DAN ARBEL RISK ENGINEERING Ltd., 27 Al. Schweizer, Haifa, ISRAEL 34995
Email: dan@riskmanage.com ☎ **Tel.** 972-4-8243337, **Fax.** 972-4-8243278

Date: 29/11/99
Ref.: Sefen99F3

Insurance Co.
Industrial Department
Tel Aviv,

LDI PANELYTE - FIRE SURVEY

INTRODUCTION

Following a fire event that consumed a Roll Paper Storage building, office rooms and damaged a vertical type Impregnator located in an adjacent hall, the Insurers asked us to perform a Fire Risk Survey.

The purpose of the survey is to evaluate the Fire and Explosion Risks and the Fire Protection means and to suggest risk reduction measures and improved fire protection means as we see fit.

The recommendations set forth in this report are subject to discussion between the Insurers and the Insured.

Further steps on our part may consist of:

- Preparation of basic specifications,
- Budget Estimates,
- Reasonable timetable.

At the moment, we provided only rough estimates.

The report includes the plant plan. It is based on original updated computerized layout. We added some pertinent information. Due to the high scale ratio on A4 page, we divided the plan into three parcels.

The report consists of 2 major parts:

PART 1 - BASIC INFOAMATION, SUMMARY AND RECOMMENDATIONS.

This part contains the basic information required by the Underwriters.

PART 2 –Description of the Plant, the Risks, Fire Protection arrangements and what we learnt from the recent fire event.

Engineers serving the Underwriters may read this part.

If any question arises, any underwriter may approach us using our Email.

III. REPORT DETAILS

Survey on:	**IDL PANELYLE J.V. Sefen / Etz Lavud**
Subject:	**Fire and General Risk Survey.**
Dates:	14/07/99, 4/08/99.
Referents:	Y. Sofer, H.Rosenblum, A. Sayda, R. Storz, A. Salama, E. Eliyahu
Commissioned By:	**Israel Phoenix Insurance Co.**
The survey:	In the course of our work we met various personnel involved in the management of the plant, including key personnel in various technical fields with special emphasis on the risks surveyed.
Surveyed By:	Dan Arbel & Arie David.
Scope:	**Risk Survey without Property evaluation.**

IV. BUSINESS DETAILS

Insured:	**Sefen Ltd.**
Main Plant Location:	Jordan Valley (along the road #80 between Tsemach and Beit Shaan), -201 m. below Sea Level.
Business:	Manufacturers of Formica and associated products for the Furniture Industry
No. of Employees	358 + 17 employed in a rented distribution premises in Rishon Le'zion (near Tel-Aviv).
Turnover:	1998- $ 59,000,000. 1999 - $ 40,000,000.
G. Manager:	Mr. M. Kremerman.
Share Holders:	ETZ LAVUD LTD. - 57.50%, SEFEN LTD. - 42.50%
Wages & Salaries:	US $ 13,000,000.
Brief History:	Established originally in 1951, took over by Etz Lavud in 1998.
Products:	Formica Sheets**,** Low Pressure Decorative Paper, Lacquered Finished Foils, Drilling Boards,
Markets:	60% export, 40% local market.
Quality:	**ISO 9002 Certification**

V. MAIN SUMS INSURED

Property: $ 79,000,000

Gross Profits: $ 20,000,000

VI. RISK SUMMARY

Products:	Melamine and Phenol based laminates.
Geographical Location:	In the northern part of the Jordan Valley, south of the Sea of Galilee, near Ashdod Ya'akov. The area is basically flat, height is –202.5 to -200.0 m. (below sea level).
Climate:	Mild Winter, hot Summer (35-40^{0}C). Avg. annual precipitation below 300 mm.
Site:	Area - about 80,000 m^3. There is a surrounding fence.
Flood Risk:	Not considerable (to be ascertained).
Earthquake Risk:	Outside the scope of this report.
Building area:	About 39,000 m^3, 51% for Production, 36.5% for Storage and 12.5% for the balance.
Access ways:	Reasonable around the buildings.
Neighbors:	None adjacent except a main Trafo station of the IEC next to the western fence.
Typical Construction:	Concrete Floor, concrete frame and C.B. Walls, unprotected steel frame covered by Asbestos sheeting Roof.
Combustible elements in the Construction:	Suspended ceilings in air-conditioned halls have newer EPS[1] or older Cellulose type insulation (made of wood waste). Some of the ceiling area is made of non-combustible materials.
Main Production Lines & Equipment	Reactors, 2 Phenol and 4 Melamine impregnators, 5 presses and 1 continuous laminator.
Main Production Blocks	a. The main production building includes the chemical department, all the impregnators, Layers preparation, four (4) presses and one (1) continuous laminator. b. The finishing department includes Sawing, Sanding, Cutting, Sorting and Packaging machinery. But, it also contains one (1) press.
Raw Materials:	Phenol, Formaldehyde, Methanol, Fuels, IPA, Melamine, Urea, Caustic Soda, various Paper in Rolls, Alum. Foil and various others.

