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SURVEY REPORT

MACHINERY BREAKDOWN

ELECROCHEMICAL INDUSTRIES (FRUTAROM) Ltd

PROPERTY DAMAGE

&

BUSINESS INTERRUPTION

INSURANCE

DATE : AUG. 15, 1992

SURVEYOR : DAN ARBEL

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MACHINERY BREAKDOWN REPORT

I. REPORT DETAILS

1. **Report No.** : EIF92E
2. **Date** : August I992.
3. **Surveyor** : Dan Arbel
4. **Scope** : Machinery Breadown, Material & Interruption Report, to be used as part of the **Fire Extended Report No. EIF92F.** This report contains information regarding the explosion risk currently covered under the M.B. section.

II. DESCRIPTION OF THE BUSINESS

Please refer to the applicable sections of the aforesaid **Fire Extended Report**. ***"Item 10 - Insurance"*** contains information i.r.o. the Sums Insured which apply to the Engineering Cover as well.

III. DESCRIPTION OF THE OPERATIONS

A. MAIN OPERATIONS AND SYSTEMS:

1. Electrolysis, production of CL_2, by products and derivatives.
2. Production of VCM.
3. Production of PVC.
4. Utilities.

A general process flow sheet is given in Appendix E01.

B. MAIN RAW MATERIALS:

- **a. Electrolysis** : NaCL & KCL
- **b. VCM** : EDC (imported - in excess of own production) and ETHYLENE. The latter is supplied directly by a pipeline from the Oil Refineries, situated 12 Kms to the South.
- **c. CO2** : From Chemicals & Fertilizers for the production of Potassium Carbonate.

C. ELECTROLYSIS:

Production of Chlorine:

1. **Raw Materials** : NaCl and KCl salts supplied by the Dead Sea Works Ltd. by Railroad.

2. **Main Product** : Cl_2. About 70% are used for production of EDC, the rest is used for production of by-products (see 2.2) and for sale.

3. **By-products** : NaOH, KOH and H_2. These are used for further processing and for sale.

4. **Process** : The salts are received by railroad or trucks in bulk, dissolved and treated in the "salt dissolving unit" and pumped to the Electrolysis plant.

   The plant operates at 150V, 110KA, producing Chlorine at the rate 110 tons/day .

   The 36 cells are of the Mercury type, De-Nora 8M2, each composed of 2 sections:

   a. Electrolyser with Titanium anode, Mercury being the anode. Here, Chlorine & Amalgam are formed.

   b. Decomposer, where Amalgam decomposes to Hydrogen & Sodium which reacts with water to form NaOH (or KOH).

   The Chlorine is cooled and dried over Sulphuric Acid.

Derivative Products:

1. *Sodium Hydro-Chlorate (Javel)* produced from Caustic Soda and Chlorine.

2. *Hydrochloric-acid 33%:*

   Synthetic Process: by reacting H_2 and Cl_2.
   Adiabatic Process: Absorbing HCL gas from the VCM Plant.

3. *Caustic Potash, Potassium Carbonate* derived from Caustic Potash and CO_2.

4. *Inert gas (Nitrogen)* by burning H_2 in air.

D. PRODUCTION OF VCM :

The raw materials are: CL_2 from **ELECTROLYSIS**, additional **EDC** (Ethylene Di-Chloride) from IMPORT, **ETHYLENE** from the Ethylene Plant of **CARMEL OLEFINS**.

The VCM (Vinyl Monomer) Plant consists of 4 sections:

1. Production of EDC by the reaction of Chlorine and Ethylene (The Direct Chlorination Process).
2. Cracking of **EDC** in 2 crackers. The products are **VCM** and **HCL** .
3. Purification of **VCM**.
4. **HCL** is further reacted with **Ethylene** to produce **EDC** in the **Oxy-chlorination** reactor.

An EDC Tank Farm is located near the VCM Plant. The storage is supplied by EDC after refining and drying from 3 sources:

1. EDC produced in the Direct Chlorination Process (see above), 38,500 TPY.
2. EDC produced in the Oxy-Chlorination Reactor, 86,000 TPY.
3. Import of EDC via a mooring facility located 800 m. off-shore, 56,000 TPY.

