

(a) Product quality

	<u>Effective Chlorine Concentration (%)</u>
1983	7.10
1984	7.38
Standard	8

(b) Raw material unit consumption

	<u>Slaked Lime (90%) (kg/t)</u>	<u>Chlorine (kg/t)</u>	<u>Water for Process (t/t)</u>
1981	200	100	1.12
1982	206	100	1.12
1983	200	100	1.12
Standard	200	100	0.96

2.1.5 Auxiliary section

(1) Water treating facility

The main equipment consists of water intake pump, concrete settling basins (650m³ x 2), sand filters (120m³ x 2) and water feed pump. It also has 2 sets of cooling towers (300m³/h x 1, 110m³/h x 1).

Raw water sucked up from a stream flowing through the premises is transferred to the settling basins, aluminum sulfate and soda ash being added to it as precipitants. The supernatant in the settling basins is then filtrated by the sand filter and pumped to each process plant as process water.

On the other hand, unfiltrated water which does not pass through the sand filter is used as cooling water for each process. Part of this water is used as make-up water for the cooling tower. Cooled water supplied from the cooling tower of each process system passes through the specified process heat-exchangers and enters the receiver where it

is again returned back to the cooling tower. Figure III-2.6 shows the schematic flow of the unfiltered water, process water, cooling water and cold water, and the water requirement of each process and apparatus in the case of actual maximum production capacity.

(2) Demineralized water facility

The main equipment consists of one set of cation exchange resin tower, one set of anion exchange resin tower and a demineralized water tank, and has a designed capacity of 10 m³/h. The demineralized water produced in this facility is used for decomposing water to produce caustic soda and for material water for synthetic hydrochloric acid.

(3) Power generation facility

The power generation facility consists of 3 sets of diesel generators manufactured by Niigata Engineering Co., Ltd. and provided by Asahi Glass Co. in 1970. The main equipment and its design capacity are as follows:

Three-phase A.C. synchronous generator (output 1000 KVA (750 KW), 3300 V, 10 poles, 600 rpm, 50 Hz) 3 sets, exciter panel (indoor type) 3 sets, synchronizing panel (indoor type) 2 sets, diesel engine (vertical type, single acting, 4 cycle, water cooled type, with a super charger and an air cooler, 1130 ps, 600 rpm, 250 ϕ x 320 x 8 cycle) 3 sets, pure water cooler (shell & tube type) 3 sets, lubricating oil cooler (shell & tube type) 3 sets, air compressor (4 ps, gasoline engine), etc.

This facility was originally installed to supply power for electrolysis. Afterward, however, the supplier of power for electrolysis was changed to the National Electric Power Company (PLN) because of the increased production of caustic soda, and therefore, this facility is now used for supplying power for the plant as well as an emergency power generator.

(4) Power receiving, transforming and distribution facility

The power receiving and transforming facility of this plant consists of 2 systems, one for purchasing power of 20 KV from The National Electric Power Co. (PLN) and one for private power generation by diesel engines mentioned in the previous paragraph.

The current contract capacity of 20 KV system is 6010 KVA. The 20 KV line power flows to No. 1 series electrolyzers rectifier and No. 2 series electrolyzers rectifier after the voltage is decreased to 3.3 KV and at each rectifier it is transformed to D.C. A very little part of 20 KV system power decreased to 3.3 KV in voltage is used for power and lighting in the plant after the voltage is further decreased to 220 V and 110 V.

Figure III-2.7 shows the distribution line system and the power consumption (approximate) for power and lighting by each production process.

(5) Air compressor

The air compressor system of this plant consists of 3 sets of 420 l/min. at 7 kg/cm²G capacity, 1 set of 400 l/min. at 7 kg/cm²G capacity. Among these the one of the maximum capacity is for pressure-transferring the liquefied chlorine.

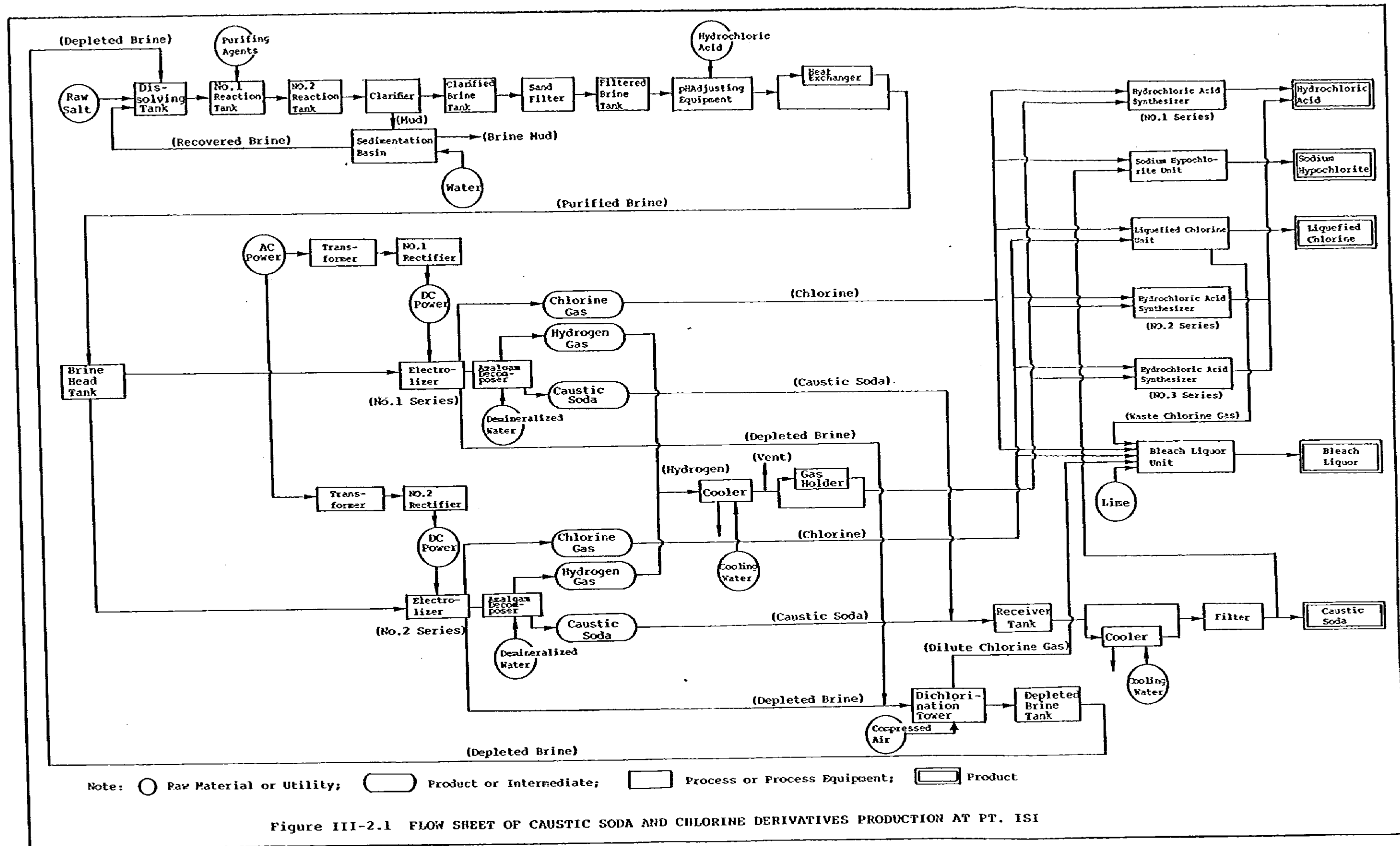
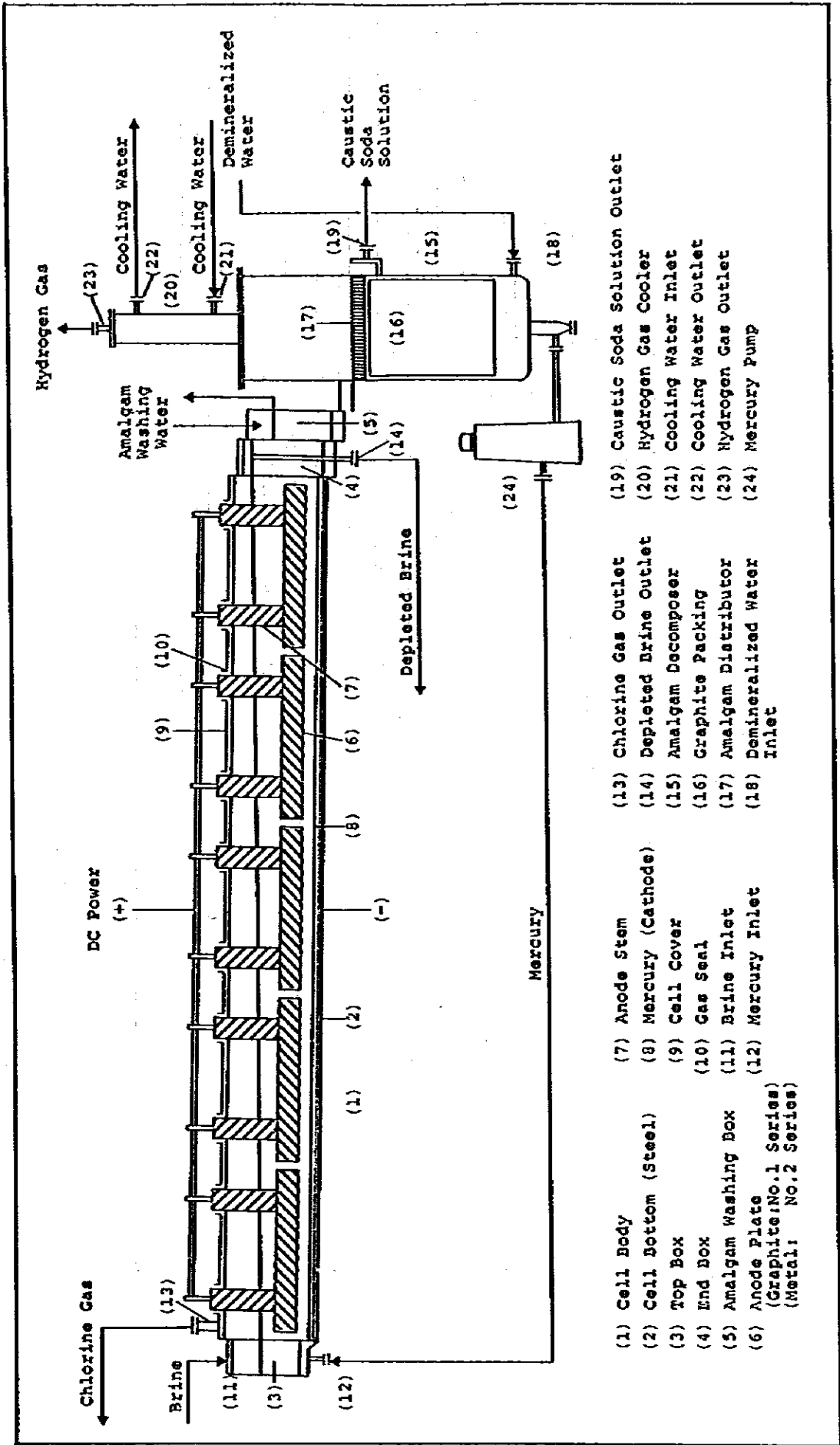


Figure III-2.1 FLOW SHEET OF CAUSTIC SODA AND CHLORINE DERIVATIVES PRODUCTION AT PT. ISI



- | | | | |
|--|-----------------------|-----------------------------------|-----------------------------------|
| (1) Cell Body | (7) Anode Stem | (13) Chlorine Gas Outlet | (19) Caustic Soda Solution Outlet |
| (2) Cell Bottom (Steel) | (8) Mercury (Cathode) | (14) Depleted Brine Outlet | (20) Hydrogen Gas Cooler |
| (3) Top Box | (9) Cell Cover | (15) Amalgam Decomposer | (21) Cooling Water Inlet |
| (4) End Box | (10) Gas Seal | (16) Graphite Packing | (22) Cooling Water Outlet |
| (5) Amalgam Washing Box | (11) Brine Inlet | (17) Amalgam Distributor | (23) Hydrogen Gas Outlet |
| (6) Anode Plate
(Graphite, No. 1 Series)
(Metal, No. 2 Series) | (12) Mercury Inlet | (18) Demineralized Water
Inlet | (24) Mercury Pump |