[1] **The EPS panels:** we received from the supplier UL 1715 (UBC 17-5) approval letter and test report. This test is a corner test considered to be rather severe.

SUMMARY OF THE RISKS (Cont-ed):

Main Toxic Materials:	Phenol, Formaldehyde. This is outside the scope of covered risks, except for some probable hindrance of fire fighting efforts.
Main Combustible materials:	Phenol, Formaldehyde, Methanol, I.P.A, various papers, wood pallets. Laminates are difficult to ignite.
Storage Areas – Separate buildings but, There is storage also within the main production block.	a. Phenol, Formaldehyde, Methanol, IPA and small amount of other materials in barrels. Paper roll storage in two separate storage buildings, Finished goods for export in separate buildings. Paper roll storage in halls inside the main production block. e. Finished goods storage for the Local Market in part of the main production building.
Exposure to Production Facilities: Exist due to the internal significant fire loads. This is the main Fire Risk problem in the Plant.	a. The chemical department from the materials uses therein (Phenol, Formaldehyde and Methanol). b. Phenol Impregnators from IPA barrels and from the "paper preparation department. c. Press No. 4 and Phenol impregnators from the adjacent finished goods storage and Press No. 8 from adjacent Roll Paper storage. d. Continuous laminating line from the own use of heating oil. e. Overhead steam main line and the steam heat exchanger from paper roll storage. f. Paper roll storage in halls inside the main production blocks. g. Finished goods storage for the Local Market in part of the main production building.
Large Fire Areas:	The main production block consists of many interconnecting buildings with no fire rated separations (except some). However the shear size of the building block (20000 m^2), many partitions and non-continuous fire loads may not allow total involvement.
Steam Generation:	There are three Boilers in the Boiler House. The Insured claimed that two (2) boilers may supply all needs, but we believe that a shortage may result in the cold season if the largest unit is off.
Electrical:	There are several Trafo stations using 630+1250 kva oil cooled type units. Backup power may be supplied by 5 diesel Generators necessary to prevent solidification and other problems in the processes.
Air Compressors:	There are 6 C.A stations with over 15 small to medium size units. We do not envisage a considerable problem in this respect.

SUMMARY OF THE RISKS (Cont-ed):

Explosion Risk:

The Phenol Reaction process is exothermic. This may lead to explosion if it runs out of control. The chemical department building section is open one side, thus pressure venting is nor a problem.

Another probable risk source is the drying tunnel of any impregnator where hot air at 110º to 170ºC extract remains of solvents from the impregnated paper.

The electrical systems in these areas have explosion proof rating.

Another type of explosion risk is the duct collection system serving the Sawing and Sanding operations. It is equipped with automatic sprinklers.

Water Supply:

a. Water from 6" source boosted by an electrical pump (3 bar).
b. Fresh water from 4" source (5 bars)
c. 2000 m^3 reservoirs – not used for fire (but may be used).

We consider the water supplies with and without the pump (see below) as insufficient as far as Sprinkler Systems is concerned.

We have to note however, that the Fire Brigade did not complain about water shortage during the last fire event (see below – water for hydrants).

Water Mains for fire:
None dedicated

None dedicated. The Mains consists of 8" to 4" main loop and 8" to 2" branches serves the process reservoirs, hydrants and the sprinklers systems.

Fire Pump:

One dedicated Petrol engine driven automatically started Pump. We concluded that: the pump is not standard, have insufficient capacity and is fitted with unreliable starting arrangement.

Fire Hydrants:

There is a great deal of hydrants around the site and within the buildings. When all water sources where used and the fire pump operated at max. capacity, 145 m^3/h of water at 6 bars were obtained. This is reasonable for hose supply.

Sprinklers:

Installed in the main Roll Paper storage buildings, the Chemical department, local market laminates storage and in other several small areas. The largest system is in the local market storage. We note that there are internal constructions within the area that are not protected.

We are of the opinion that their design criteria are insufficient ver. the related hazards.

Extinguishers:

There is a considerable amount of units around the plant.

Electrical Boards:

Most of the boards are protected by automatic BCF extinguishing systems.