The VCM is stored in horizontal tanks in the VCM area and in 2 Spherical Vessels (1,000, 2,000 M^3) between the PVC-2 and PVC-3 Plants. The total capacity of VCM storage is 3,600 M^3 which is equivalent to 11 production of VCM.

E. PRODUCTION OF PVC:

PVC is produced from VCM in 3 plants:

E-PVC : Production of Emulsion PVC, 6,000 TPY.

PVC II & III: Production of Suspension PVC in 2 Plants, 100,000 TPY.

F. UTILITIES:

PUBLIC SUPPLY:

Electricity : Up to 26 MW from I.E.C., but the normally kept limit is 19 MW. The balance is generated by their own Power Station.

Fuels : #6 fuel is used for firing Boilers and Furnaces. An 7 day supply is kept in several tanks. A small amount of LPG & Kerosene is used as Pilot fuel.

PUBLIC SUPPLY, Cont.,

Water : Fresh water from the Public Supply, for Cooling-Tower and Boilers make-up, Fire-Fighting and Sanitary use. Storage on site includes 2 x 500 cum tanks. Pumping is provided by 2 x 200 M^3/h Electric + a Diesel powered Pumps.

Electricity : Power Station, capacity 10 MW, providing a saving in electricity cost and for safety in case of public supply failure. Annual production 70,000 MWH.

Steam : About 35 TPH From Power Station Boiler (capacity-80TPH) or from stand-by Boilers (capacity each -45TPH).

Water : Brackish water from own 2 wells for the purpose of cooling units in Electrolysis plant and PVC 2 Chillers.

Nitrogen : For safety purposes (see below).

Hydrogen : For the production of Nitrogen and for Sale.

Plant air : 2 x 1,000 cfm units for all plants.

Cooling water: Two separate systems:

(1) The PVC 3 and VCM Plants: 3 concrete built cells, with PVC filling.

(2) The Rest : 3 Cooling-Towers in the old section of the plant.

EMERGENCY:

Compressed air for Instruments: 2 independent batteries:

(1) PVC III and VCM Plants: 5 x 200 cfm compressors

(2) The Rest: 1 x 500 cfm & 3 x 400 cfm compressors.

Electric: primary, In the event of Public Supply failure ,the POWER STATION is able to keep the PVC III and the VCM plants running to enable orderly shutdown.

Electric: secondary, by DIESEL GENERATORS: 1.5 Mw unit in PVC-3 Plant in order to keep cooling water flowing through the reactors' jackets; 1 Mw unit in VCM plant for various important circulations and for Instrument Air. 195 Kva unit in Electrolysis.

Emergency and Back Up, Cont.,

Steam: 2 water tubes type STEAM BOILERS capacity 2 x 45 TPH at 25 Bar are used as "double" back-up for the POWER STATION BOILER. The consumption of the plants is 25-35 TPH.

Nitrogen: For safety purposes in the VCM & PVCII Plants and for purging H_2 lines.

Cooling: water, two systems of cooling water in the old plant, a separate system for the PVC and VCM Plant.

IV. MAIN EQUIPMENT

The following table contains concise data on machinery items of the various plants. These items are important for production and/or may have a mechanical breakdown risk of any significance.

Note : The heading "Consequence of Failure" at the right end of the following table relates to the specific plant and not to the whole business of the Insured.

	DESCRIPTION	**N.R.V. US $ (DATE)**	**SPARE PARTS**	**CTRL. OF PLANT**
INORGANIC SECTION:				
ELECTROLYSIS PLANT: THE RECTIFYING SYSTEM:		**110 KA**		**Ctrl. of Electrolysis Plant**
1.	New 22.5 KV AC to 155V-66KA DC conversion Plant (Thyristor Rectifier), 1992.	1,450	Diodes, Fuses, and other Elec. parts. No major Components.	60%.
2.	66 KA Rectifier ELCO-BBC, 1974 Including: 2*6.24Mva Regl.Trafo., Rect.Trafo, Rectifier, Inter.ph.Trafo, Control board.	1,350	Diodes, Fuses, and other Elec. parts. No major Components.	40%
3.	24 KA Rectifier, 1962, As above 6,640 KVA, MATERIAL ELECTRIC	350	Ditto	Back up.
4.	12 KA Rectifier, 1955, As above BBC, 3940 KVA.	180	Ditto	Back up.

