sodium ferrocyanide decahydrate - A.R.

Sodium chloride - A.R.

Glass stoppered graduate - 100 ml. capacity

Filter paper, Whatman No. 42 or equivalent

II. Solutions

A. Sodium Ferrocyanide, Decahydrate ($Na_4Fe(CN)_6 \cdot 10H_2O$)

1. Weigh exactly 1.5927 grams of sodium ferrocyanide decahydrate, dilute to volume in a liter flask with distilled water and mix well.

2. Pipette 100 ml. of solution A-1 into a liter flask, dilute to mark and mix well.

One ml. contains 100 micrograms of $Na_4Fe(CN)_6$.

3. Pipette exactly 10 ml. of solution A-1 into a liter flask, dilute to mark and mix well. One ml. contains 10 micrograms of $Na_4Fe(CN)_6$.

B. Ferrous Sulfate Solution

Dissolve 10 grams of ferrous sulfate heptahydrate ($FeSO_4$ $7H_2O$) in 100 ml. of distilled water add 0.5 ml. of concentrated sulfuric acid and mix well. If not perfectly clear, filter. Prepare fresh daily.

III. Graph Preparation

A. For Low Level of Ferrocyanide (0-20 p.p.m.)

To each of six 100 ml. glass stoppered graduates add 20 grams of Reagent grade sodium chloride. Add 0, 10, 20, 25, 30 and 40 ml. of solution A-3. These amounts represent 0, 100, 200, 250, or 0.0, 5.0, 10.0, 12.5, 15.0 and 20.0 p.p.m. sodium ferrocyanide in the salt respectively if 20 grams samples are used. Add distilled water, dissolve salt and dilute to 95 ml. Using a pipette or burette add 5 ml. of ferrous sulfate solution and mix well. Allow to stand 15 minutes before measuring absorbancy in colorimeter against a distilled water blank using a 640 mu. filter (Klett filter No. 64) and 40 mm cell. Record Klett readings and plot absorbancy, against micrograms of sodium ferrocynanide (or against p.p.m. sodium ferrocyanide in salt).

B. For High Level of Ferrocyanide (up to 150 p.p.m.)

To each of seven glass stoppered graduates add 10 grams of Reagent grade sodium chloride. Add 0, 5, 10 and 25 ml. of solution A-3 add 5, 10 and 15 ml. of solution A-2. These amounts represent 0, 50, 100, 250, 500, 1000 and 1500 micrograms of sodium ferrocyanide respectively. Proceed as in III-A where it states "add distilled water dissolve salt and ......etc."

IV. Procedure

A. For Salts Containing Low Level of Ferrocyanide (Dendritic, TFC Treated Salt, etc.)

Place 20 grams representative sample in 100 ml. glass stoppered graduate. Add about 75 ml. of distilled water and mix to dissolve. (If the sample shows visible turbidity or a very precise analysis is required, filter through a No. 42 Whatman filter paper into another glass stoppered graduate. Wash graduate and filter paper taking care not to exceed the 95 ml.). Dilute to 95 ml. and proceed as in III-A, Graph Preparation, where it states "using a pipette or burette add 5 ml. of ferrous sulfate solution, dilute to..." Determine sodium ferrocyanide level from the standard curve for low level of ferrocyanide. (For use at Peshawar.)