Figure III-2.2 CROSS SECTION OF MERCURY CELL (MODEL)

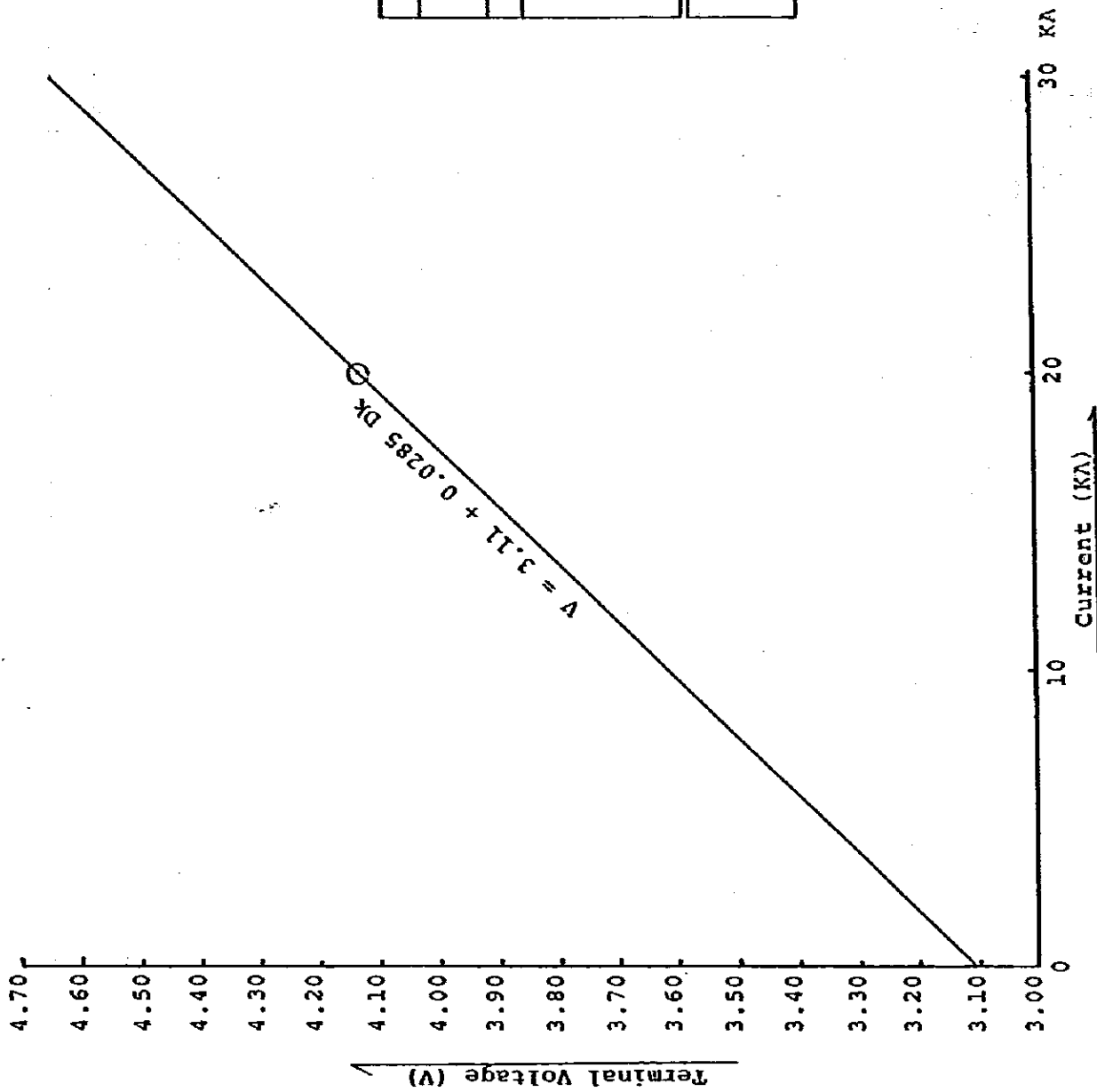


Figure III-2.4 VOLTAGE — CURRENT CURVE AT NO.1 SERIES ELECTROLYTIC CELLS

Current (KA)	20		
Cathode current density (A/dm ²)	35.71		
Date	19 May 1984		
Cell Voltage (Terminal)	Measured	n	
	\bar{X}_1	4.135	24
	\bar{X}_2	4.122	24
	\bar{X}	4.128	
Cell Temperature (°C)	\bar{X}_1	64.6	24
	\bar{X}_2	66.3	24
	\bar{X}	65.4	

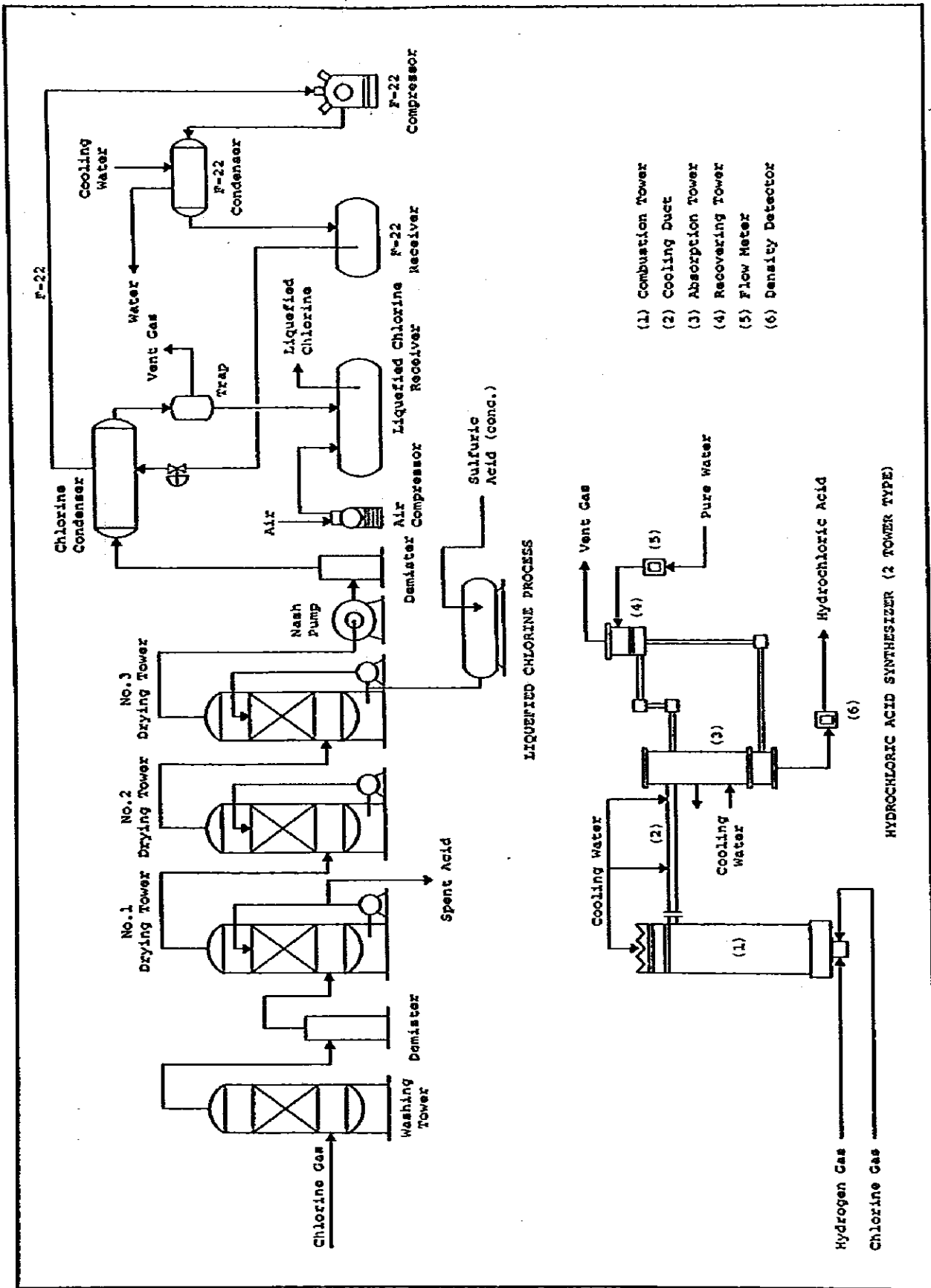
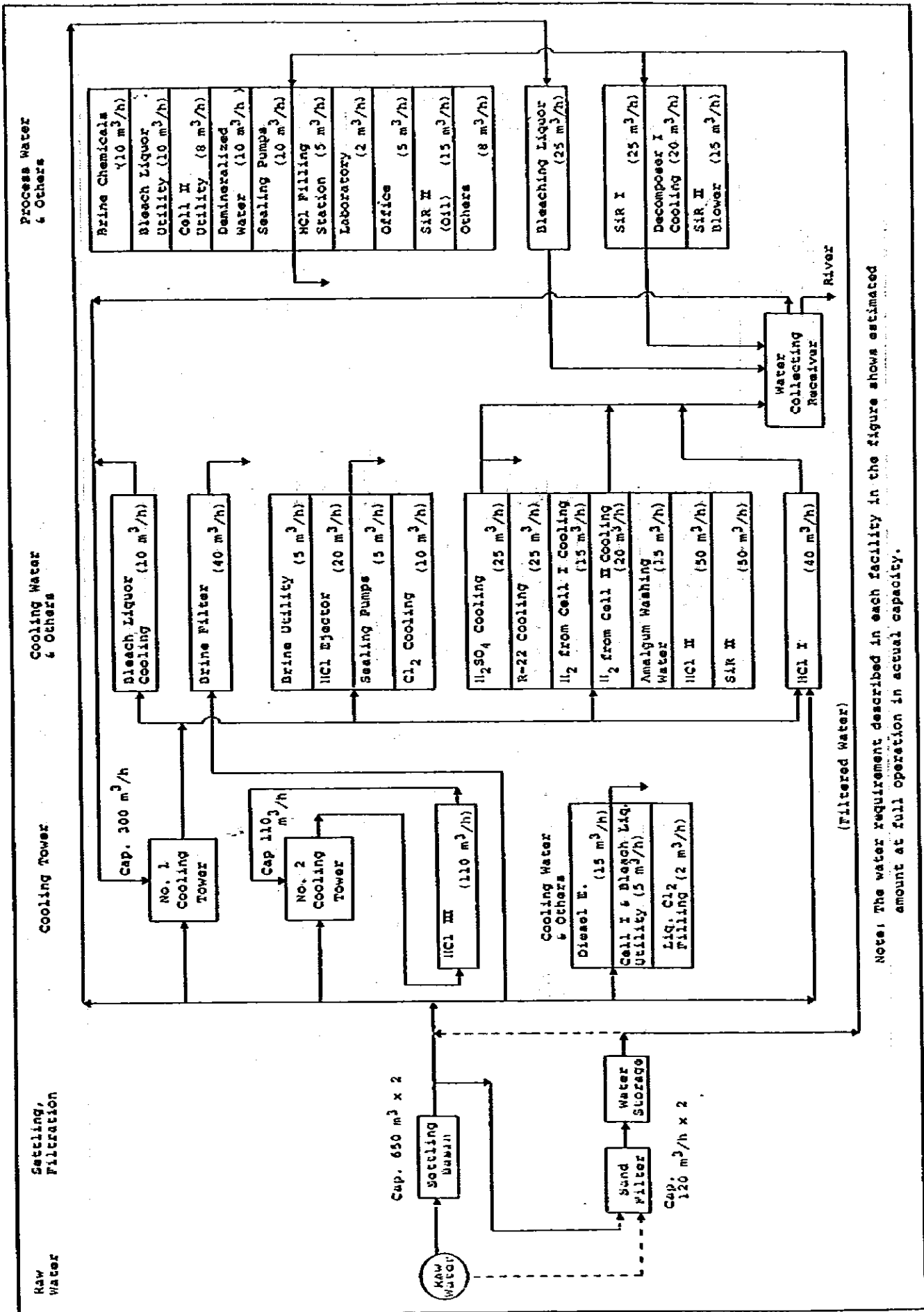


Figure III-2.5 LIQUEFIED CHLORINE PROCESS AND HYDROCHLORIC ACID SYNTHESIZER



Note: The water requirement described in each facility in the figure shows estimated amount at full operation in actual capacity.