SUMMARY OF THE RISKS (Cont-ed):

Fire Brigades:	There is a substantial station located within 10 min. from the site.
Emergency Preparedness:	The Insured prepared a plant safety file several in 1994. It is comprehensive, but was not updated. Our impression is that there in insufficient maintenance and operation testing.
Security:	The area is surrounded with wired fence with one 24 hours a day supervised gate. There is no other sophisticated intruder alarm systems on site.
PML:	There is not a single catastrophic event that we can point at. The reader is referred to "**Exposure to Production Facilities"** section in the preceding page. Our estimate is that **35% of the total sums insured** may be involved.

VII. RECOMMENDATIONS

IMMEDIATE MEASURES

1. ***Reduce the exposure of the production facilities*** from adjacent fire loads. This can be done by:
   - ***a.*** Reducing the amount of stocks.
   - ***b.*** Removing stocks from sensitive equipment. For instance: Paper rolls should not be stored just below the main steam pipe.
   - ***c.*** Remove idle pallets storage away from the partition separating from the Stainless steel plates (or remove the plate storage likewise). The partition should be upgraded to 2 hours rating.

2. ***Temporary Measure:*** *Until permanent system is installed (see item below),* the performance of the existing system may be improved. The engine of the pump should be replaced or overhauled.

   This included simulated operation of every riser by opening the respective ITC. A recorder that will be installed will provide the necessary logging, including pressure change versus time records.

   We suggest making sure that a pressure of 5 bars will be achieved within 60 seconds from the onset of the signal of respective flow switches. The latter should be set at delays not exceeding 20 sec.

RECOMMENDATIONS/ Maintenance (Cont-ed).

3. Maintenance:

a. All water based system should be maintained and tested including all the required logging according with NFPA 25 (adopted as Israeli Standard).

b. All detection systems should be maintained and tested according with I.S.1220 part 11.

c. Infra Red inspection of electrical boards and gear should be performed twice a year.

d. Periodic maintenance of high-tension electrical systems should be done every year including testing of oil samples from the transformers.

e. Make sure that the main valves of all sprinkler risers are chained in the fully open position. Every week the position of the valves and the condition of the chain will be noted and signed for.

f. Simulate automatic system operation every week and ensure that the flow switch of any system initiate the fire pump. Every month, the pump shall be tested under load. This may be done by fitting the nearby 3" hydrant with a 2" storz and opening the valve fully. The discharge pressure of the pump shall be recorded.

4. Fire Drills: *At least 12 employees per shift should attend fire drills twice a year.* After every session, a report shall be drafted that will include the names of the participants, the description of the drill and the length of time it took. *See also item 5 below.*

5. Pre-Emergency Planning: The 1994 safety plan should be updated. It shall include also the following:

a. A "valve man" and "pump man" per each shift will be nominated. In case of fire, their role would be to ascertain pump operation at full capacity and valve in fully open position (of the system operating to suppress the fire). They will be trained and participate in weekly testing).

b. The names of the valve and pump men will be noted in the safety plan.

6. Reporting to Insurers: Copies of all reports (*items 2, 3, 4 & 5* above) should be forwarded to the Insurers twice a year.

MID -TERM MEASURES

7. Design: complete designs of the installations required under ***recommendations 8 to 12*** below within ***6 months***.

LONG -TERM MEASURES

To comply with within 12 to 18 months.

8. ***A dedicated infrastructure for automatic sprinklers*** should be provided. This includes:

a. At least one diesel driven UL/FM listed fire pump (at least 1500 gpm at 145 psi). The Pump will be arranged to take suction from the water reservoirs of the Plant. The arrangement shall follow NFPA 20 ($ 60,000).

b. New dedicated steady pressured maintained network for the individual sprinkler system (at the moment we cannot estimate the cost: $ 60 per meter should be taken as a yardstick. A probable budget is $ 120,000).

9. **Automatic Sprinklers Installations:**

a. Provide strong sprinkler system protection over the Roll paper storage. We suggest a demand of 18 mm/min at 280m^2. This will cover also unbanded open array medium weight paper up to 4.6 m. high.

b. Automatic Sprinklers should be installed throughout the paper preparation department (Extra-Hazard 1 - rating).

c. Ordinary hazard Automatic sprinklers should protect all the Air-Conditioned areas near the presses. We suggest installing the sprinklers at a distance not exceeding **2.7 m**. (to compensate for the combustibility of the ceilings).

d. We advise to install sprinklers in the hall containing the Continuous Lamination line and over the heating oil boiler.

e. Install automatic sprinklers in all laboratories.

f. All the sprinklers systems should be secured for earthquake loading as per NFPA 13 (applies also to the existing systems, below).