B. For Salts Containing High Level of Ferrocyanide (Safe-T-Salt and other Treated Salt)

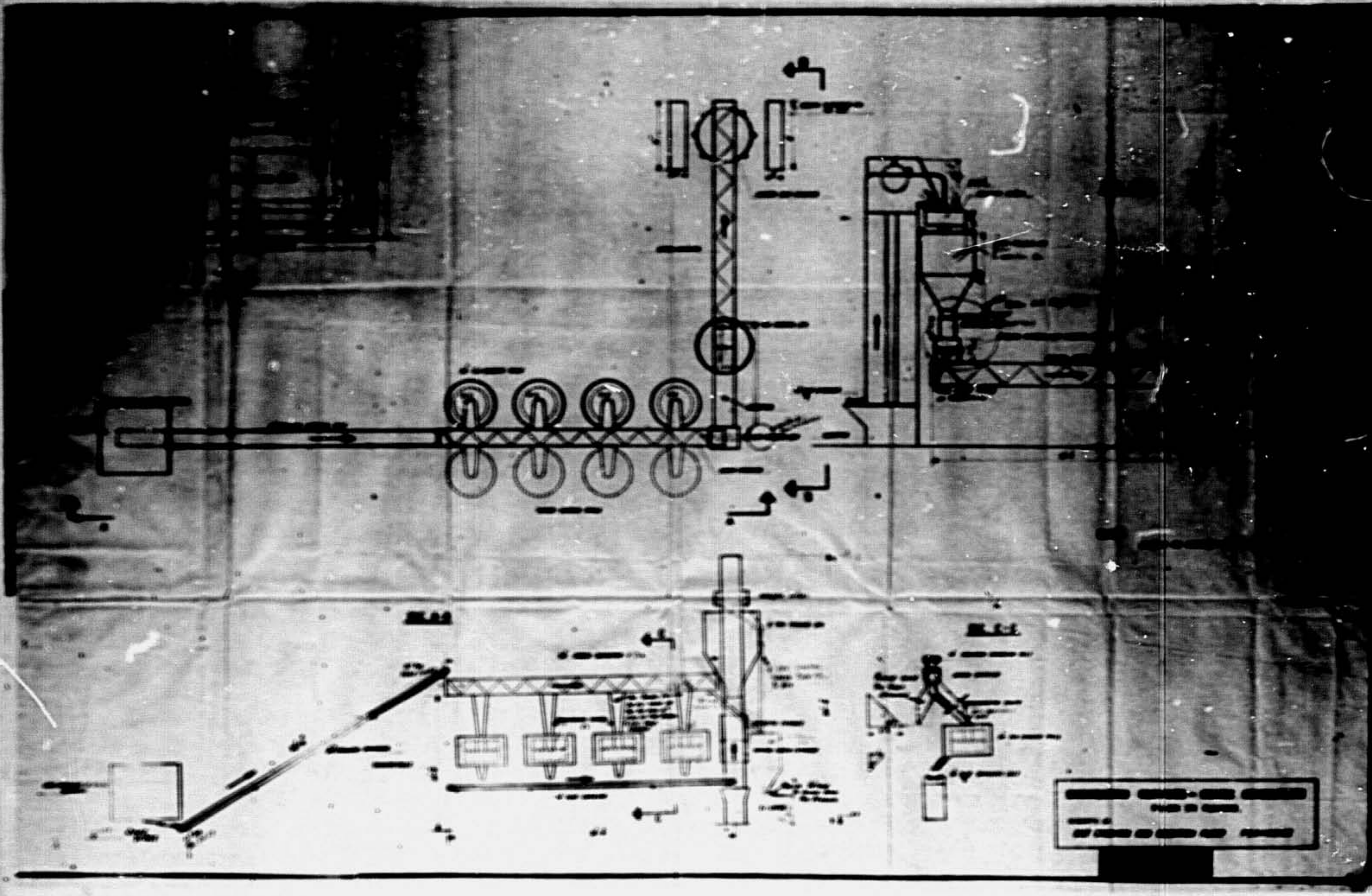
Weigh 10 grams of representative salt sample, preferably ground sample into a 250 ml. beaker. Add 2 sodium hydroxide pellets and about 75 ml. of distilled water. Heat to boiling to dissolve salt and to convert any insoluble ferrocyanide into soluble form. Filter through a No. 42 Whatman filter paper into a glass stoppered graduate. Wash beaker and filter paper with distilled water taking care not to exceed the 90 ml. Cool to room temperature. Using a blue litmus paper carefully neutralize the filtrate with concentrated hydrochloric acid. Dilute to 95 ml. and proceed as in III-A where it states "using a pipette or burette add 5 ml. of ferrous sulfate solution and mix well." Determine equivalent micrograms of sodium ferrocyanide and proceed as in Calculation.