MAIN EQUIPMENT, Cont.,

	CHLORINE LIQUEFACTION:	**N.R.V. (US $)**	**Spare Parts**	**Ctrl. of Chlorine**
1.	Chlorine Compressor 340 HP, Gabrioneta,	250	All internal parts. 1 spare motor.	60%
	POTASSIUM CARBONATE PLANT:			**Ctrl. of Pot. Carb.**
1.	Centrifuge, Horizontal pusher, overhaul 1974, 30Kw Pump, 3Kw Drive.	150	Internal parts, no basket	100%.
2.	Rotary Dryer, D38"*L20', Burner parts, Gear parts, LOUISVILLE, 3Hp, (1964).	200	Burner parts, Gear Parts, Rolls.	100%
	VCM PLANT (1979):			**Ctrl. of VCM Plant.**
1.	Ref-12 YORKPAK open sys. 4 Stg. Centif. Compr. 11 Bar, 1750Hp.	750	A comp. unit in overhaul abroad. Internal parts, Motor, Stator Coils, Gear.	100%
2.	2 Units Air-Compressors, JOY, 4 Stgs., 1500Hp	2 x 400	All internal parts of one unit. 1 spare Motor. 2 new inter-coolers installed. Spares on order.	1st unit 50% 2 units 100%
3.	Oxychlorination Reactor Tubes & Materials.	1,400	Tubes (inconel 625) and other materials	100%
	Emulsion PVC Plant (1964):			**Ctrl. of EPVC.**
1.	2 x Atomizing Pump, 25 Hp	2 x 60	Internal parts, no cranksht.	Full b/u by installed unit.
2.	Micro Atomizer pulverizing Hammer Mill, 125 hp, 3500 rpm	80	Internal Parts	100%
3.	YORK 400 TR Centrifugal Chiller (new - 1991).	280		Full B/U by the Chillers below.
4.	2*Ref-11 units, 300TR, CENTRAVAC, 189HP, Hermetic-Centrifugal, Water cooled.	2 x 240	Internal parts, Impellers. No windings.	Serving as B/U.
3.	2 x Disintegrator, RIETZ 40 hp	2x 40	Internal parts. One is backup.	
4.	Grinder RIETZ 10 hp.	30	Internal parts .	100%

MAIN EQUIPMENT, Cont.,

	Suspension PVC II Plant (1972):	**N.R.V. (US $)**	**Spare Parts:**	**Ctrl. of PVC 2**
1.	Centrifuge, Deutz 60 Hp.	70	Internal parts, no bowl.	100% .
2.	2*Ref-11 units, TRANE, Hermetic, Centrifugal, Gas cooled, 750Hp, 600TR.	2 x 360	Internal parts incl. 2 Stg. impellers, no windings.	1st. unit- None. 2 units - 100%
	Suspension PVC III Plant (1979):	**N.R.V. (US $)**		**Ctrl. of PVC 2**
1.	DC Fisher Ctrl. System.	1,500		100% .
2.	Centrifuge, BROADBENT, Bowl - 60", 200Hp. New Centrifuge is on order to be installed in parallel.	350	Internal parts, no bowl	100%. to be improved by the end of the year when a new unit is added.
3.	2x200 Hp, + 3x100 Hp Blowers. 2 new units in stocks.	50 Each	Bearings, complete units in stock	100
4.	2 x Ref-22 compressors, YORK and VILTER, 200 Hp each.	30 each.		1st - none.
5.	4 x Agitators for the Reactors, 250 Hp.	120 each.	Small basic parts. 1x250hp Motor.	10% First unit.
	Utilities:	**N.R.V. (US $)**		**Loss Potential**
1.	2 x 30 MVA Power Trafos. 161/22Kv with Tap Changers, 1978, 1991 (new).	600 each	Only external Parts.	1st - none. 2 units - 40%
2.	1.5 MVA Diesel Generator, 1978, MAIBACH, emergency for PVC 3	250	External parts	None.
3.	1.0 MVA Diesel Gen. Emergency for VCM Plant, 1988.	150	Ditto	None.
4.	Power Station Steam Boiler 85 TPH at 63 bar. Radiant type superheater, 1980.	1,500		Annual loss of savings $ 1 MM. 2 full B/U Boilers. See below.
5.	Turbo-Generator 6.6 KV, 12 MVA, BBC (ABB) extract/condense type.	2,500		Ditto.