Figure III-2.6 DISTRIBUTION DIAGRAM OF PROCESS WATER AND COOLING WATER AT PT. ISI

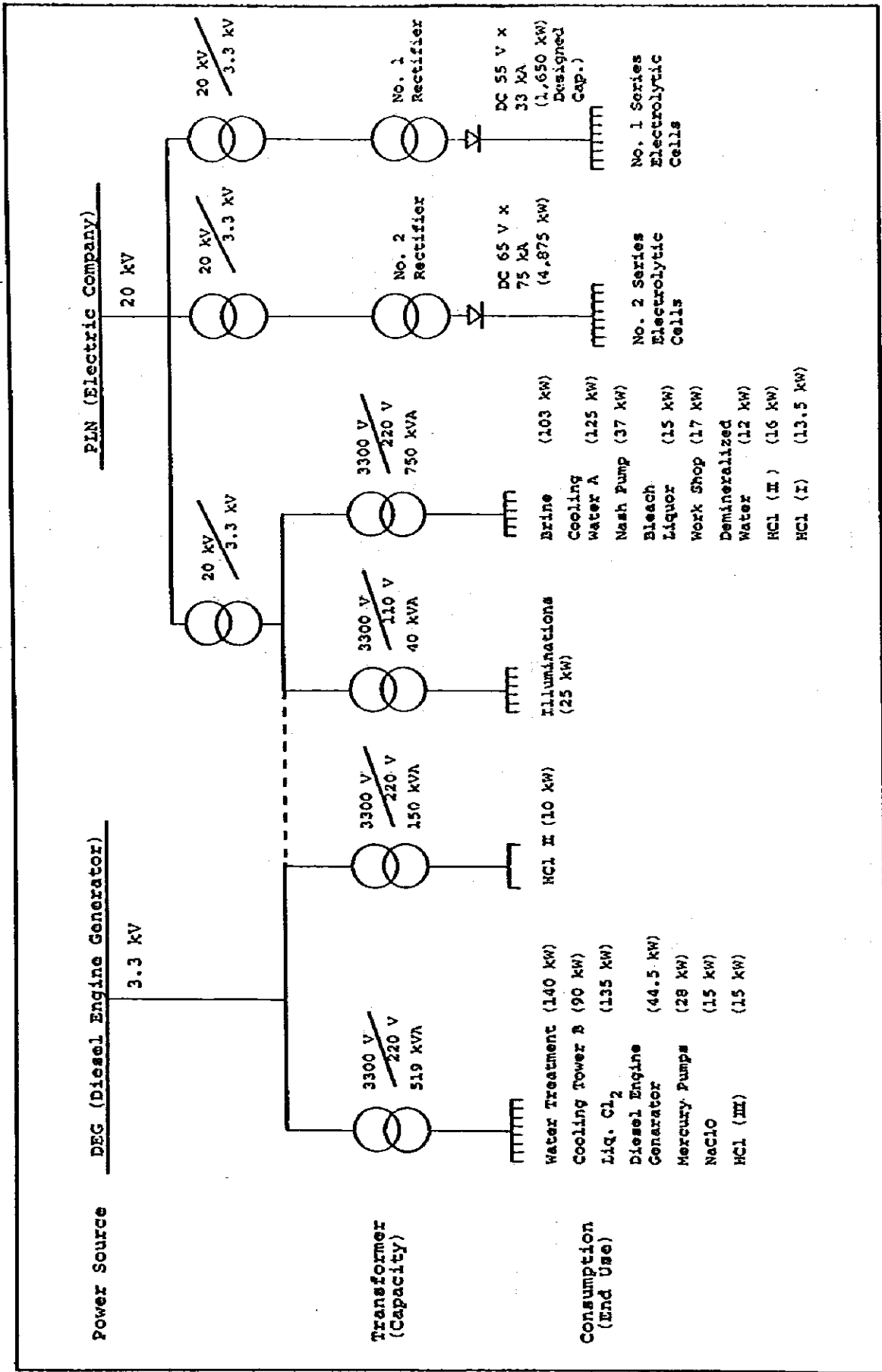


Figure III-2.7 POWER SOURCE AND CONSUMPTION AT PT. ISI

Table III-2.1 QUALITY OF PURIFIED BRINE IN 1982 - 1983 AT PT. ISI

Month	Ca ²⁺ (mg/l)		Mg ²⁺ (mg/l)		SO ₄ ²⁻ (g/l)	
	1982	1983	1982	1983	1982	1983
January	22.80	27.50	21.70	19.90	5.55	5.3654
February	21.80	40.50	22.10	31.10	5.26	5.1633
March	18.60	11.96	18.90	21.84	5.52	5.4148
April	19.90	29.82	19.80	62.70	6.00	8.0032
May	21.80	60.85	19.10	151.58	5.89	8.1100
June	23.60	28.05	21.20	33.29	5.25	9.4146
July	56.70	18.43	48.60	18.71	5.08	9.6642
August	79.90	22.25	69.50	27.21	5.22	9.2405
September	138.10	38.07	108.60	31.34	5.45	8.5455
October	81.10	24.84	77.60	27.20	5.41	6.0765
November	28.90	22.85	26.70	29.62	5.94	9.7245
December	67.0	15.63	47.80	20.89	5.79	9.4642
Average	48.35	28.39	41.80	39.61	5.53	7.8488
Standard	less than 10		less than 3		5 - 7 g/l as Na ₂ SO ₄	

2.2 Present State and Issues of the Existing Plant

2.2.1 Brine process

(1) Facilities

- (a) The effective volume and effective surface area of the clarifier were 11.0 h and 0.35 m/h, respectively. Usually, the standard for the retention time and the ascending flow rate is considered to be more than 3 h, and less than 3 m/h, respectively, and therefore, it is judged that the clarifier of this plant has an enough capacity.
- (b) Total filtration capacity of 4 sets of sand filters, calculated from their total filtration surface area, becomes 93.4 m³. Comparing this value with the required quantity of the brine of 62.7 m³/h for caustic soda production of 40 t/d, the capacity of this facility is enough.

(2) Operation and related matters

- (a) By adding the settling accelerator to the raw brine after processing agents were added, the impurities coagulates by forming flocs, and are separated from the supernatant of the brine in the clarifier. The larger the formed floc is, the greater the separation effect of the precipitation becomes. During the period when survey was made by, the size of the floc mentioned above was considerably small. Since many kinds of settling accelerators have been sold recently, it is recommended that accelerators suitable for the condition of this plant should be selected through careful field experiments after laboratory tests on some samples.

- (b) Because of low revolutions of agitators of both No. 1 and No. 2 reactors, air is blown into No. 1 reactor to increase the agitation effect, but the agitation is still insufficient.
- (c) The mud slurry discharged from the bottom of the clarifier has not been dehydrated by any filter press. A filter press is required to be installed for reducing the loss of the brine as well as for taking measures for environmental control.
- (d) The raw salt corresponding to the caustic soda daily production quantity is fed into the brine saturator in 6 segments every 4 hours intermittently. On the other hand, the raw salt used in this plant is of low quality and contains more impurities - about 10 times more Mg^{2+} , about 5 times more Ca^{2+} and 4-5 times more SO_4^{2-} compared with Australian salt and Mexican salt.

When the above-mentioned Indonesian salt is charged into the brine saturator, the raw salt begins to be dissolved in the depleted brine. It is easily supposed that the peak of Mg^{2+} and Ca^{2+} dissolution appears almost concurrently with the beginning of the raw salt dissolution because the impurities such as Mg^{2+} , Ca^{2+} which are sticking on the surface of salt crystals, are dissolved more quickly than the salt, and the dissolution quantity per hour decreases considerably sharp with a lapse of time, soon approaching a constant value.

Therefore, when the continuous process such as the brine processing system in this plant is employed, it is necessary to add the processing agents in proportion to and in excess of the dissolution quantity of the impurities. For the purpose, the automatic control system must be employed which immediately controls the addition of the agent solutions meeting the excess concentration of the processing agents - caustic soda and soda ash -

in the brine detected by the instrument as the free alkali concentration.

The present agent addition system does not always immediately meet the change in the dissolution quantity of the impurities and a time-lag inevitably occurs between them. This problem becomes more significant with the raw salt which has a higher content of impurities such as Mg^{2+} . The survey team judges that one of the reasons why the brine processing has not satisfactorily been carried out lies in this point.

- (e) The filtration residue in the sand filter consists of a part of components of the brine mud which mixed into the supernatant of the clarifier, calcium carbonate of relatively low reactivity, etc. In this plant, the residue which adhered to the surface of the packing (anthracite) in the sand filter is washed back by the industrial water and disposed.

The survey team recommends in the renovation plan that the above-mentioned residue should be washed back with the clear brine, that after settling the back wash brine, the layer containing sludges should be filtrated gradually by the filter press, and that the filter cake should be treated together with the brine mud while returning the filtrate to the brine saturator.

- (f) Mercury of a very low concentration is dissolved in the depleted brine returned from the electrolyzers. This mercury which is dissolved in the brine also precipitates with other impurities by addition of processing agents and transfers into the brine mud.

However, in the brine which contains about 10 ppm hypochlorite ion (ClO^-) beforehand, most mercury stably exists in a form of chloro-mercury ion ($HgCl_4^{2-}$) and therefore, the ratio of mercury which transfers into the

brine mud decreases remarkably even if the processing agents are added. Inclusion of ClO^- into the brine can be achieved by adding again a definite quantity of sodium hypochlorite solution to the dechlorinated depleted brine.

2.2.2 Electrolysis process

(1) No. 1 Series electrolyzers

(a) Facilities

- i) No. 1 series rectifier is being manually controlled because of the obsolescence and damage of the DC outlet automatic control device. As a result of consideration of this matter, it was concluded that it is necessary to replace some of the devices and parts (automatic control devices, rectifier panel, some defective silicon elements, oil pump and detector fuse) and to inspect them followed by repair.
- ii) No. 1 series electrolyzers have conspicuously obsolesced because of the past insufficient maintenance, and have brought about a shortage of parts.

(b) Operation and related matters

- i) The measurement for operation control of the cells for both No. 1 and No. 2 electrolyzers is made two times per shift for each cell and the readings are entered in the log sheets, which are transferred to the next shift operators. The measuring items are as follows:
 - Cell voltage
 - Amalgam concentration (at cell inlet and outlet)

- Gas analysis (chlorine concentration and hydrogen content in the chlorine gas)
- Brine concentration (specific gravity and temperature at cell outlet)
- Caustic soda solution concentration (specific gravity and temperature)

Items required for operation control of electrolyzers are all included. The measuring results for No. 2 series electrolyzers are shown on the blackboard at the central part of the room so that they can easily be seen.

- ii) In No. 2 series electrolyzers as well as No. 1 series electrolyzers, corrosion was observed on the stages, piping, equipment and other iron apparatus due to the past insufficient inspections and repairs. For example, as to the electrolyzer in outage, the cathode bottom plate (steel) was left exposed to atmosphere while the anode plate and electrode gap adjustment device were dismantled.

Since the flatness of the surface of the cathode bottom plate which influences the uniform flow of amalgam is important, the surface of the bottom plate should be covered by a dilute caustic soda solution to prevent corrosion for a short outage (within about one week). For a long outage it is necessary to clean the surface and wash it with water thoroughly, followed by smearing grease on it after the moisture is wiped out. In case the condition of the bottom plate is not adequate, it may be necessary to burnish the surface with whetstone.

iii) The cell room of both No. 1 and No. 2 series electrolyzers have no sidewalls and man does not smell of chlorine so much when a bit of chlorine leaks, because it is diffused by wind. However, sometimes when the suction pressure of the chlorine derivatives facility fluctuates, man smells of chlorine strongly. Since the leakage of chlorine gas not only causes sanitary problems but also promotes corrosion of the equipment and devices, it is always necessary to inspect and repair any leakage point. The point where the leakage frequently occurs is supposed to be the space between the cell cover and the anode stems penetrating it where the gas sealing is insufficient.

iv) In some places of the cell buildings of both No. 1 and No. 2 electrolyzers the spill of a small amount of mercury was found. The recovery effect of the mercury recovering tool used in this plant is considered to be insufficient.