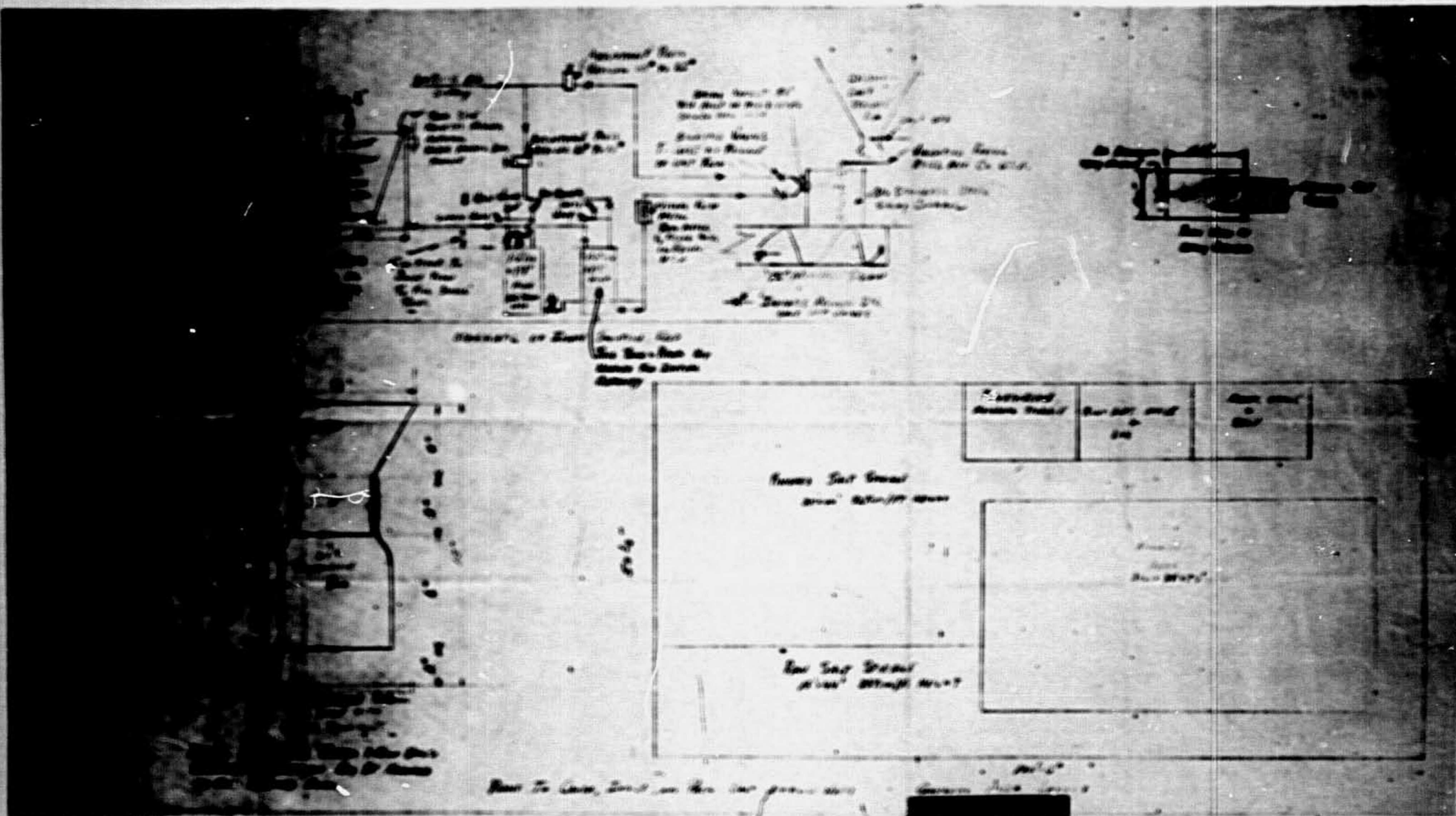
V. <u>Calculation</u>

Total Ferrocyanide as:

1. P.P.M. Sodium Ferrocyanide $= \frac{\text{Micrograms } Na_4Fe(CN)_6}{\text{Wt. of sample in grams}}$

2. P.P.M. Prussian Blue = P.P.M. Sodium Ferrocyanide x 0.942.





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APPENDIX A

SOLUTION MINING RESEARCH INSTITUTE, INC.
2635 FLOSSMOOR ROAD
FLOSSMOOR, ILLINOIS 60422

A.C. (312) 799-3120

April 8, 1977

Mr. Paul Rod Crowley
Department of Agriculture
Room 252 - GHI Building
500 12th Street
Washington D.C. 20250

Dear Mr. Crowley:

I have reviewed Mr. Willse's report "Salt Iodization Plant Pakistan 1977" which includes a cover letter of his visit to Pakistan from January 23 through February 24, 1977 as well as a general description of his recommended process and in particular have reviewed final drawings IV and V giving a schematic arrangment of the proposed equipment.

I am in agreement with the proposed process and the equipment required. The equipment proposed should do an adequate job of both blending and controlling the addition of potassium iodate to the salt.

I am sure that Mr. Willse and I would agree that the particle size of the final product is unsatisfactory on a number of counts. The type of crushing and grinding equipment will produce a product which, because of the large amount of fines or dust it contains, will undoubtedly give considerable problems in handling and packaging. It is possible to forsee extreme difficulties in getting the material to flow through the bins. You will recall that during our trip to Windsor that considerable study had been given to this problem and as a result rather sophisticated grinding operations had been developed which involved considerable recycling of salt and the reduction of the salt in several stages. This is not to infer that there is anything wrong with the efficacy of the final product but if a somewhat more sophisticated grinding operation would be acceptable certainly the plant would operate freer of problems and a more uniform final product would be obtained.

I am enclosing with this letter Mr. Villse's report.

Very truly yours,

Horace W. Diamond
Executive Director

jab

Enc.

CC: Mr. E. M. Villse
114 Palo Verde Drive
Leesburg, Florida 32748

APPENDIX B

General cover letter of trip to Pakistan for consultation on design of plant to crush, iodize and pack rock salt from Pakistan government mines.

Sunday, January 23, 1977

Arrived at Islamabad, Pakistan. Joined Mr Crowley on plane from Istanbul to Karachi, January 22, 1977.

Monday, January 24, 1977

Meeting in USAID nutrition branch with Mr Nasir Reza Jafri, my contact.

Meeting with UNICEF to discuss general approach to project with Mr Kennedy.

Meeting with Director, Village Level Food Processing technology. General discussion of project and other nutritional projects.

Tuesday, January 25, 1977

Meeting with Mr McIntyre, Asst Director of AID mission.

Held general discussions with Mr Jafri, Mr Crowley and David Cot.

Left Islamabad for Peshawar.

Wednesday, January 26, 1977

Meeting. Those present were: Mr Rod Crowley, Nasir Jafri, David Cot, Ed Willse, Mohammed Ibrahim Beg (Chairman), Mr Abdul Hamid Khan (proposed Project Director, Goiter Control project, who apparently could not agree on compensation and left for home the following day), Mohammed Sharif Khan (Planning Officer, Health Dept), Dr Sardar Ali (Asst Director, Health Dept), and Mr Aslam Khan (Dep Sec, Food N.W.F.P.

After much discussion about whether Mr Abdul Hamid Khan would be appointed Project Director, the matter was tabled.

Mr Willse advised that he preferred feeding KI instead of KIO_3 for three reasons. Apparently, the balance of the group favored KIO_3 so the matter was dropped.