MAIN EQUIPMENT, Cont.,

	Utilities Cont.,	N.R.V. (US $)		Loss Potential
6.	Steam Boiler, 45 TPH, 1991.	400		Full B/U for P.S. Boiler.
7.	Ditto., 1972.	400		Ditto.
8.	Cooling Water: 3 x 500 + 2 x 600 Hp vertical 3 stg. turbine Pumps for cooling tower serving PVC 3 and VCM Plants, 1978.	5 x 90		1st - negligible.
9.	Plant Air Compressor, Screw, 1000 cfm, 250 Hp, 1989.	60		1 unit sufficient.
10.	Plant Air Piston type ATLAS COPCO, 1000 cfm. Old unit.	60		Ditto.
11	Instrument Air : 1 x 500 + 3 x 400 + 7 x 240 cfm units.	20 to 40		Sufficient Redundancy.

V. PML, MATERIAL DAMAGE and INTERRUPTION

The following table contains PML estimates in respect of equipment items listed in the tables of section "IV" above.

The Business Interruption PML estimates are based on the annual Gross Profit of $ 45,000,000.

The MD-PML estimates are in terms of New Replacement Values.

The reinstatement PERIOD (mo - months) and the BI-PML estimates do not take account of he availability of spare parts but only i.r.o. installed back-up if available. Normally, the availability of spare parts will not give rise to the extreme conditions assumed for PML estimates.

Inorganic Section: Remarks # 1 (see the table next page):

1. The rectifying system serves 36 mercury electrolysis cells at 150 KV, 110 KA. The system was basically erected in 1974. The last 4 cells were added in 1989. To increase the reliability of the system, a new rectifying system was added in 1991. The additional system decreased the interruption risk dramatically.

In calculating the actual contol of the Electrolysis Plant we took account of gross profit earned on the derivatives of Chlorine.

EQUIPMENT		Actual Control % Whole Plant.	PML MD ($ K)	Interpt. Period (Mo.)	PML BI ($ MM)	PML Total ($ MM)	Rem. No.
ELECTROLYSIS PLANT:		15-25%			10-12		
1.	**66Ka Rectifier (New)**	None	500	8	Minor	1.0	1,2
2.	**66Ka Rectifier (1974)**	None	500	8	Minor	1.0	1,2
3.	**24Ka Rectifier**	None	150	8			3
4.	**12Ka Rectifier**	None	80	8			4
5.	**Chlorine Compressor**	10-15%	60	3	1.5	1.5	5
POTASSIUM CARBONATE :		5%			3.5		
1.	**HEINS Centrifuge**	5%	70	3	0.5	0.6	7
2.	**Rotary Dryer**	5%	90	3	0.5	0.6	8

Inorganic Section: Remarks # 2 - 5:

2. The old (1974) 66KA system has operated satisfactorily for 18 years at nominal Amperage. For several years it was operating at temp. of 80-85^{0}C. Now, with the introduction of a new Rectifier, this unit operates only at less than 70% of its capacity. In case of failure of either system, the small Rectifiers will provide sufficient back-up (Remarks 3 & 4 below.)

3. The 24KA system is having both regulating & rectifier transformer elements in one housing. No problems experienced during 24 years of operation. The system is kept as a backup.

4. The 12KA system is 30 years old (but it was not in use for 12 years). No problems experienced. Normally used at 80% nominal Amperage. The system is used as a backup.

5. The chlorine compressor. There is a 40% back-up compressor available. In addition main spare parts are available as well.

6. Theses units are pretty old.

ORGANIC SECTION:

VCM PLANT: Remarks # 6 (see the table next page):

6. **The VCM plant** : VCM may be imported at $ 100/ton increased cost or higher depending on the market prices. Mitigation is therefore possible.