We estimate the required budget at $ 60,000 - $ 70,000.

10. **Existing Automatic Sprinklers Installations:**

These systems have to be upgraded to as close as possible to contemporary standards. We would wish to increase the density by at least 2 folds. This may be done by the following measures:

a. A new pump with a 60% increase in pressure will provide 30% additional flow.

b. All sprinkler heads should be replaced with retrofit type K=8 (50% more flow), 141^{0}C. The existing K=5.6 heads are temp. rated 60 to 70^{0}C. Too low temp. rating may cause too may heads to open, leading to overtaxing of the system with eventual failure.

c. In order to sustain the increased flow, all systems must go debottlenecking. An hydraulic analysis and cost analysis should precede any plan. Most of the installations are old type with heavy gauge pipes and fittings. It would be necessary to determine how this type of fittings is connected with contemporary lighter gauge. It will be easier to deal with systems installed in the eighties.

d. The coverage in the chemical department is insufficient. Many areas below equipment and gratings were left unprotected. This step is easy to accomplish. In this area we would suggest adding a foam system as per NFPA 16A.

An estimate budget for the upgrading is $ 50,000.

11. Electrical Boards:

Complete automatic extinguishing systems in all electrical boards having a main C.B. of 500 A.

12. *Reduce the exposure of the production facilities* from adjacent fire loads.

In addition to Item 1 above, two (2) hours fire rated partitions should be installed to segregate storage from production facilities.

Specifically, in respect of the phenol impregnators hall:

a. A C.B. wall should be constructed between the Paper Roll Storage and the Impregnators hall.

b. A fire door has to installed at the northern wall separating between the Impregnator hall and the Layers Preparation Hall.

13. Controlling Overflow:

All elevated tanks should be provided with high level cutout in addition to the normal level control to prevent overflow of liquids, whether combustible or toxic.

14. Daily Storage of IPA Barrels:

Iso-Propyl-Alcohol liquid is a NFPA Class Ic flammable liquid.. Several barrels are located near the Phenol Impregnation machine. It is preferable that the insured find a way of using a controlled metering system rather than barrels.

VIII. THE PROCESS

The following description is general. Process Hazards are discussed in ***Section VIII.***

The manufacturing of Formica involves:

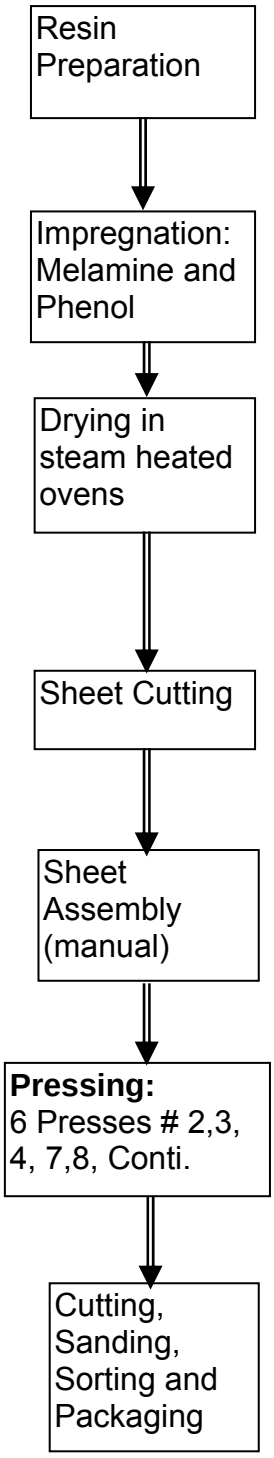
1. **Chemical reactions:** The initial stages of all products involve **chemical reactions**. These are carried out in two sets of **two Reactors (each)**. One set produces **Phenol Formaldehyde resin** and the other one produces **Melamine Formaldehyde resin**. Both reactions involve polymerization under condensation. The processes are batchwise.

2. **Impregnations:** The next step is split into two lines. One line contains **two impregnators for phenolic** resin and the other one contains **four impregnators of melamine**. This process involves the impregnation of the resin in suitable paper and the drying of all condensable components. The process is continuous and the paper runs first through a series of dip baths and then enters a long (tunnel shaped) drying oven, into which hot air is injected. The product is collected on rolls. Whereas craft paper with phenolic resin impregnation yields the bottom layer of the Formica sheet, transparent paper impregnated with melamine resin yields the top layer of the product. On this layer the decoration will be embedded in a subsequent step.