UNICEF representative advised they would pay the cost of the Project Director for six months after which the Pakistan government would take over costs. No ancillary help for Project Director would be paid for by UNICEF.

Willse asked Dr Sardar Ali accuracy of potasium iodate that would be satisfactory. Dr Sardar Ali stated a minimum of 25 PPM and 50 PPM maximum would be accepted. Willse advised this could be achieved.

Second meeting was set for 9:00 a m, 1/27/77. Those to be present were E H Willse, Mr David Cot, Dr Sardar Ali, Mohammed Sharif Kahn, Mr Abdul Hamid Kahn and a qualified engineer to permanently work with the adviser.

Meeting adjourned.

Thursday, January 27, 1977

Meeting held in office of Dr Sardar Ali. Present: Dr Sardar Ali, Mohammed Sharif Khan, engineer from planning office, Health Dept, Mohammed Rafiq, Food Dept, Karachi (visitor) and Zaffir Ali Khan, Exec Engineer, Bldg Projects.

Abdul Hammid Khan did not appear at meeting but returned home.

Zaffir Ali Kahn promised use of draftsman, Hakim Jullah, to work with E M Willse.

Trip to mine at Jetta was planned; left about 10:30 a m, returned 16:30.

Analysis of salt at Jetta mine:	CA 0 2.6%, other elements less than 1%
	Na Cl 90 to 93%
Analysis at Bahadar Khel Mine:	CA 0 0.6%
	Na Cl 98.0%

Salt at Jetta mine was apparently originally horizontal bedded. Upheaval of mountains thrust salt to almost vertical vein about 10' thick at place observed. Salt vein was about 15° from vertical with only 30 to 50 feet of cover on top. Were told at mine that test drilling had been done to 2,000 feet and were still in salt. Would assume bed might be thicker if mining were continued lower. Mining started just below outcrop and continued downward until overhang appeared dangerous when new place was opened. Hand drilling of holes for dynamite. Lumps hauled to mine head on backs of donkeys. Production about 80 tons per day.

Left for Islamabad.

Friday, January 28, 1977

Meeting. Present: David Oot, Ed Willse.

Mr Kennedy agreed UNICEF would pay cost of hiring general engineering firm to prepare detailed drawings and equipment specifications if suitable people not found WFP staff.

Meeting, Mr Wheeler's office. Present: Mr Wheeler, David Oot, Rod Crowley, Nasir Jafri and Ed Willse.

Explained project to Mr Wheeler, answering his questions. Was again warned not to install too complicated equipment as people were not capable of maintaining it.

Saturday, January 29, 1977

Worked on preliminary design of plant.

Sunday, January 30, 1977

Worked on preliminary design of plant.

Monday, January 31, 1977

Worked on design.

Left at 6:45 p m, with Mr Jafri, for Peshawar.

Tuesday, February 1, 1977

Meeting, Peshawar.

Present: Aboul Jalk Mogual, Asst Chief (HCE), Planning and Development Dept - Phone 75575; M S Shakirri, Architect, Bldg Eng Roads - Phone 73887; Dr Sardar Ali; Mr Jafri; Ed Willse; Mr Zakir Ullah, Chief Engineer, Mech Engineer, who is my contact in Peshawar.

M S Shakirri agreed they would design and build building. Basically, it would be brick walls with steel trusses and corrugated transite roof. Building floor to be at truck body height.

Mr Zakir Ullah appeared very cooperative and to understand equipment discussed.

Went out to visit plant site. Very large area in industrial development of Pakistan government, next to new Rodi plant being built.

Mr Jafri and Willse met with general engineering firm, C.E.M.E. Co - phone 72309, Peshawar.

Mr Mohammed Rias - Head of firm, and E.E.
Mr Yasin Ahmed - B.S. - B.E.
Mr Bashir Ahmed - M.E.
Mr Naveet Saeed - M.E.
Mr Parvez Saeed - M.E.