EQUIPMENT		Actual Control % Whole Plant.	PML MD ($ K)	Interpt. Period (Mo.)	PML BI ($ MM)	PML Total ($ MM)	Rem. No.
THE VCM PLANT:		88%			35		6
1.	Yorkpack HCL Refrigeration Unit	88%		10	32	32	7
	- The Compressor	88%	350	Spare			7.1
	- Motor.	88%	80	Spare			7.2
	- Gear Transmission	88%	100	4	11	12	7.3
2.	2 units Air Compressors JOY.	50%		8	11	11	8
	- The Compressor	50%	100	8	11	11	8.1
	- Electric Motor	50%	60	2	2	2	8.2
3.	One Condensor Heat Exch. for the HCL Refrig. system.	8%	25	2	0.3	0.3	9
4.	The "Oxychlorination Reactor"	90%	1500	14	40	41.5	10

7. The Refrigeration unit is 100% Vital for the VCM plant.

7.1 The Compressor & Gear. Complete spare units are available. The Compressor unit is being overhauled abroad.

7.2 The Motor. A complete spare and a set of coils for the stator are available.

8. The Air Compressors. Vital for the VCM plant. Loss of one unit may result in loss of 50% of VCM production.

8.1 The Compressor: One spare set of internal parts are available. The PML relates to an extreme event of failure of the spare parts.

8.2 The Motors: A spare motor for either unit.

9. There are 5 condensors for the HCL condensation. Loss of one unit may have a certain effect during the hot season.

10. The Oxychlorination Reactor: The main risk is explosion. The Reactor contains a tube bundle (Inconel 625) used to generate steam from the exothermic process.

EQUIPMENT	Actual Control % Whole Plant.	PML MD ($ K)	Interpt. Period (Mo.)	PML BI ($ MM)	PML Total ($ MM)	Rem. No.
THE E-PVC PLANT:	5%			55		
1. 2 x Atomizing Pumps 25 hp.	5%		Spare installed			
2. New Centrifugal Chiller	5%	80	Spare installed			
3. 2 Chillers Centravac	-	50	B/U			
THE S-PVC_2 PLANT:	15%			55		
1. Centrifuge, DEUTZ	15%	40	6	4.0	4.0	11
2. 2 Chillers Centravac One unit	15% B/U	80	6			12
THE S-PVC-3 PLANT:	55%			55		
1. Computer Fisher	15%	40	6	4.0	4.0	13
2. Centrifuge Broadbent B/U available in 1/93.	15% B/U	100	6			14

PVC PLANTS: Remarks # 11 - 16:

11. **The Centrifuge:** A vital unit. Internal spare parts exist except for the bowl. The unit is reliable.

12. **Centravac chiller:** One unit is for back up.

13. **DCC Fisher system:** Direct Digital Control of the PVC-3 with a new Computer (1991), Fisher Controls "PROVOX distributed system. The system consists of: 2 x μVAX RT 1000 computers, one is redundant + 4 x CRTs in the Control room, all other equipment is situated in a reinforced concrete building near the dry section of the Plant.

14. **The Centrifuge (PVC III plant):** A vital unit. There are spare parts but no bowl. This is a reliable unit. A new unit is on order. Lead time - 6 months.

Further remark i.r.o. the PVC Plants: In case of serious interruption in one of these plants, arrangements may be made to export excess VCM, thus providing a degree of mitigation of the Loss depending on the availability of vessels and the commerce conditions prevailing at the time of the occurrence.

UTILITIES:

	EQUIPMENT	Actual Control % Whole Plant.	PML MD ($ K)	Interpt. Period (Mo.)	PML BI ($ MM)	PML Total ($ MM)	Rem. No.
THE UTILITIES:							
1.	2 units 30 MVA Power Trafos. 1 unit	5%	600	8		1.2	15
2.	Power Station Steam Boiler	100%	1500	Full B/U	1.0	2.5	16
3.	Power Station Turbine 12 MVA		1,500	12	1.0	2.5	16
4.	Power Station Generator 12 MVA		500	8	1.0	1.5	16
5.	Emergency 45 TPH Steam Boiler	B/U	300				17

UTILITIES: Remarks 17 - 22:

15. **The Main Power Transformers:** One unit (with the help of the Power St.) is sufficient. The Power Station generate enough eletricity for operating the PVC-3 & VCM Plants.

16. **The Main Boiler:** In case of failure, there would be a loss of savings in the annual rate of $ 800,000 (depending on changing cost factors). The aforesaid savings is i.r.o. saving in consumption during Peak and Intermediate rating times. The steam capacity has 100% back-up.

17. **The Back up Boilers (2 units):** Steam vital for the plants may be generated by the New back up Boiler. Additional safety is provided by the old back up Boiler which was recently overhauled.