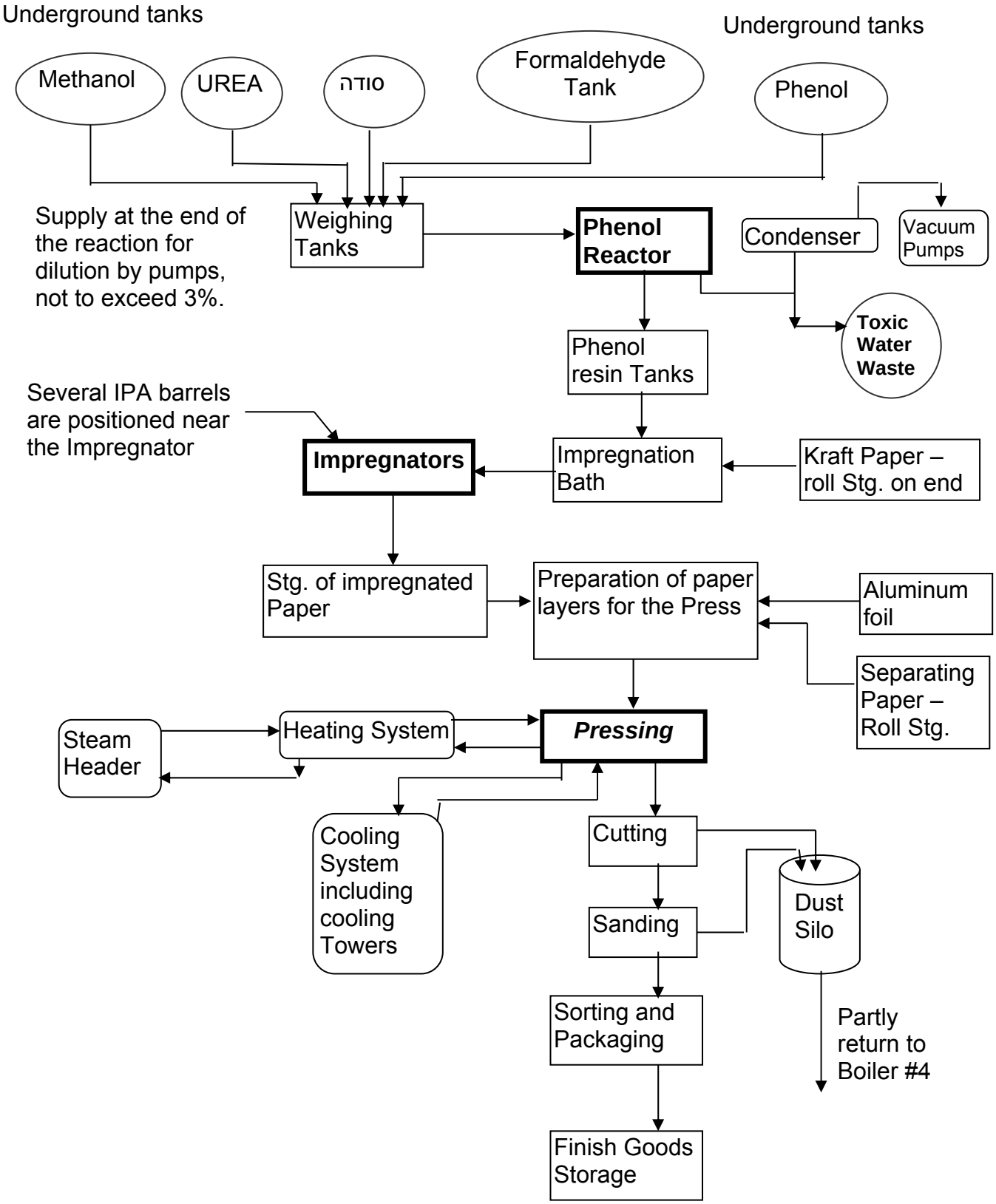
3. **Pattern Preparation:** The orders of hundreds of possible patterns, colors, dimensions and surface appearances (shiny, mat etc.) are prepared in a special **Sorting** hall by manual labour. The "**sandwiches" prepared** on special platforms are sent to the presses.

4. **Pressing:** There are altogether **six presses** in the works. Five of them (each of a different size) operate **batchwise** and one is **continuous**. The platforms with sandwiches containing a polished stainless steel sheet (for each Formica sheet) containing the decorative pattern are fed to the presses. The process involves the application of high pressure (by hydraulic pistons) at controlled temperature conditions. The product sheets are separated before the next step.