Were looking for firm to take over general engineering. I had a schematic drawing of plant showing jaw crusher, six chuckie mills (based on best advice we could obtain from local operator), scalping screen to eliminate coarse particles, spray chamber for applying iodate solution, iodate mixing and spray unit, mixing conveyor and volumetric filler for packing.

Engineering group appeared young and inexperienced but were eager to attack job.

Left Peshawar for Karachi at 6:45 p m.

Wednesday, February 2, 1977

Meeting, Karachi.

Present: Mr Naser Moorag and his son Mr Abas Moorag, Mr Jafri and Ed Willse.

Naser Industries, Ltd
Habib Bank Bldg
Victoria Bunder Road
P O Box 7107, Karachi
Cable: Konsult
Telephones: 70596
70597

Met Dr J Haroon, Ph D, Mech Eng, Chem Eng
Project Engineer
M A Jinnah - A Haroon Rd
P O Box 7107
Karachi 3

February 2, 1977 meeting (continued)

Discussed project. Made copies of schematic diagrams and equipment list. Met 9:30 a m until 2:00 p m. Made tentative designs for volumetric filler, developed costs for various pieces of equipment. Made appointment for following day for further discussion.

Late afternoon, visited Dr A H Khan, head of Dept Food Technology, Pakistan Council of Scientific and Industrial Research, Country Club Road, Karachi. Had screen test made of salt obtained in Karachi.

16 mesh	trace
18 "	trace
22 "	less than 1%
52	16.55%
52-85	26.56%
85-120	16.76%
120-150	26.75%
150	13.36%

Dr Kahn claimed this brand of salt very impure. Contained an adulterant of ground limestone. Probably accounts for unusual screen distribution.

Thursday, February 3, 1977

Second meeting at Hazer Industries. Received balance of estimate on equipment and supervision of erection by them. We felt because we pressed for immediate figures that estimates were high. Received written quotation.

Paid second visit to university labs to obtain screen test figures.

Left for Lahore - 19:00.

Friday, February 4, 1977

Lahore. Spent most of morning looking for equipment manufacturer. Finally located Moghal Engineering Works, 90 Railway Road, Lahore.

Met with Mohammed Alla-Ud-Din who claimed to manufacture jaw crushers, hammer mills, chuckie stone grinders, conveyors, elevators. He apparently ran a series of small shops making these items. Saw a partially completed jaw crusher and some vertial chuckie mills and hammer mills.

Mohammed Alla-Ud-Din claimed 30 inch horizontal chuckie mills would produce 70 maunds per hour. On this basis, changed design to two mills instead of six. Price quoted 32,000 R's, including drive, and 40 HP motor for jaw crusher. Quoted price of 15,500 R's for 30 inch horizontal chuckie mill complete with drive and 15 HP motor.

In afternoon, met briefly with chairman (Director) NDIEM, a government design group in Lahore. Explained general schematic drawing to group of engineers. Claimed would be two weeks before could make any preliminary estimates or suggestions.

Spent balance of time looking for polyethelene supplies. Found apparently suitable bags 6" x 9" .002 MM thickness. Price 8 R's per pound - 120 bags per pound or .066 R's per bag. 16" x 24" x .03 MM thickness for packing 20 one kilo bags. Price 8 R's per pound, 16 bags per pound or 0.50 R's per bag. Estimated printings cost of 15 R's per 1000 bags or .015 R's per bag.

Had planned to spend Saturday, February 5, investigating further in Lahore but government had declared the day a national holiday and everything was closed. Returned to Islamabad Saturday about noon.

Monday, February 7 through Friday, February 11, 1977

Spent time redrawing planned arrangement to incorporate two chuckie mills instead of six and to provide manual packing of one kilo bags instead of machine packing. Also prepared equipment list, employee list (with job descriptions) laboratory requirements and chemical test methods for potassium iodate and sodium ferro cyanide if used.

Left Friday night, February 11, 1977, for Peshawar.

Saturday, February 12, 1977

Discussed revised plans with CEME Co; also made courtesy calls on a number of NWFP officials, including discussions for a project director which had not been appointed yet.