(2) No. 2 series electrolyzers

(a) Facilities

No. 2 series electrolyzers show satisfactory operating results when operated at caustic soda concentration of 40-43%, but when the caustic soda concentration increases to about 50%, undecomposed amalgam increases and number of cells which show poor operating results gradually increases. This phenomenon clearly indicates shortage of the decomposition capacity of the decomposer. According to the explanation of an engineer in this plant, replacement of the graphite grains (manufactured by De Nora Co.) for decomposer packing by the graphite pellets (made in Japan) for No. 1 series electrolyzers decomposer packing did not show any improving effect. However, this is not due to a

substantial error of design, because the decomposer of No. 2 series electrolyzers was originally designed for caustic soda concentration of 40%.

(b) Operation and related matters

- i) Some caustic consumer pointed out that the caustic soda produced in this plant contained intolerable amount of chloride in (Cl^-). Usually, in the mercury method brine electrolysis controlled adequately, Cl^- content of 50% caustic soda solution is 0.001% and below, and if the value at the product test in the production plant is greatly higher than 0.01%, it must be considered that Cl^- was mixed in during the production.

Usually, the following two cases are considered as the cause of Cl^- mixing-in during the production of caustic soda:

1. Cl^- is mixed into the ion-exchange water used for decomposition due to troubles at the time of its production.
2. At the end box and water washing box of the cell, sodium amalgam is separated from the brine and washing water by the two dived wickets, but depending on the condition of the mercury flow, a slight brine may be involved in the mercury and enter the decomposer, thereby causing Cl^- increase.

When the increase of Cl^- in the product is due to (1), it is easy to examine into the cause and to take measures by testing the ion-exchange water for decomposition, but when it is due to (2), it is necessary, as a rule, to check each cell, because depending on the structure of two dived

wickets which are installed in the end box and in the water washing box and on the condition of mercury flow, the quantity of the brine involved in the mercury differs and the specific cell with the specific amalgam flow condition may frequently cause involvement of the liquid.

- ii) The investigation of the electrolyzer operating log sheets found that the hydrogen content values of chlorine gas produced in No. 2 series electrolyzers were all noted as 0.1%. For example, the hydrogen content values of chlorine gas from the electrolyzers which showed the undecomposed amalgam concentration of 0.348% and the amalgam concentration of 0.488% at cell outlet were also noted as 0.1%. If the amalgam concentration increases to 0.488%, part of the amalgam naturally decomposes in the cell and the hydrogen content of the chlorine gas increases. Therefore, this fact suggests that the analytical method has some problems. It is desirable to examine the analytical procedure by exchange the catalyzer to a flesh one or by comparison with explosion pipette method.

Since reliability of the analysis and measurement is very important for operation control, the standard of the measurement and analysis should properly be followed, and always it should be confirmed by check that there are no problems.

2.2.3 Chlorine derivatives process

(1) Liquefied chlorine

(a) Facilities

Among the liquefied chlorine production facilities, the automatic control device of the chlorine gas liquefaction system being completely inoperable because of its corrosion and damage due to the past insufficient maintenance, it is being manually controlled. Therefore, the actual capacity has dropped to 6 t/d against the designed capacity of 10 t/d. The automatic control device mentioned above being very important for not only operation control but also safety control, it should be renewed.

(b) Operation and related matters

- i) Comparing the operation standard for liquefied chlorine producing facilities, which is shown below, with the measured values on the log sheets, it can not be said that this standard has completely been followed. The greatest cause is supposed to lie in the manual operation of the above-mentioned liquefaction process. It is necessary to establish the practical standard considering the stability and safety of the operation.

1. Chlorine gas cooling and washing tower

Circulating temperature	: 38°C
Chlorine gas outlet temperature	: 40°C
Water circulating flow rate	: 13 m ³ /hr

2. Chlorine gas drying tower

No. 1 tower circulating sulfuric acid concentration	: 78 - 80%
No. 2 tower circulating sulfuric acid concentration	: 90 - 93%
No. 3 tower circulating sulfuric acid concentration	: 93 - 98%
Sulfuric acid temperature	: 38°C
Water in dry chlorine gas	: 26.8 ppm
Dry chlorine gas temperature	: 40°C

3. Chlorine gas compressor (Nash pump)

Chlorine gas pressure (after pressurized)	: 1.76 kg/cm ² G
Chlorine gas temperature	: 45°C
Cooler outlet sealing sulfuric acid temperature	: 36°C

4. Chlorine gas liquefaction

Liquefied chlorine temperature	: -20°C
Condenser inlet chlorine gas temperature	: 40°C
Waste gas temperature (to bleaching liquor process)	: 20°C
Hydrogen content of waste gas	: 6 Vol %
Liquefaction pressure	: 1.76 kg/cm ² G
Liquefaction rate	: 94%

5. R-22 Compressor

R-22 condensing temperature	: 45°C
R-22 condensing pressure	: 16.8 kg/cm ² G
R-22 evaporating temperature (Chlorine condenser; R-22 gas outlet)	: -30°C

R-22 evaporating pressure
(compressor suction)

: 0.65
kg/cm²G

- ii) The quantitative imbalance of chlorine and alkali in PT. ISI caused by a small demand of chlorine and by manual control of the liquefied chlorine gas producing facilities due to failure of the automatic control device of the chlorine gas liquefaction system has decreased the liquefaction rate and has sent a great amount of the waste gas to the bleach liquor process. When the liquefaction rate is low, danger of explosion decrease because the hydrogen content in the waste gas decreases.

However, the chlorine concentration and the hydrogen content on the condenser inlet chlorine gas and the liquefied waste gas should be controlled as specified to set the appropriate liquefaction condition meeting the varied composition of the feed gas.

- iii) In the liquefied chlorine charging process, residual gas evacuation, washing, drying, visual inspection, regular pressure test, valve inspection, defective parts replacement on returned cylinders are important administrative items for maintaining safety. Further, it is also important to recover liquefied chlorine gas cylinders which were shipped to consumers surely within a specified period. Since accidents occurred, and cylinder bodies and their valves corroded or were damaged very frequently on the side of consumers due to their insufficient safety control, it is desirable to recover used cylinders early.

- iv) A matter to which special attention should be paid in filling cylinders with liquefied chlorine is to prevent "overfilling". Cylinders which were overfilled are subject to excessive pressure due to liquid expansion brought about by temperature rise and may cause accidents such as liquid blowoff from a safety valve, or a cylinder rupture. Therefore, the survey team recommends that a double check system should be established to prevent overfilling in this plant.

- v) When a cylinder is exposed to direct rays of the sun for many hours, its internal pressure abnormally increases (for example, the equilibrium vapor pressure of liquefied chlorine becomes about 20.9 kg/cm²G at 70°C), and therefore it is necessary to instruct operators, transporters and consumers thoroughly to cover cylinders which are placed in a cylinderyard or under transportation to protect direct rays of the sun.

(2) Hydrochloric acid

As shown in Figure III-2.1, chlorine gas is supplied from No. 1 series electrolyzers to 1st hydrochloric acid series and from No. 2 series electrolyzers to 2nd and 3rd hydrochloric acid series. On the day when survey was conducted, among 2nd series synthesis facility one equipment was under replacement and only one equipment was in operation. The designed and actual capacities of each series hydrochloric acid synthesis facility are as follows:

	Designed Capacity (t/d)	Actual Capacity (t/d)
1st hydrochloric acid facility	20	16
2nd hydrochloric acid facility	30	12 (one equipment in shutdown)
3rd hydrochloric acid facility	50	40

The reason why the actual capacity of each synthesis facility is lower than its design capacity lies, according to the plant's personnel, in each facility's incapability of increasing the concentration of hydrochloric acid to 35% due to shortage of absorption capacity, besides the damage of the automatic control device of 1st hydrochloric acid synthesis facility. Considering that the inlet temperature of the cooling water is not higher than 40°C, shortage of the capacity is supposed to be not due to the design error but due to a great decrease of heat transfer coefficient of the absorption tubes of the absorber caused by the cooling water scaling on the outside of the tubes. The survey team recommend that inspection should be made during the regular turnaround and dilute hydrochloric acid washing of the scale should be carried out inside the absorber to confirm this point.

(3) Sodium hypochlorite

- i) The designed and actual capacities of the sodium hypochlorite production facility are 5t/d and 4t/d, respectively. The difference of the capacities is due to the insufficient capacity of a titanium made heat-exchanger to remove the reaction heat and control the temperature of the reactant fluid.

- ii) The operation procedure for the sodium hypochlorite production process is simple and if control of the concentration of the raw caustic soda solution, chlorine feed rate and cooling of the reactant liquid are appropriate and decision on the reaction end point is made correctly, it can be operated satisfactorily.

(4) Bleach liquor

- i) Chlorine gas used for chlorinating slaked lime consists of chlorine gas from No. 1 series and No. 2 series electrolyzers (including dilute gas from the end box of electrolyzers), waste gas from chlorine gas liquefaction, waste gas generated when liquefied chlorine is transported or charged into cylinders, etc. Each of these gases except the gas directly sent from the electrolyzers is a lean gas which usually contains a large amount of air, carbon dioxide, hydrogen, oxygen, etc., and the gas composition and flow rate vary with the operating condition of other process with a lapse of time. Therefore, it is difficult to measure the chlorine quantity accurately to get the material balance.

However, approximate sum total of quantity of chlorine contained in these gases in a given time can be estimated from the increment of available chlorine in the reactant slurry and the reactant liquid quantity in a given time.

- ii) When transparent or semi-transparent bleach liquor product with few suspended matters have to be shipped at consumers' request, the liquid layer with a lot of suspended matters in the lower part of the setting tank not be shipped and so the yield decreases. As a measure of yield improvement in this case, it is recommended to add a slight amount

of settling accelerators to the reaction-completed slurry to coagulate suspended matters and increase the clear part of liquid. As a settling accelerator, alkali starch with addition rate of 0.01 - 0.2% of reaction-completed slurry or high polymer settling accelerator (such as Separan 2610) which is stable to alkali with addition rate of 5 - 20 ppm is recommendable.

- iii) A certain brand of slaked lime which is used for producing bleach liquor may color the product red or orange due to existence of MnO_4^- or CrO_4^{2-} which is formed by oxidation of impurities in the slaked lime during chlorination. If the colored product is disliked by consumers, it is recommended to add about 10 ppm of mild organic reducing agent such as alkali starch solution or glucose water solution which easily decolorizes the product to the reaction-completed liquid.

2.2.4 Auxiliary section

(1) Water treating facility

Outline of the present water treating facility is shown in Figure III-2.6. Currently, because of shortage of the sand filter capacity, the supernatant treated in the settling basins is directly sent as a source of cooling water. However, according to the water analysis data of this plant, the quality of the cooling water, hardness of which is low, has not yet become an big issue under present conditions.

However, it is not desirable also for suppressing the scale formation to use the unfiltered water as cooling water, and therefore, the survey team recommends to re-utilized part of the used water which causes no qualitative problem among the used filtered water a great amount of which is drained presently.

(2) Power generation facility

The actual capacity of the diesel generators in this plant is 500 kW x 3 sets against the designed capacity of 750 kW x 3 sets. The decrease of the capacity is due to the increased vibration of the base frame of this facility caused by its obsolescence. This facility was originally installed to supply the total plant power including the electrolysis power, but presently the electrolysis power being purchased from PLN because of the increase of power supply caused by the production increase after that time, this facility supplies power only to power equipment other than electrolysis. Therefore, presently the capacity shortage of this facility does not become a problem.

(3) Power receiving, transforming and distribution facility

As shown in Figure III-2.7, the purchased power received through 20 kV line from PLN is rectified by No. 1 series SiR and No. 2 series SiR as power for electrolysis after its voltage is decreased to 3.3 kV. Part of 3.3 kV line power is further decreased to 220 V and 110 V in voltage and the power at 220 V and 110 V is distributed as power for part of the plant power equipment and for lighting, respectively. On the other hand, 3.3 kV private power generation line from the diesel generators distributes power to each manufacturing facility as power for the power equipment.