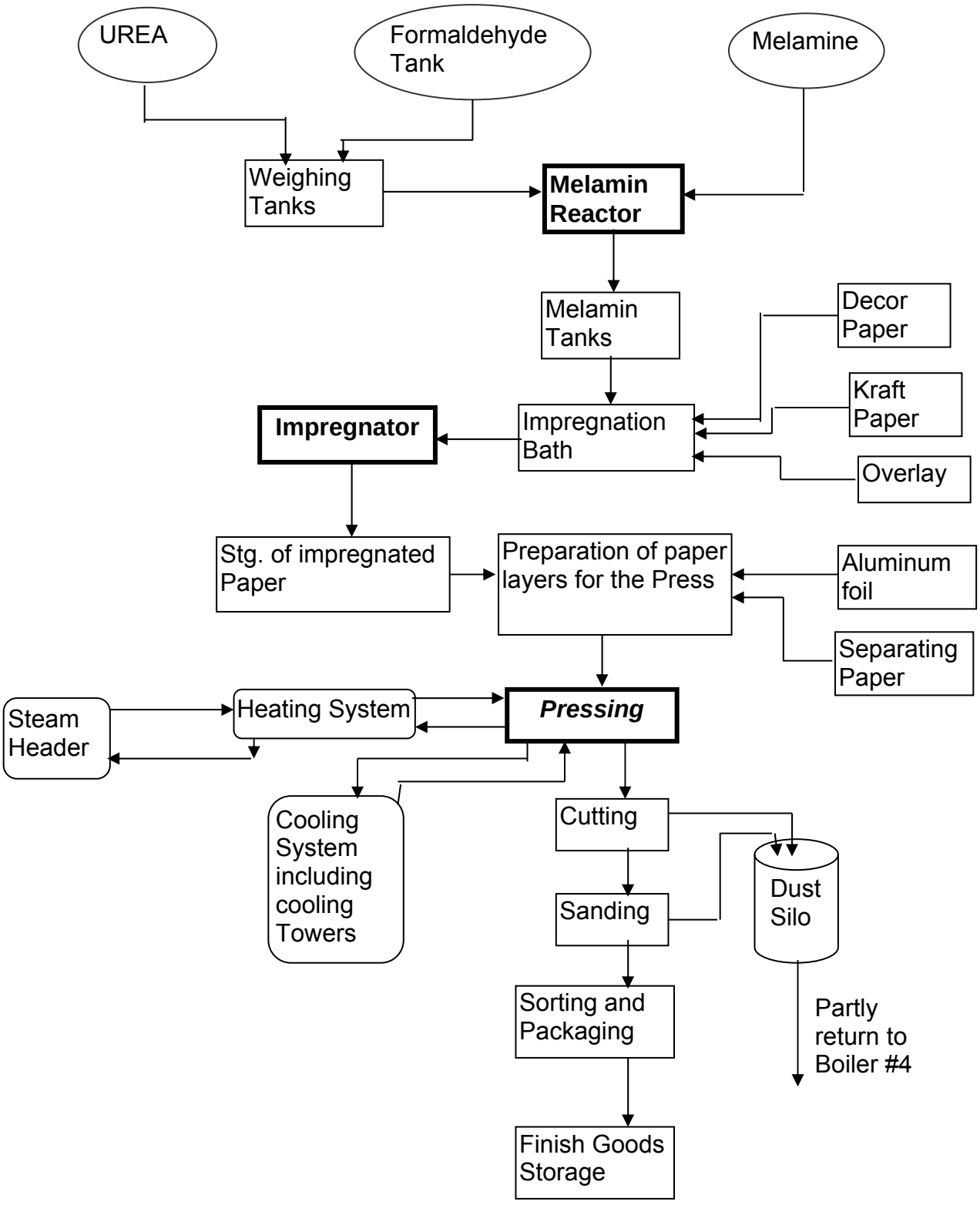
5. **Finishing department:** various machines execute the steps required for obtaining the final product. These include sawing (edges and special order sizes), surface sanding, sorting (quality assurance) and packing.



Phenol Formaldehyde Laminates – Process Diagram



Melamine Laminates – Process Diagram



IX. DESCRIPTION

1. *The Buildings:*

The site occupies an area of about 80,000 m^2.

The various departments are located sometimes at great distances from each other.