Monday, February 14, 1977

Held further discussions with CEME Co regarding design of plant pending approval of Mr Tony Kennedy of UNICEF who are paying for plant equipment and engineering costs.

Tuesday, February 15, 1977

Made further calls on Pakistan government officials in morning. Met with CEME Co at which time Mr Kennedy authorized them to work with me until Friday noon to complete preliminary drawings.

Wednesday, February 16, 1977

Worked with CEME Co engineers to make preliminary drawing of final revised machinery layout.

Made a courtesy call on Mr Shera Ul Mulk, chairman of Sarhad Development Authority, Peshawar. The SDA has been authorized by the NWFP officials to appoint a project director for the salt iodization project. As I understand it, the SDA will also have the responsibility for the operation of the plant. The Chairman advised me that he had selected a project director but could not give me his name until he was formally approved.

Thursday, February 17, 1977

Continued working with CEME Co engineers on preliminary equipment drawings. Was promised the final tracing and 3 prints before noon, Friday, February 18.

Friday, February 18, 1977

Worked with CEME Co until noon at which time received one tracing and 3 prints of final schematic layout of plant. CEME Co's grasp of the proposal was not very good as shown by the lack of correct proportioning of different size pieces of equipment on the drawing. As a result of this preliminary work, it was decided not to award the detailed design job to CEME Co.

Left for Islamabad in the afternoon.

Saturday, February 19 and Sunday, February 20, 1977

Worked on cost figures for capital costs of plant and plant operation.

Monday, February 21, 1977

Held meeting with Mr Kennedy of UNICEF and two gentlemen from UNICEF in Delhi, India. Explained flow diagram to the group and discussed some alternate ideas. It was decided that the UNICEF staff in India had engineers who were not too busy who were capable of taking the schematic prints and making detailed structual drawings with specifications of sufficient detail so that individual pieces of equipment could be put up for competitive bidding. As a result, it was decided that I would meet with these people on Sunday morning, February 27, at their office in Delhi, India. I was to explain the schematic drawings along with any details of construction to facilitate their detailed drawings.

Tuesday, February 22, and Wednesday, February 23, 1977

Worked at US AID office, Islamabad, getting reports typed and having copies made of prints for the Delhi meeting and for my final report.

Thursday, February 24, 1977

Left Pakistan for India at 11:45 and arrived at Delhi 16:30.

Met with Dr D.V.S.K. Rao of UNICEF and a mechanical engineer from their engineering department. Discussed the project in detail, showed the drawings and gave them a copy of the General Description of the process.

They had done similar work with iodising salt in India and of course had their own ideas on how it should be done. Their work has been with sea salt which is quite different because of crystal size and moisture. I explained that our proposal was based on the fact that we had large lumps of rock sald and wished to produce a product similar in appearance to the salt presently used. They agreed that they could take my preliminary drawings and equipment list and make detailed drawings with detailed equipment specifications so that the machinery could be put out for competitive bidding. Whether or not they take on this job or not I suppose is a decision of the head of UNICEF in Delhi and Mr Kennedy of UNICEF in Islamabad. They felt that Lahore and Karachi are close enough to Delhi so that personal contact could be made with machinery manufacturers. They claimed that they could build equipment out of stainless steel for only 10% more than regular steel. This, I question very much.

GENERAL SUMMARY

I would like to acknowledge with gratitude the help given me by Mr Rod Crowley, Mr Nasir Jafri, Mr David Oot and Mr Kennedy of UNICEF during my stay in Islamabad. With three parallel organizations (UNICEF, US AID and the Pakistan Govt) each having a part in this project it is going to be difficult to carry the project to conclusion. I look to Mr Nasir Jafri of US AID to be the coordinator. Mr Jafri assured me at the time I left Pakistan that with the information and the material given him (he has copies of all material contained in this report, except the Delhi meeting) that he would be able to carry on and have the plant built in about one year.

Edwin H Willse