(4) Air Compressor

Among the four air compressors those for instrumentation except those for pressurizing and transferring liquefied chlorine are not dehumidified.

Moisture in the air for instrumentation will corrode the inside of instruments and cause their failures and therefore, the air for instrumentation should surely be dehumidified.

2.3 Diagnosis of the Machinery and Equipment in the Plant

2.3.1 Outline

When the old equipment the Asahi Glass Co., Ltd. supplied in 1970 is compared with the equipment newly supplied by Wah Chang International Corp. in Taiwan, it is natural that the former is much more superannuated.

As regards machinery and equipment, most of the tanks, vessels and piping were repaired by PT. ISI themselves, and were generally in good condition.

Many of the rotation machines such as pumps and blowers and heat exchangers were in a marked degree of obsolescence, which might be due to the difficulty of obtaining spare parts which are necessary for repairs.

The structure and operation stage are much corroded with the leakage of chlorine gas and hydrochloric acid gas, coupled with insufficient maintenance of painting and the like. The operation stage of a brine saturator is already in a dangerous condition, which needs immediate repairing.

The majority of instruments, control valves, and various other gauges are either poorly working or work no longer owing to the environmental pollution from gas leakage and inadequate maintenance. This is one of the factors that has worsened the operation of the whole plant.

2.3.2 Inspection and diagnosis of each equipment

Machinery and equipment were inspected and diagnosed, and the degree of obsolescence was classified into three ranks as below.

Rank A: The machinery and equipment which need to be replaced at once.

Rank B: The machinery and equipment which are desirable to be replaced.

Rank C: The machinery and equipment which need not be replaced (and are expected to last more than five years).

The following shows a list of the machinery and equipment and the result of their diagnoses:

(1) Brine purifier

The purifier was supplied by Wah Change international Corp. in Taiwan in 1978, and its designed brine-flow capacity is 80m³/h, which is shared by both No. 1 series electrolyzers and No. 2 series electrolyzers.

Although only about seven years have elapsed since the refiner was used, it has already advanced in superannuation as a whole.

- Tank and vessel

Most of the rubber lining on the interior of tanks were exchanged for FRP lining by PT. ISI, which might be due to the poor rubber lining done at the time of supply.

The performance of the brine reaction tank has deteriorated considerably that the solution in the clarifier looks cloudy after reaction as in [P-1] indicated that the reaction was imperfect and that the reaction product did not form a flock and failed to settle down.

- Pump

The pump motors are generally corroded [P-2], and most of the belts and coupling have no safety guard.

- Instrument

The pressure gauge [P-3] and the level gauge at a job site are highly deteriorated, which makes it impossible

to carry out the operation control sufficiently. Because of poor maintenance and shortage of spare parts.

- Structure

The structure is entirely corroded. Especially, the operation stage of the structure for the brine saturator [P-4] is in a dangerous condition due to the poor maintenance. Chlorine gas surround the saturator, which is caused by the insufficient dechlorination of depleted brine.

The following machinery and equipment are considered as Rank A.

(a) Brine reactor

Reaction is conspicuously bad, which greatly affects the quality of refined brine.

(b) Slurry pump

The outside of casing is remarkably corroded with brine.

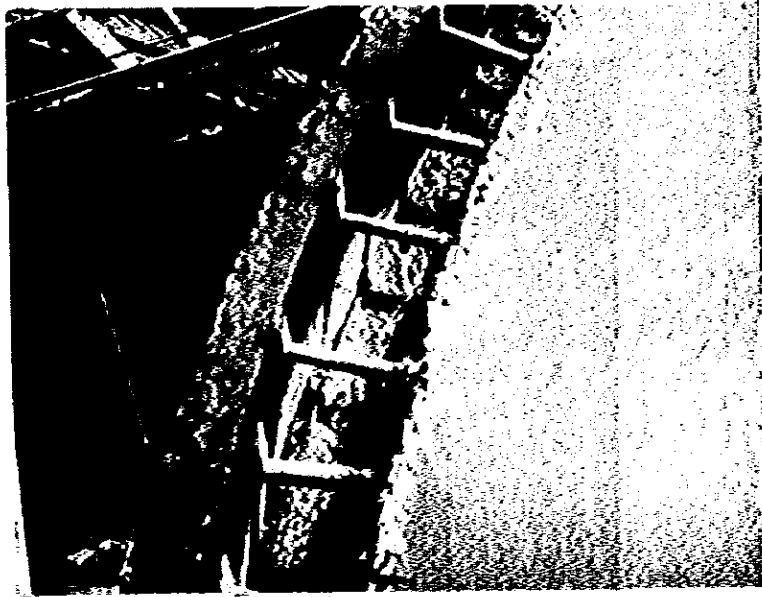
(c) Return brine pump

The inside of casing is corroded by depleted brine.

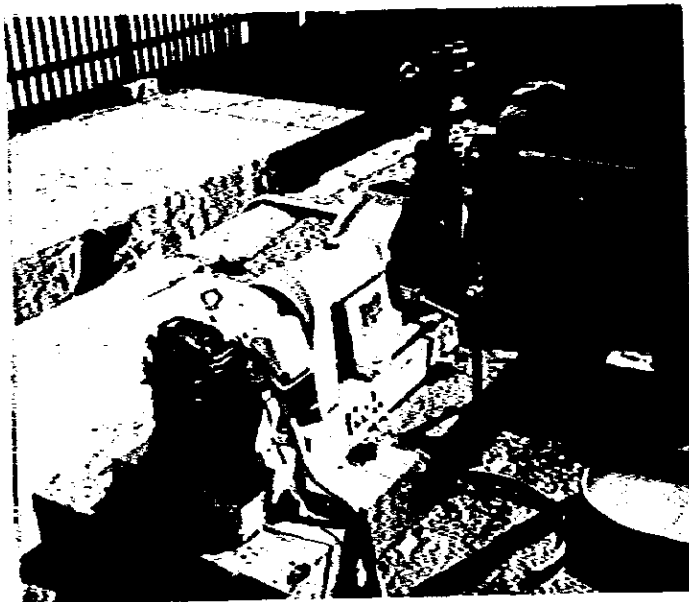
(d) Stage for brine saturator

Corrosion with chlorine gas is so striking that operation is dangerous.

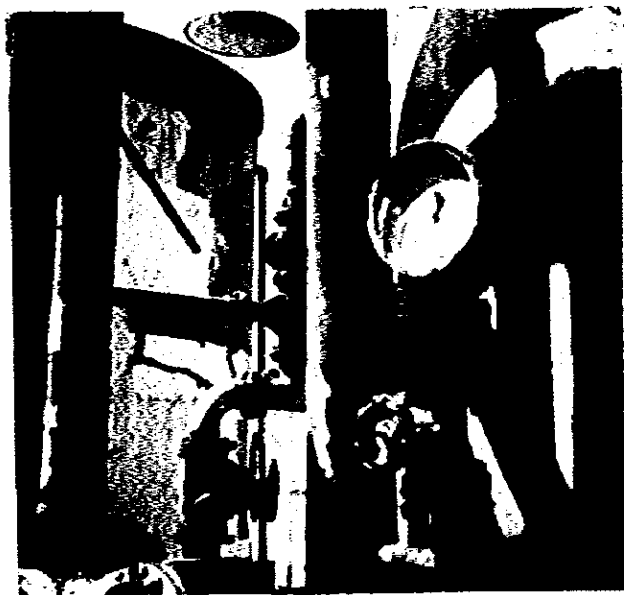
Result of diagnoses on major machinery and equipment are shown in Table III-2.2.



[P-1] Brine Purifier



[P-2] HCL Pump



[P-3] Pressure Gauge for Sand Filter



[P-4] Structure of Brine Saturator

Table III-2.2 RESULT OF DIAGNOSIS

BRINE PURIFICATION PROCESS

NO.	EQUIPMENT NAME	SPECIFICATION	Q'TY	DECISION	REMARK
1	Brine Saturator	Capa: 30 m ³ Dime: 2,540 φ x 8,350 H Mate: SS41 + 5 t HRL	2	C	One of them was changed inside Rubber Lining into FRP Lining.
2	Slurry Receiver	Capa: 30 m ³ Dime: 6,200 L x 3,600 W x 1,500 H Mate: Concrete	1	C	
3	Treated Brine Receiver	Capa: 50 m ³ Dime: 3,890 φ x 4,540 H Mate: Concrete + FRP.L.	1	C	Original one (SS + HRL) was replaced by Concrete Tank.
4	Filtered Brine Tank	Capa: 100 m ³ Dime: 5,100 φ x 5,300 H Mate: Concrete + FRP.L	1	C	Original one (SS + Epoxy) was replaced by Concrete Tank.
5	Charge Brine Head Tank	Capa: 6 m ³ Dime: 1,690 φ x 3,000 φ Mate: SS41 + 5t HRL	1	C	
6	Return Brine Receiver	Capa: 20 m ³ Dime: 2,000 φ x 6,850 φ Mate: SS41 + 5t HRL	1	C	Original one (SS + HRL) was replaced by FRP tank.

Table III-2.2 (CONTINUED)

NO.	EQUIPMENT NAME	SPECIFICATION	Q'TY	DECISION	REMARK
7	Brine Reaction Tank with Agitator	Capa: 18 m ³ Dime: 2,900 φ x 3,030 H Mate: SS41 + 5t HRL	2	A	Reaction ability is declining.
8	Barium Chloride Dissolving Tank with Agitator	Capa: 2.5 m ³ Dime: 1,280 φ x 2,000 H Mate: SS41 + 5t HRL	2	C	
9	Soda Ash Dissolving Tank with Agitator	Capa: 10 m ³ Dime: 2,530 φ x 2,000 H Mate: SS41 + 5t HRL	2	C	
10	Starch Dissolving Tank with Agitator	Capa: 4.5 m ³ Dime: 1,780 φ x 2,000 H Mate: SS41 + 5t HRL	2	C	
11	Caustic Soda Preparing Tank	Capa: 4.5 m ³ Dime: 1,710 φ x 2,000 H Mate: SS41 + Epoxy Resin	2	C	
12	Hydrochloric Acid Receiver	Capa: 2.5 m ³ Dime: 1,380 φ x 1,820 H Mate: FRP	1	C	Original one (PVC) was replaced by FRP Tank.
13	Brine Sand Filter	Capa: 30 m ³ /H Dime: 2,300 φ x 3,000 H Mate: SS41 + 5t HRL	4	C	

Table III-2.2 (CONTINUED)

NO.	EQUIPMENT NAME	SPECIFICATION	Q'TY	DECISION	REMARK
14	Brine Purifier with Agitator	Capa: 80 m ³ /H Dime: 15,240 φ x 4,800 H Mate: SS41 + 5t SRL	1	C	
15	Dechlorination Tower	Capa: 9 m ³ Dime: 1,750 φ x 4,000 H Mate: SS41 + FRP.L	2	C	Original HRL was changed into FRP Lining.
16	Dilute Chlorine Gas Cooling Tower	Dime: 750 φ x 3,670 H Mate: PVC Packing: 2" PVC Raining Ring	1	C	
17	Treated Brine Pump	Capa: 86 m ³ /H Head: 25.4 m Size: 150 φ/125 φ Mate: Porcelain Motor: 3.7 kW	2	C	
18	Charge Brine Pump	Capa: 88 m ³ /H Head: 20 m Size: 150 φ/125 φ Mate: Porcelain Motor: 3.7 kW	2	C	
19	Slurry Pump	Capa: 15 m Head: 80 φ/65 φ Size: Cast Iron Mate: 3.7 kW Motor:	1	A	

Table III-2.2 (CONTINUED)

NO.	EQUIPMENT NAME	SPECIFICATION	O'TY	DECISION	REMARK
20	Return Brine Pump	Capa: 90 m ³ /H Head: 20 m Size: 150 φ/125 φ Mate: Porcelain Motor: 3.7 kW	2	A	
21	Chemical Feed Pump	Capa: 1 m ³ /H Head: 15 m Size: 25 φ/25 φ Mate: Cast Iron + HRL Motor: 1.5 kW	8	C	
22	Hydrochloric Acid Pump	Capa: 1 m ³ /H Head: 17 m Size: 25 φ/25 φ Mate: Porcelain Motor: 1.5 kW	2	B	Motor: A
23	Dechlorination Blower	Roots Blower Capa: 17 m ³ /min Motor: 15 kW	2	C	
24	Brine Heat Exchanger	Plate Type Surf: 10.88 m ² Mate: Ti	1	C	
25	Salt Elevator		1	B	

(2) No. 1 series electrolyzers (No. 1 Unit)

The facilities were supplied by Asahi Glass Co., Ltd. in 1970, the design capacity of which is 10 t/d in terms of 100% NaOH. The facilities consist of 12 cells of the rated 30KA electrolyzer using graphite electrodes and of auxiliary equipment.