The main structures on the site are as follows:

Building Block		Construction	Area (m2)
Administration	3 floors.	massive	3x 400
Main Production Block	Reactors, Melamine Impregnating hall, Phenol Impregnating Hall, Sorting hall, Presses (#2,3,4 & 8) Halls, Storage Halls, Continuous Press and finishing.	Reinforced Concrete frame, CB walls, Asb. covering on unprotected steel frame. Suspending ceilings allow A.C. in areas near the Presses.	17,500
	Melamine impregnation depart.: On top of the roof, the resin tanks are installed.	The roof is made of pre-stressed slabs, 4 m. high (non-fire rated).	
Finishing + Press #7	Sawing, Sanding, Sorting and Packaging Building.	Ditto.	4,500
Roll Paper Stg.	2 halls	Reinforced Concrete frame, CB walls, Asb. covering on unprotected steel frame.	2 x 450
Roll Paper Stg.	2 hall.		900
Boiler House,		Ditto.	680
Maintenance structures	Various workshops, garages, and a store.		
Technical Offices	Production management building including quality assurance, manpower etc.		
Various sheds.			

DESCRIPTION (Cont-ed)

2. Production Means:

Process	Location	Equipment	Construction
Reaction Phenolic resin	Main Production Bldg.	Two batch reactors incl. Reflux condensers, capacity 15 and 4 tons.	Concrete structure
Reaction Melamine resin	Main Production Bldg.	Two batch reactors, capacity 4 and 3.5 tons.	Concrete structure
Phenolic resin Impregnation	Main Production Bldg.	Two parallel "Vits" impregnation lines, complete with air supply and exhaustion systems	Concrete structure
Melamine resin Impregnation	In a separate Production Bldg.	Four parallel "Vits" impregnation lines, complete with air supply and exhaustion systems. 3 lines for melamine and 1 line for lacquered paper	Concrete structure
Pressing	Various six locations	Presses no. 2,3,4,7,8 (for sheets 4'-5'wide and 8'-12' long) and a continuous Press **Hymmen** 4' wide.	Various buildings, fully air-conditioned
Finishing	Finishing bldg.	4 manual saws, 2 automatic. Saws, 3 sanding machines. Packing and wrapping equipment.	Concrete structure

3. Tank Farms:

Item	Location	Details	Structure
Phenol bulk Storage (new)	Near the front fence	2x100 cum CS tanks. Temp. Controlled.	Mounded
Formaldehyde bulk Storage	Part of main production building	Vertical Insulated tanks 2x60cum +1x40 cum	Blast proof concrete structure
Phenolic Resin (old)	Part of main production building	6x FRP vertical thermally insulated tanks, each 20-30cum	Concrete bund walls
Phenolic Resin (new)	Adjacent to production building	4x FRP vertical thermally insulated tanks, each 15-20cum	Outdoors with light roof. Inside Concrete bund walls
Phenolic Resin (old)	Inside the Reactors bldg.	3 vertical tanks on legs, each 10-30cum.	Concrete, open to front

DESCRIPTION / Tank Farms, (cont-ed)

Item	Location	Details	Structure
Methanol	Near the gate	14 + 8 tons.	Underground.
I.P.A.	Ditto	8 tons	Underground

Remarks:

a. underground Phenol tanks were tested for leakage 2 years ago. None was found.

b. 2" line delivered Phenol from the underground tank farm to 2 daily tanks. The line is hanged on the external walls of the Roll Storage building (exposed).

4. *Electrical Systems:*

Items	Location	Description	Remarks
Electrical Power Transformers	Around the whole site	Public Supply grid at 23KV. 4 transformer stations with 2x1,250 and 6x630 KVA	Outdoor installations
H.T. Stations		A single Breaker for the site and 4 HT Boards.	
Generators			

Consumption/Capacity Ratio: ;Age:

5. *Steam Generation and Organic Fluid:*

Location:	Boiler House, Concrete frame, C.B. walls, Asb. Roof on steel structure.
Steam Boilers:	3 independent smoke tube boilers, with a common header. Total capacity 56 TPH. ***a.*** StandardKessel 1973, 400 m^2, 18 bars, twin tubes + 2 burners, Smoke tubes (4/99 report – requires cleaning). ***b.*** Danstoker 1992, 408 m^2, 22 TPH, 19 bars, twin tubes + 2 burners, Smoke tubes. ***c.*** Hameichal 1971, 350 m^2, 18 bars, water tubes (12/98 report – requires repair and hydrostatic testing). All tested within last year as required by the law. Using heavy fuel. Main Header may be exposed to roll storage inside the main Bldg. **Redundancy:** Not very clear. Seems to be a problem in the winter.