VI. MAINTENANCE

1. **Team:** The work force consists of 118 emplopyees (the plants' total is 460), including 11 engineers. In addition there are several contractors controlled by a supervisor.

2. **Organization:** The maintenance team is divided into professional departments such as Mechanical, Locksmith, Lathe work, Electrical, Valves, Instrumentation, Carpentry & Plastic work and Constructors department. Each department has a workshop and branches in the plants.

3. **Preventive Maintenance:** The P.M. is controlled by computer. Every week a computer report is issued for each department. This report contains instructions as to what operations should be carried out.

   At present the system does not contain a History File. Thus, it is not possible to draw a report relating to a specific item and to analyze it. However, there is an intention to develop such a program.

4. **Control of Spare Parts:** The AS-400 computer runs a control program for spare parts. Minimum and maximum levels of S.P. are determined by the maintenance department according to original suppliers' recommendations, accumulated experience, the supply period and the availability considerations. Automatic ordering is issued upon arrival at the minimum levels. The levels are checked continuously.

   Details on spare parts availability are given in respect of important equipment items in section "IV" above. In general, the plants are built around the concepts of "in situ" back-up or "Load" divided between 2 or more important items. Where decision was made to install one major item, complete sets of main spare components were purchased.

   Thus, there are "in situ" back up pumps in most locations, a pair of Chillers for each of the PVC plants, complete Gear & Compressor units for the single YORK refrigeration assy., 2 JOY Air Compressors, HCL Condenser, Reboilers, Electric motors.

5. **Availability Reporting:** Availability reports are made each month. The also records contain information about the dates, the underlying causes, and which maintenance group carried out the repairs.

6. **The Computer:** The IBM computer runs Cost Accounting, Production, P.M., and Spare parts programs. At present there are no programs for Availability reporting and History file.

7. **Maintenance Backup:** Outside help is available from Pressure Vessel and Heat Exchanger manufacturers, experienced Constructors of chemical plants and Mechanical workshops situated in the Haifa Bay industrial area. The Oil Refineries, the Petrochemical industry and the Fertilizer industry are located in the area. There is also a common interest and mutual help between the various Plants.

MAINTENANCE, Cont.,

8. **Monitoring:** The major equipment is equipped with vibration monitoring devices that are designed to cut off the operation when the signals exceed a predetermined level. Such devices are installed in the YORKPAK refrigeration assembly, on the JOY air compressors and on the BBC turbo-generator.

   There are also portable units, one is a general purpose device that gives total readings and one is designed to monitor ball bearings.

   The large motors of the above units as well as the generator are also equipped with overheating and phase fault protection. The bearings are monitored for high tempratures.

   The Centrifuges of PVC 2 and PVC 3 plants are equipped with a Torque-Limit device on its drive. Vibration monitoring devices are installed as well.

   An Ultra-Sound device is available for the measurement of thicknesses.

   A new infra-red device was purchased in order to check high temperatures in electric boards.

   Upon shutdown a regular program to measure thickness of tubing and shells is employed wherever access is possible.

9. **Maintenance Skill:** The experience of the last 24 years has shown that the maintenance department has overcome all problems within a short period. No interruption exceeding 2 weeks resulting from mechanical cause has been experienced for many years.

10. **Thermography Monitoring:** Monitoring by means of a Thermovision system is planned to take place soon. A hand held scanner is used periodically.

VII. MAJOR MAINTENANCE WORKS

1. **The Steam Boiler of the Power Station:** It is an 85 TPH Boiler operating at 63 Bar. The Superheater is a radiant type. During 1988 the whole Superheater was replaced. Early 1992 a third of the tubes of the Boiler's wall were replaced.

2. **The Turbine of the Power Station:** Following vibrations trip on 19.11.87, Cracks were detected in several Blades. The Rotor was despached to Swizerland BBC facilities for repairs. Full capacity was regained on 26th July 1988.

   On Feb. 1990, damage was detected in a bearing seat. After 3 months the Turbine temporarily returned to operation. In 10/90 the Turbine was sent to BBC (now ABB) for major modifications. The nature of the modification was to increase its flexibility in order to decrease its 2nd critical speed (to about 9,000 rpm versus the operating speed - 12,000 rpm). Yet, only after handling by of one of the best experts of ABB early this year, a satisfactory vibrational behaviour was achieved (40 □M versus □□□□□M in the past).