All equipment are fairly superannuated and cells are repaired frequently.

When diagnosis was conducted in May 1984, four out of the 12 cells were suspended their operation. Auxiliary equipment were particularly deteriorated.

It is difficult to classify the superannuated degrees of the equipment which are generally worn out, but the equipment which are thought to fall within Rank A are as follows:

(a) Caustic liquor cooler

The exterior is conspicuously worn out, and is unable to perform cooling.

(b) Washing water pump

The pump is entirely corroded, and its capacity deteriorated.

(c) Caustic liquor pump to cooler

The exterior is so much worn out that it is impossible to perform maintenance.

Result of diagnoses on major equipment are shown in Table III-2.3.

Table III-2.3 RESULT OF DIAGNOSIS FOR NO. 1 UNIT

NO. 1 ELECTROLYSIS PROCESS

NO.	EQUIPMENT NAME	SPECIFICATION	Q'TY	DECISION	REMARK
1	Electrolyzer	Capa: 30 KA Mate: SS41 + HRL	12	B	
2	Decomposer	Size: 542 φ x 800 H Mate: SS41	12	B	
3	Hydrogen Gas Cooler	Shell & Tube Type Capa: 1.6 m ² Mate: SS	12	B	
4	Washing Water Level Tank	Capa: 0.5 m ³ Mate: SS	1	B	
5	Washing Water Tank	Capa: 0.5 m ³ Mate: SS	1	B	
6	Washing Water Cooler	Shell & Tube Type Capa: 3.2 m ² Mate: SS	1	B	
7	Hydrogen Gas After Cooler	Shell & Tube Type Capa: 5 m ² Mate: SS	3	B	
8	Caustic Liquor Receiver	Capa: 0.5 m ³ Mate: SUS	1	B	

Table III-2.3 (CONTINUED)

NO.	EQUIPMENT NAME	SPECIFICATION	Q'TY	DECISION	REMARK
9	Caustic Liquor Cooler	Plate Type Capa: 2.85 m ² Mate: SUS	1	A	
10	Caustic Liquor Filter	Capa: 2.5 3/H Mate: SUS	1	B	
11	Pure Water Level Tank	Capac: 0.5 m ³ Mate: SS + HRL	1	B	
12	Mercury Pump	Capa: 0.9 m ³ /H Head: 2.5 m Mate: FC Motor: 0.75 kW	12	B	
13	Washing Water Pump	Capa: 6 m ³ /H Head: 12 m Dime: 40 Mate: FC Motor: 1.5 kW	2	A	
14	Caustic Liquor Pump to Cooler	Capa: 0.7 m ³ /H Motor: 28 m Dime: 35 Mate: SUS Motor: 3.7 kW	2	A	

Table III-2.3 (CONTINUED)

NO.	EQUIPMENT NAME	SPECIFICATION	Q'TY	DECISION	REMARK
15	Caustic Liquor Pump to Filter	Capa: 0.7 m ³ /H Head: 28 m Dime: 35 Mate: SUS Motor: 3.7 kW	2	B	
16	Caustic Soda Pump	Capa: 5 m ³ /H Head: 7 m Dime: 35 Mate: SUS Motor: 3.7 kW	2	C	

(3) No. 2 series electrolyzer (No. 2 Unit)

The facilities were supplied by Wah Chang International Corp. in Taiwan in 1978, the initial design capacity of which was 20 t/d in terms of 100% NaOH. The electrolyzers were a product by Italian firm Pestalozza, consisting of 12 cells of the rated 50 KA using graphite electrodes. The graphite electrodes were replaced by a metal electrodes of a West German firm Sigrü in 1983, and the rated capacity was augmented from 50 KA to 75 KA. The present production capacity is 30 t/d in terms of 100% NaOH.

The electrolyzers and the auxiliary equipment are in good condition, and are considered falling within Rank C.

Result of diagnoses on major equipment is shown in Table III-2.4.

Table III-2.4 RESULT OF DIAGNOSIS FOR NO. 2 UNIT

NO. 2 ELECTROLYSIS PROCESS

NO.	EQUIPMENT NAME	SPECIFICATION	Q'TY	DECISION	REMARK
1	Inlet Boxes Wash Water Head Tank	Capa: 2.6 m ³ Dime: 1,500 φ x 1,500 H Mate: FRP	1	C	
2	Inlet Boxes Wash Water Tank	Capa: 2.6 m ³ Dime: 1,500 φ x 1,500 H Mate: FRP	1	C	
3	Outlet Boxes Wash Water Tank	Capa: 2.6 m ³ Dime: 1,500 φ x 1,500 H Mate: FRP	1	C	
4	Caustic Soda Receiver	Capa: 3.5 m ³ Dime: 1,500 φ x 2,250 H Mate: SUS316	1	C	
5	Caustic Soda Tank	Capa: 100 m ³ Dime: 5,100 φ x 5,300 H Mate: SS + EPOXY Resin	1	C	
6	Mercury Cell	Capa: 75 KA	12	C	
7	Decomposer	Capa: n.a Mate: SS	12	C	
8	Mecury Pump	Capa: n.a Mate: FC	12	C	

Table III-2.4 (CONTINUED)

NO.	EQUIPMENT NAME	SPECIFICATION	Q'TY	DECISION	REMARK
9	Amalgam Washing Pump	Capa: 6.0 m ³ /H Head: 15 m Mate: FC Motor: 1.5 kW	2	C	
10	Feed Water Pump	Capa: 6.6 m ³ /H Head: 20 m Mate: FC Motor: 2.2 kW	2	C	
11	NaOH Pump to Filter	Capa: 3 m ³ /H Head: 35 m Mate: SUS Motor: 7.5 kW	2	C	
12	Caustic Soda Filter	Capa: 3 m ³ /H Dime: 630 φ x 1,010 H Mate: SB42 + Ebonite Elem: Graphite Tube	2	C	
13	Hydrogen Gas Cooler	Shell & Tube Type Capa: n.a Mate: SS	12	C	
14	Amalgam Washing to Top Box Cooler	Plate Type Sufo: 2.16 m ² Mate: SUS316	1	C	

Table III-2.4 (CONTINUED)

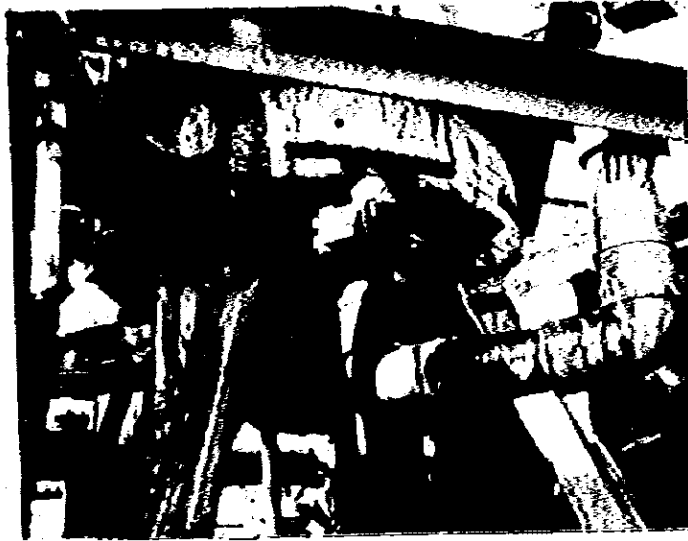
NO.	EQUIPMENT NAME	SPECIFICATION	Q'TY	DECISION	REMARK
15	End Box Cooler	Plate Type Sufa: 1.8 m ² Mate: Ti	1	C	
16	NaOH Cooler	Plate Type Sufa: 5.28 m ² Mate: Ti	1	C	

(4) 1st hydrochloric acid plant

The facilities were supplied by Asahi Glass Co., Ltd. in 1970, the designed capacity of which is 20 t/d in terms of 33% HCl, the equipments have generally advanced in superannuation, especially corrosion on the metal part of the combustion tower [P-5] and a structure [P-6] is conspicuous. The instrumentation is all unusable, and operation is being done by hand.

The diagnosis indicates that the equipments are wholly superannuated, and are thought to last only two years or so.

Diagonoses on major equipment are shown in Table III-2.5.



[P-5] Bottom of Combustion Tower



[P-6] Structure of Unit

Table III-2.5 RESULT OF DIAGNOSIS FOR 1ST-HCL

1ST HYDROCHLORIC ACID PROCESS

NO.	EQUIPMENT NAME	SPECIFICATION	Q'TY	DECISION	REMARK
1	Mist Catcher	Dime: 600 φ x 1,200 H Mate: SS + 4t HRL.	2	B	
2	Combustion Tower	Dime: 450 φ/358 φ x 4,500 H Mate: Graphite	2	B	
3	Cascad Cooler	Dime: 3B Mate: Graphite	2	C	
4	Absorption Tower	Dime: 15B Mate: Graphite	2	C	
5	Waste Gas Elimination Tower	Dime: 670 φ x 600 H Mate: PVC Packing: Raschig Ring	2	C	
6	Waste Gas Mist Catcher	Dime: 200 φ x 2,300 H Mate: PVC Packing: Raschig Ring	2	C	
7	Cooling Water Head Tank	Capa: 1 m ³ Mate: SS41	1	B	
8	Pure Water Level Tank	Capa: 0.5 m ³ Mate: SS + 3t HRL	1	B	

Table III-2.5 (CONTINUED)

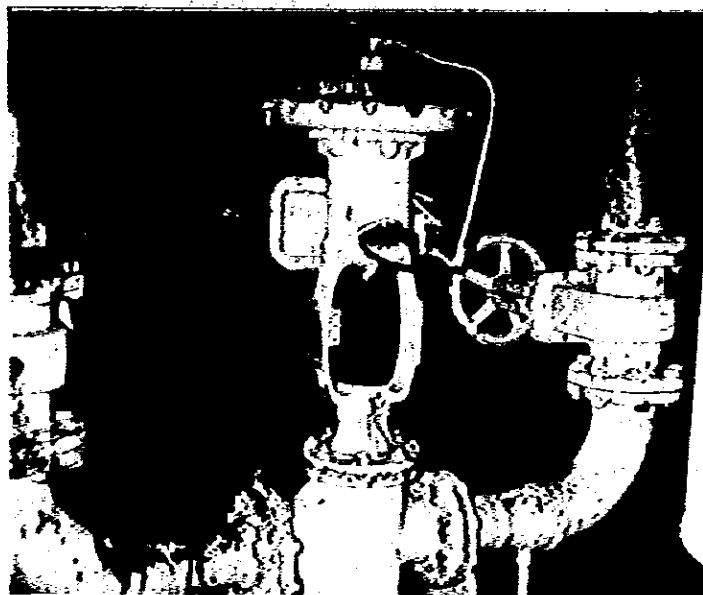
NO.	EQUIPMENT NAME	SPECIFICATION	Q'TY	DECISION	REMARK
9	Condensed Acid Receiver	Capa: 0.6 m ³ Mate: SS + HRL	1	B	
10	HCl Receiver	Capa: 1 m ³ Mate: SS + 4t HRL	1	B	
11	Chlorine Gas Fan	Capa: 1 m ³ /min Head: 105 mmAQ Mate: Porcelain Motor: 1.5 kW	3	B	
12	Waste Gas Fan	Capa: 1 m ³ /min Head: 105 mmAQ Mate: Porcelain Motor: 1.5 kW	3	B	
13	HCl Pump	Capa: 1.3 m ³ /H Head: 7 m Mate: Porcelain Motor: 1.5 KW	2	B	
14	Structure for Unit		1	B	

(5) 2nd hydrochloric acid plant

The facilities were supplied by Wah Chang International Corp. in 1978, the design capacity of which is 15 t/d unit in terms of 33% HCl, and 30 t/d by two units. One unit was damaged by explosion, and its operation is suspended at present. PT. ISI is expected to start its restoration in the near future. The equipment has not so advanced generally in superannuation, but the pressure control system of hydrogen gas [P-7] is entirely out of order.

The other equipment is also feared to get superannuated rapidly under the present plant environment; but if sufficient maintenance is done, the equipment may be usable for more than five years.

Result of diagnoses on major equipment is shown in Table III-2.6.



[P-7] Pressure Control Valve
for Hydrogen Gas

Table III-2.6 RESULT OF DIAGNOSIS FOR 2ND-HCL

2ND HYDROCHLORIC ACID PROCESS

NO.	EQUIPMENT NAME	SPECIFICATION	Q'TY	DECISION	REMARK
1	Hydrogen Gas Holder	Capa: 20 m ³ Dime: 3,000 φ x 3,050 H Mate: SS41	1	C	
2	Soft Water Receiver	Capa: 7.5 m ³ Dime: 1,940 φ x 2,700 H Mate: SS + 5t SRL	1	C	
3	Soft Water Head Tank	Capa: 0.45 m ³ Dime: 815 φ x 940 H Mate: PE	1	C	
4	Ejector Water Circulating Tank	Capa: 2 m ³ Dime: 1,500 φ x 1,500 H Mate: SS + 5t SRL	2	C	
5	Dilute HCl Acid Receiver	Capa: 0.9 m ³ Dime: 1,060 φ x 1,070 H Mate: PE	1	C	
6	Hydrochloric Acid Receiver	Capa: 9 m ³ Dime: 1,690 φ x 4,300 L Mate: SS + 5t HRL	2	C	
7	HCl Storage Tank	Capa: 100 m ³ Dime: 5,100 φ x 5,300 H Mate: SS + 5t HRL	2	C	

Table III-2.6 (CONTINUED)

NO.	EQUIPMENT NAME	SPECIFICATION	Q'TY	DECISION	REMARK
8	H ₂ Gas Scrubber	Dime: 700 φ x 2,600 H Mate: SS41 Packing: Rashig Ring	1	C	
9	Hydrochloric Unit	Capa: 15 T/D Mate: Graphite	2	C	
10	Soft Water Circulating Pump	Capa: 3 m ³ /H Head: 14 m Mate: Porcelain Motor: 2.2 kW	2	C	
11	Ejector Pump	Capa: 19 m ³ /H Head: 19 m Mate: Porcelain Motor: 3.7 kW	2	C	
12	HCl Receiver Pump	Capa: 8.2 m ³ /H Head: 7 m Mate: Porcelain Motor: 3.7 kW	2	C	
13	HCl Transfer Pump	Capa: 8.2 m ³ /H Head: 7 m Mate: Porcelain Motor: 3.7 kW	2	C	

Table III-2.6 (CONTINUED)

NO.	EQUIPMENT NAME	SPECIFICATION	Q'TY	DECISION	REMARK
14	HCl Waste Pump	Capa: 3 m ³ /H Head: 15 m Mate: Porcelain Motor: 1.5 kW	1	C	
15	Hydrogen Gas Roots Blower	Capa: 9 m ³ /min Head: 1,400 mmAq Mate: FC Motor: 7.5 kW	2	C	

(6) 3rd hydrochloric acid plant

The facilities were supplied by the Carbon Lorraine in 1982, and the newest equipment in the PT. ISf plant. The design capacity is 50 t/d in terms of 33% HCl. Periodical maintenance was done on the equipment in May 1984 and is entirely in good condition. All the equipment is considered falling within Rank C.

Result of diagnoses on major equipment is shown in Table III-2.7.

Table III-2.7 RESULT OF DIAGNOSIS FOR 3RD-HCL

3RD HYDROCHLORIC ACID PROCESS

NO.	EQUIPMENT NAME	SPECIFICATION	Q'TY	DECISION	REMARK
1	HCl Unit	Capa: 50 t/d Mate: Graphite	1	C	
2	Washing Tower	Dime: 900 φ x 3,000 H Mate: PVC	1	C	
3	Mist Catcher	Dime: 700 φ x 2,000 H Mate: PVC	1	C	
4	HCl Receiver Tank	Capa: 6 m ³ Dime: 2,000 φ x 2,200 L Mate: SS + HRL	2	C	
5	Pure Water Tank	Capa: 5 m ³ Dime: 1,900 φ x 2,000 H Mate: FRP	1	C	
6	CL Water Pump	Capa: 12 m ³ /H Head: 15 m Mate: Porcelain Motor: 2.2 kW	2	C	
7	Pure Water Pump	Capa: 3 m ³ /H Head: 20 m Mate: Porcelain Motor: 1.5 kW	2	C	

Table III-2.7 (CONTINUED)

NO.	EQUIPMENT NAME	SPECIFICATION	O'TY	DECISION	REMARK
8	HCL Pump	Capa: 3 m ³ /H Head: 20 m Mate: Porcelain Motor: 1.5 kW	2	C	
9	CL Gas Blower	Capa: 4 Nm ³ /min Pres: 1,000 mmAq Mate: FRP Motor: 3.7 kW	2	C	
10	Waste Gas Blower	Capa: 4 Nm ³ /min Press: 600 mmAq Mate: FRP Motor: 3.7 kW	2	C	
11	CL Water Cooler	Plate Type Sufa: Ti Mate: Ti	1	C	

(7) Chlorine liquefaction plant

The facilities were supplied by Wah Chang International Corp. in 1978. Its design capacity is 15 t/d in terms of liquefied chlorine. Although only 7 years have passed since it was used, superannuation is getting on as a whole.

- Tower

The sulfuric acid cooler does not work well, and the drying tower made of PVC is heated without being cooled, which has resulted in deforming the lower part of the tower.

- Tank

The wall of the liquefied chlorine receiver is remarkably corroded [P-8], which may be due to the dew condensation caused by the defect in insulation on the cooler and to the environmental pollution through the leakage of chlorine gas.

The valve for chlorine attached to the receiver is conspicuously corroded.

- Heat exchanger

The sulfuric acid cooler of a double-tube type for the drying tower is being replaced almost every six months because of being unable to obtain the material of appropriate quality.

The sulfuric acid cooler of a shell and tube-type for Nash pump is out of use because of leakage, and a box-type cooler is being used temporarily for heat exchanger [P-9].

- Instrument

The instruments and the control valves of the liquefier are entirely out of order, and manual operation is being done.

The equipment belonging to the liquefier, that are considered falling within Rank A are as follows:

(a) Insulation

Owing to the poor heat insulating materials being used for the liquefied chlorine tank, dew condensation is seen on the tank exterior.

(b) Sulfuric acid cooler

Because of leakage of liquid from the tube, the cooler does not work.

(c) Chlorine condenser

Conspicuous corrosion occurred on both interior and exterior and also the control system does not work. Hence, regular operation is impossible.

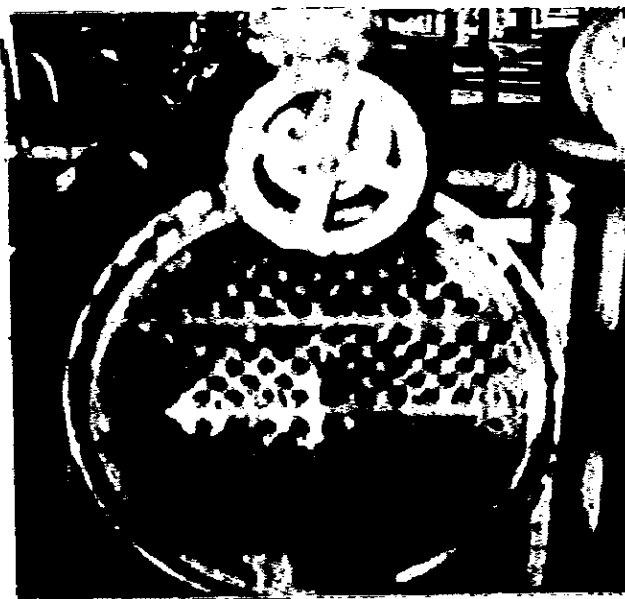
(d) Sulfuric acid cooler for drying tower

The quality of materials is unsuitable and the cooling capacity is inadequate.

Result of diagnoses on major equipment is shown in Table III-2.8.



[P-8] L-Cl₂ Receiver



[P-9] Sulfuric Acid Cooler
for Hush Pump

Table III-2.8 RESULT OF DIAGNOSIS

LIQUID CHLORINE PROCESS

NO.	EQUIPMENT NAME	SPECIFICATION	Q'TY	DECISION	REMARK
1	Chlorine Gas Cooling Tower	Dime: 770 φ x 6,100 H Mate: PVC Packing: PVC Tellerette	1	C	
2	Mist Eliminator	Dime: 500 φ x 3,450 H Mate: PVC	1	C	
3	Chlorine Gas Drying Tower	Dime: 650 φ x 6,100 H Mate: PVC Packing: PVC Tellerette	2	B	
4	Chlorine Gas Drying Tower	Dime: 650 φ x 6,100 Mate: SS Packing: PVC Tellerette	1	B	
5	Drying Tower Mist Catcher	Dime: 500 φ x 800 H Mate: SS Cycloidal Type		C	
6	Liquid Cl ₂ Receiver	Capa: 5 tons Dime: 1,400 φ x 4,400 L Mate: SM41	3	C	Insulation: A Valve: B
7	Liquid Cl ₂ Charge Tank	Capa: 5 tons Dime: 1,400 φ x 4,400 L Mate: SM41	1	C	Insulation: A Valve: B

Table III-2.8 (CONTINUED)

NO.	EQUIPMENT NAME	SPECIFICATION	Q'TY	DECISION	REMARK
8	Conc. H ₂ SO ₄ Storage Tank	Capa: 7 m ³ Dime: 1,940 φ x 2,400 H Mate: SS41	1	C	
9	Dil. H ₂ SO ₄ Storage Tank	Capa: 5 m ³ Dime: 1,700 φ x 2,400 H Mate: SS + SRL	1	C	
10	Level Control Tank	Capa: 0.1 m ³ Dime: 450 φ x 800 L Mate: SS41	1	C	
11	H ₂ SO ₄ Separator	Capa: 0.2 m ³ Dime: 500 φ x 1,000 H Mate: SS41	1	C	
12	Cl ₂ Water Circulating Pump	Capa: 15 m ³ /H Dime: 12 m Mate: Porcelain Motor: 3.7 kW	2	C	
13	H ₂ SO ₄ Circulating Pump	Capa: 10 m ³ /H Head: 13 m Mate: Cr Cast Iron Motor: 3.7 kW	3	C	
14	H ₂ SO ₄ Seal Pump.	Capa: Head: Mate: FC Motor: 1.5 kW	1	C	

Table III-2.8 (CONTINUED)

NO.	EQUIPMENT NAME	SPECIFICATION	Q'TY	DECISION	REMARK
15	Nush Pump	Capa: 290 m ³ /H Press Su: 0.005 kg/cm ² Di: 1.76 kg/cm ² Motor: 37 kW	2	C	
16	Freon Compressor	Capa: 75 kW	1	C	
17	Air Compressor	Capa: 45 m ³ /H Press: 7 kg/cm ² Motor: 7.5 kW	1	C	
18	Cl ₂ Water Cooler	Plate Type Surf: 6.24 m ² Mate: Ti		C	
19	H ₂ SO ₄ Cooler	Shell & Tube Type Surf: Mate:	1	A	
20	Snife Gas Heat Exchanger	Double Tube Type Surf: 3.5 m ² Mate: STPG	1	B	
21	Cl ₂ Condenser	Shell & Tube Type Surf: 39 m ² Mate: SM41	1	A	

Table III-2.8 (CONTINUED)

NO.	EQUIPMENT NAME	SPECIFICATION	Q'TY	DECISION	REMARK
22	Freon Condenser	Shell & Tube Type Dime: 492 ϕ x 2,400 L Surf: 48 m ³ Mate: .	1	C	
23	H ₂ SO ₄ Cooler for Drying Tower	Double Tube Type Surf: 1.8 m ² Mate: Pb	3	A	

(8) Bleaching liquor plant

The facilities were supplied by Nippon Soda Co., Ltd. in 1970, and its design capacity is 30 t/d in terms of bleaching liquor of 8% active chlorine.