   The causes of the problems in the past are related to "2nd critical speed too close to operating speed".

MAINTENANCE, Cont.,

3. **The YORKPAK refrigeration assembly:** The installed compressor has operated satisfactorily since 1981. In 1992 it was sent to the Mfg. for overhaul.

4. **The JOY air compressors:** The Impellers on the unit 2-C-1 were replaced during 1984 in order to upgrade it and to match it to the 7-C-1 unit. The two units are now identical.

5. **The 600TR TRANE refrigeration units:** There are two (2) units. These are hermetic-centrifugal 2 stage units. The 750Hp motor is gas cooled (R-11). The condensers are cooled by Brine pumped from wells (close to the sea shore). One unit is sufficient for normal production. The other is kept as backup. Each unit has one shell +and tubes condenser and there is one additional condenser as spare. The brine flows through the tubes which are made of Admiralty and coated with Sekaphen (corrosion resistant).

6. **The Centrifugal Chillers of E-PVC plant:** During 1986, the motor of one of the chillers failed. It is replaced. No problems were reported since. In 1991, a new 400 TR unit was aquired. The old units are kept as B/U.

7. **YORK K4 Refrigeration Unit in PVC III Plant:** One of the twin YORK 200TR refrigeration units which are used in the preparatory stage in the PVC III Plant failed in August l984. The process was kept with the backup unit. It was replaced by one of the old 200TR VILTER refrigeration units existing in the Plants. This was not critical to the main stream of production. Since 1984, no problems were reported.

9. **Transformers:** All the transformers which are equipped with tape changers were last treated by the manufacturer's (ELCO) experts in l989.

   Another important factor is the temperature of the cooling oil of the transformers. This is related to the energy losses which in turn are related to the square of the current.

   It is recommended by the IEC that the temprature of the Oil in a Transformer shall not exceed 60^0C over the ambient temprature, provided the temp. in the windings shall not exceed 65^0C over the ambient. An additional increase of 8^0C may decrease the life expectancy by 50%. Conversely, operation at lower tempratures may increase the life expectancy by a considerable margin.

   The 110 KA D.C. system of the Electrolysis Plant consists of 4 rectifiers operating in parallel:

   * 12 KA, 230/150 V, opearating 31 years used as a B/U.
   * 24 KA, 230/150 V, operating 28 years used as a B/U.
   * 66 KA, 150 V, operating 18 years. (ELCO System).
   * 66 KA, 150 V, installed in 1992.(New ELCO System).

   In Feb. 1991 one of the main power Transformers (161/22 KV, 30 MVA) sustained serious damage and was replaced by a new unit. The combined MD + BI (increased cost) was about $ 830,000.

MAINTENANCE, Cont.,

10. **The Ethylene Plant (Supplier Extension):** The Insured plant is dependent on the supply of Ethylene from the Ethylene plant of the Oil Refineries. The Ethylene is supplied at the rate of 40,000 tons/year. The Insurance Policy provides cover for this effect under the supplier extension clause. The time deductible is 7-10 days.

    The plant is on stream since 1979. Until 3th June 1988 no accident giving rise to a claim had occurred.

    On 3th June 1988 there was a breakdown of the F.D. fan of Steam Boiler No. 2 at the Ethylene Plant. At that time another one of the three Boilers was undergoing maintenance work. The accident forces a complete shutdown of the Plant.

    On 9.6.88 start-up of the Plant commenced and during this operation another accident occurred. This time the Grids of the reactors operating in the C_2 Hydrogenation section were destroyed due to over-pressure, the cause of which is attributed to mistake made during the exchange of one of the operating reactors with a reactor which had completed regeneration of its catalyst.

    Due to these occurrences and subsequent non-supply of Ethylene, the business of the Insured was Interrupted until July 15.

    The loss was settlement was $ 2,315,000.-

    In May 1990, several days after a shutdown made for 48 days, for the purposes of overhaul and expansion, damage was found in the steam turbine driving a gas compressor. This mishap caused a delay in the re-starting of the plant and subsequent interruption in the Insured Plant. The loss was settled for about $ 400,000.