The tower and tanks made of concrete may still be usable, while the pump [P-10] and the blower are corroded considerably.

The diagnosis indicates that the following fall within Rank A:

(a) Reacting pump

Conspicuous corrosion is seen on the exterior, and the gland of the pump is damaged.

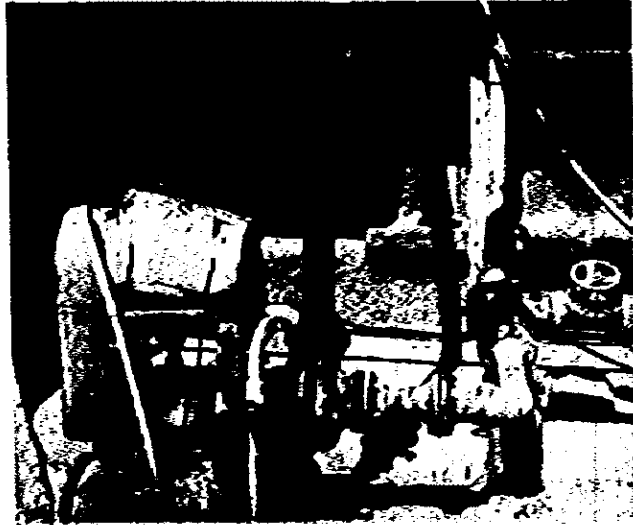
(b) Ca-Hypo pump

The same as above.

(c) Cl blower

Conspicuous corrosion is seen on the exterior and the bearings are damaged.

Result of diagnoses on major equipment is shown in Table III-2.9.



[P-10] Ca-Hypo Pump

Table III-2.9 RESULT OF DIAGNOSIS

Ca-HYPO PROCESS

NO.	EQUIPMENT NAME	SPECIFICATION	Q'TY	DECISION	REMARK
1	Ca(OH) ₂ Dissolving Tank with Agitator	Capa: n.a Dime: Mate: Concrete	1	C	
2	Reacting Tower	Dime: n.a Mate: Concrete	2	C	
3	Liquor Circulating Tank with Cooler	Capa: n.a Dime: Mate: Concrete	2	C	
4	Slurry Settling Tank	Capa: n.a Dime: Mate: Concrete	2	C	
5	Ca-Hypo Storage Tank	Capa: 80 m ³ Dime: Mate: n.a	2	C	
6	Ca(OH) ₂ Pump	Capa: n.a Head: Mate: Motor:	2	B	

Table III-2.9 (CONTINUED)

NO.	EQUIPMENT NAME	SPECIFICATION	Q'TY	DECISION	REMARK
7	Reacting Pump	Capa: n.a Head: Mate: Motor:	2	A	
8	Ca-Hypo Pump	Capa: n.a Head: Mate: Motor:	2	A	
9	Cl2 Blower	Capa: n.a Press: Mate: Motor:	2	A	

(9) Sodium hypochlorite plant

The facilities were installed by PT. ISI themselves in 1970, and its design capacity is 5 t/d in terms of 12% effective chlorine solution.

Superannuation has fairly advanced on the entire equipment. Particularly, the Cl₂ blower is working with violent vibration [P-11].

The diagnosis indicates that the following fall within Rank A:

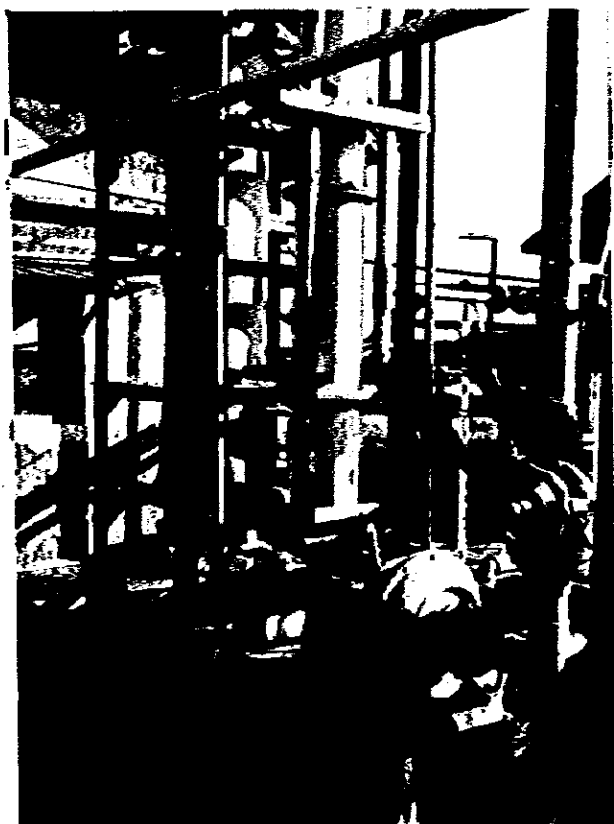
(a) Cl gas blower

Corrosion on the exterior and damage on the bearings.

(b) Reacting cooler

Damage is seen entirely caused by corrosion.

Result of diagnoses on major equipment is shown in Table III-2.10.



[P-11] Reaction Tower and Cl₂ Blower

Table III-2.10 RESULT OF DIAGNOSIS

Na-HYPO PROCESS

NO.	EQUIPMENT NAME	SPECIFICATION	Q'TY	DECISION	REMARK
1	Washing Tower	Dime: n.a Mate: PVC Packing: Rashig Ring	1	B	
2	Reaction Tower	Dime: PVC Mate: PVC Packing: Rashig Ring	1	B	
3	NaOH Dissolving Tank	Capa: Dime: Mate: SUS	1	C	
4	NaOH Storage Tank	Capa: Dime: Mate: SUS	1	C	
5	Reaction Tank with Cooler	Capa: Dime: Mate: FRP	2	C	Cooling ability is insufficient.
6	Circulating Pump	Capa: Head: Mate: Motor:	2	B	
7	Na-Hypo Pump	Capa: Head: Mate: Motor:	2	B	

Table III-2.10 (CONTINUED)

NO.	EQUIPMENT NAME	SPECIFICATION	Q'TY	DECISION	REMARK
8	NaOH Feed Pump	Capa: Head: Mate: Motor:	2	B	
9	Cl ₂ Gas Blower	Capa: Press: Mate: Porcelain Motor: 1.5 kW	2	A	
10	Na-Hypo Storage Tank	Capa: 10 m ³ Dime: Mate: FRP	1	C	
11	Structure for Tower		1	B	
12	Reacting Cooler	Plate Type Sufa: n.a Mate: Ti	1	A	

(10) Water treatment facilities

The facilities having a 400 t/hr capacity was supplied by Asahi Glass Co., Ltd. in 1970; and with the subsequent expansion of the plant, the capacity has been augmented as occasion demands.

The current design capacity is as follows:

- | | |
|----------------------------|--------------------------|
| (a) Water intake capacity: | 1,000m ³ /H |
| (b) Settling basin: | 650m ³ x 2 |
| (c) Cooling tower: | 410m ³ /H |
| (d) Sand filter: | 120m ³ /H x 2 |
| (e) Filtered water: | 200m ³ /H |

The equipment is installed at the most suitable environmental place in the plant, and each equipment is working in good condition. All the equipment are considered falling within Rank C.

Diagnosis on each equipment is shown in Table III-2.11.

Table III-2.11 RESULT OF DIAGNOSIS

WATER TREATMENT PROCESS

NO.	EQUIPMENT NAME	SPECIFICATION	Q'TY	DECISION	REMARK
1	Settling Basin	Capa: 650 m ³ Mate: Concrete	2	C	
2	Storage Tank	Capa: 330 m ³ Mate: Concrete	1	C	
3	Water Receiver	Capa: 30 m ³ Mate: Concrete	1	C	
4	Sand Filler	Capa: 120 m ³ /H Mate: SS + HRL	2	C	
5	No. 1 Cooling Tower	Capa: 300 m ³ /H	1	C	
6	No. 2 Cooling Tower	Capa: 110 m ³ /H	1	C	
7	Intake Pump	Capa: 336 m ³ /H Head: 6 m Mate: FC Motor: 11 kW	5	C	
8	Intake Pump	Capa: 400 m ³ /H Head: 15 m Mate: FC Motor: 30 kW	2	C	

Table III-2.11 (CONTINUED)

NO.	EQUIPMENT NAME	SPECIFICATION	Q'TY	DECISION	REMARK
9	Feed Pump	Capa: 200 m ³ /H Head: 30 m Mate: FC Motor: 30 kW	4	C	
10	Vacuum Pump	Capa: 24 m ³ /H Press: 570 mmHg Mate: FC Motor: 0.75 kW	1	C	
11	Filter Pump	Capa: 336 m ³ /H Head: 25 m Mate: FC Motor: 22 kW	2	C	

(11) Power source facilities

(a) Diesel-engine generator

The generator was supplied by Asahi Glass Co., Ltd. in 1970 when the plant was delivered. The design capacity is 750KW x 3 units. Of the three generators, one is suspended its operation because vibration arises due to a shortage of spare parts and to the bad foundation. The remaining two generators are usable.

The electricity for electrolysis is supplied by the electric power company (PLN). Electricity for motor driving power being constantly supplied by generators, one generator can sufficiently play its role in terms of supply capacity. The generators are also intended for emergency, ready for an occasion when PLN should fail in supply.

(b) No. 1 rectifier

The rectifier was supplied by Asahi Glass Co., Ltd. in 1970 for No. 1 electrolyzers. The rectifier having a capacity of the rated 30KA x 55V is a product of Mitsubishi Electric Corporation.

In the control system of the rectifier is seen corrosion on the panel parts and on the contact of the relay, resulting in the failure of controlling.

In the rectifier itself disorder is seen in the oil pump, diverter switch and motor driven mechanism, and partial deterioration in silicon diode. These have brought about the deterioration in rated current, and disorder of control.

(c) No. 2 rectifier

This was supplied by Wah Chang International Corp. in 1978 for No. 2 electrolyzers. The original capacity was rated 50KA. The maker is Toshiba Co., Ltd. In 1983 the anodes of No. 2 electrolyzers were replaced with a metal electrode, and the rated current was increased to 75KA x 65V. The rectifier is being operated in a good condition.

(d) Transformer for incoming electricity

This was installed by PT. ISI in 1979, and the main power source was switched from the generator to the electricity coming from outside. Operation is being done in good condition.

(12) Pipe rack and piping

The pipe rack of the existing plant is generally in good condition. The column of pipe rack, which is made of reinforced concrete, has corrosion resistance against the atmosphere of Cl_2 gas. The column poses no problem, while if the steel being used for the upper beam and for sub-rack is left as it is, corrosion will advance. Hence, anti-corrosion measures should be taken at once.

The route of the existing main pipe rack is shown in Figure III-2.8.

Such anti-corrosion material as FRP and PVC being used for the piping for corrosive fluid such as brine, Cl_2 gas and HCl , the piping is in good condition.

However, the piping around the receiver of liquefied Cl_2 is corroded markedly, and the parts, where leakage occurred, were repaired. Such parts should be replaced.

(13) Workshop and sub-contractor

PT. ISI has a 200m² (10m x 20m) workshop in its plant, and the following machinery furnished with the workshop are enough to perform the maintenance of a soda plant now being run by PT. ISI.

And each machine is in such a good condition that they can probably be used for a long time to come.

- Lathe: 4
- Drilling machine: 3
- Planning machine: 1
- Cut-Off machine: 2
- Welder: 2
- surface plate: 1

Further, there exist sub-contractors of various lines of business in the vicinity of PT. ISI's plant, and whenever PT. ISI requests, they are expected to come and perform their respective work.

The following are sub-contractors:

PT. Karpindo Bahagia	Steel works
PT. Lee Won	- vessel and tanks - steel structure - maintenance of machinery
CV. Gajah Pasacha	FRP & PVC works - FRP & PVC vessel - FRP lining - rubber lining
CV Sumber Djaya	Civil works
PT. ISI themselves	electrical works, painting works

As was mentioned above, the organization to maintain the plant is being satisfactorily, while the superannuation of

the facilities is in high degree, which might be due to the difficulty of obtaining special spare parts and to the insufficient annual budget for maintenance and inadequate control of the plant.