11. **Electric Motors:** There are few motors with repair periods exceeding 2 or 3 weeks if there is a failure of the spare unit in an extreme case:

    A. The 1750HP motor of the York Refrigeration Compressor: It has a spare motor and in addition a spare set of coils for the stator.

    B. The motors of the two Joy Air Compressors. There is a spare motor. No spare coils are available. The repair period is 2.5 - 3 months.

    C. The motors of the Chillers' hermetic Centrifugal Compressors: Repair period is up to 6 months. In each case there is close to 100% redundancy.

VIII. IMPORTANT SUPPLIERS

1. ETHYLENE:

The Insured is dependent on the supply of 40,000 tons/year Ethylene from the Ethylene plant, capacity - 150,000 tons/year, situated in the premises of the Oil Refineries some 10Km to the South. At present, it is the property of the ORL (Oil Refineries Ltd.) and managed by CARMEL OLEFINS Ltd.

The suppliers' extension is i.r.o. the Ethylene Plant and the ORL which supplies the feedstocks to the Ethylene Plant (Light Naphta, LPG, other Gases).

Main rotating machinery (Comressor - DEMAG, Steam turbine - SIEMENS: 3 Centrifugal Compressors driven by Steam Turbines, capacities: 17,000 hp, 6,000 kw & 10,000 kw

Main Ethylene storage Tank: 3,000 tons, refrigerated.

The Insured retained its priority i.r.o. last available stocks of Ethylene of 400 tons.

For many years **ORL** considered the Machinery Breakdown indemnity period of 6 months as sufficient in view of the available spare units.

2. OTHER MATERIALS:

NaCL and KCL salts are transported by trains from the Dead Sea Works some 300 km. South of the Insured Plant. The Salts are necessary for the production of Chlorine (and other related products), controlling 25% of the Gross Profits. The salts may be imported subject to increased cost. No significant machinery breakdown risk is known.

About 2,000 tons/year of **CO_2** are supplied from Fertilisers & Chemicals Ltd. in Haifa Bay using Tank Cars. The CO_2 is reacted with KOH to produce Potassium Carbonate consisting of about 5% of the Gross Profits. We do not have information regarding this risk.

IX. CLAIM RECORD (PERIOD OF 10 YEARS):

Since 1979 when the new VCM & PVC plant and the Supplier Ethylene Plant came on stream, and until 1988 (a period of 13 years), there were two (2) occurrences giving rise to Claims under the Machinery Insurances:

1. Failure of the BBC 9 MW Turbine of the Power Station of EIF on 19.11.87: The damage manifested in cracks appearing on the Turbine blades.

The Material damage was settled at $ 225,000.- and the Consequencial loss of savings at $ 135,000.- the total indemnity being $ 300,000.

CLAIM HISTORY:

2. Two successive accidents occurred in the Suppliers' Ethylene Plant on 3rd June and on 9th June 1988, with the consequence of interruption in the Insured Plant for a period of 6 weeks. The Loss was settled at the sum of $ 2,315,000.-

3. In Feb. 1991 one of the main power Transformers (161/22 KV, 30 MVA) sustained a serious damage and was replaced by a new unit. The combined MD + BI (increased cost) was about $ 830,000. The direct cause was short circuit created by a rat on a 22/3.3 KV Transformer.

X. SUMMARY OF PML

To summarise the results provided in the PML table in section V:

1. PML in respect of the ELCO 66 KA Transformer. The addition of a new unit in 1991 reduced the risk from $ 7 MM to $ 1 MM.

2. PML in repect of other mishaps in the VCM & PVC Plants - $ 11 MM. An improvement i.r.o PVC-3 plant is the ordering of a new Centrifuge. An improvement i.r.o. the E-PVC plant is the installation of a new Chiller.

3. Catastrophic PML in respect of the VCM refrigeration Compressor - $ 35 MM. This figure presents the unlikely chance of succecive failures of the operating and the spare unit, or when the spare unit is away for repairs (Actually, it is now being overhauled. Expected to be back within 3 months).

4. Catastrophic PML in respect of breakdown in any large unit of the Ethylene Plant under the Supplier Extension cover.

5. Explosion in a Process Unit: Under the present insurance arrangement the risk is covered under the Machinery Breakdown section. Please refer to the Fire & Allied Perils report for details regarding explosion risks.

Yours faithfully,

Dan Arbel

DAN ARBEL RISK ENGINEERING Ltd.