DESCRIPTION / Steam Generation and Organic Fluid (Cont-ed),

Organic Fluid	One thermal Oil Boiler BAY, 1983 used for the **Conti Press** line. Working conditions: ***a.*** Temp. - 220^0C. ***b.*** Test Press. - 10 bars, w.p. 5 bars. ***c.*** Flow – 240 l/m.
Redundancy:	None for this line.
Fuel supply-General	Heavy F.O. underground tanks. Capacity not available. Above ground tanks for Gas Oil and several 48 kg LPG cylinders.

6. *Compressed Air:*

Location: 6 locations around the site.

Equipment: 9 screw type compressors, 1 rotary vane type, 5 piston type. All with air driers, Range of power 20-125HP.

Redundancy: No problem reported.

7. *Cooling Towers:*

Location: Outdoor installations, mainly on elevated structures in five locations, adjacent to energy centers of presses (main consumers).

Equipment: Total of 12 cooling towers mainly of two sizes.

Redundancy:

8. *Internal Conveyance:*

Means: Lift Trucks, Diesel.

X. PROCESS HAZARDS

1. Raw Materials:

Some of the raw materials in storage are **Flammable or Combustible**, other are **toxic.**

Rolls of Paper are stored in two (2) separate buildings protected by automatic sprinklers.

There are also significant unprotected storage areas within the Production Buildings that create considerable exposure to the process.

The two main types of paper are:

Craft paper, made of unfinished wood fibers 80-240 g/m^2, in banded rolls stored on end in closed or standard array, 5 m. high.

Rolls of **decor paper**, which is mostly transparent and much lighter than craft paper (about 60-120 g/sqm) in unbanded rolls, stored in standard array, 5 m. high.

2. Flammable Liquids:

Two types of alcohol are stored and used, namely **Methanol and I.P.A.** (Isopropyl alcohol). The bulk storage (mostly methanol) contains some 30 tons. Methanol is pumped into the phenol reactors after the end of the reaction. Typical amount 200 liters.

IPA is stored in barrels and there is one underground storage tank near the gate.

Phenol is a combustible liquid having a Flash Point of 70^0C.

Formaldehyde (37% - 40% in water) is combustible liquid having a Flash Point between 60^0 to 85^0C.

Phenol, Formaldehyde and Methanol (up to 3%) are part of the raw materials used for the resin preparation.

3. Toxic Materials:

Phenol is categorized by DOT as 6.1 materials and by NFPA as health Hazard 4, Flammability 2. It is stored in two mounded (buried) tanks. This is a new bulk storage facility built as a result of the requirements of authorities. Total capacity about 200 m^3.

Formaldehyde, categorized by DOT and UN as Class 9 & 3 (toxic material and combustible), H3, F2 by NFPA, is stored in vertical tanks in a blast proof room. Total capacity about 160 m^3.

4. Reaction Section:

Phenol Formaldehyde resin is produced in a jacketed steel reactor under controlled conditions of temperature and pH. The reactants are fed and heated until the temperature is stable at 85ºC .The reaction becomes exothermic and the reactor is cooled. The polymerization process takes place under reflux using an overhead condenser. Part of the reaction cycle is under slight pressure and part of it is under vacuum conditions.

PROCESS HAZARDS / Reaction Section (Cont-ed),

The larger reactor is automatic, PLC controlled. **Safety measures against runaway** reaction etc are incorporated in the program. For example there are arrangements for "killing" the exothermic reaction by **automatic injection of water**, in case it gets out of control. **Bursting discs** are installed in the reactor roof. If activated the solution will simply be **ejected inside** the building, presenting a toxic hazard to operating personnel.

The smaller reactor uses the same process, but it is **fully manual**. Thus it is not equipped with the safety features of the larger reactor, but it has too a **bursting disc** for the case accidental overpressure.

The final stage after the completion of the reaction and cooling, is adjustment of viscosity of the resin by a dilute **methanol** solution.

The use of methanol always presents a certain potential fire/ explosion hazard under extreme conditions at any stage of further processing. It should be stressed that the concentration of methanol in the resin is very low (around 3%).

The resin contains about 60% solids in an aqueous solution. It is pumped to storage for cooling. The reactants as well as the water of condensation removed during the reaction are toxic. The latter is treated in special sewage ponds.

Melamine resin is prepared in similar reactors, but there is no exothermic reaction and no reflux condenser. One of the components incorporated in the reaction is urea.

Other chemicals stored on the site in relatively small quantities include:

Urea, Caustic soda, resins for ion exchange columns for water treatment, etc. These are kept in a special store. They do not present a fire hazard.

5. Impregnation Section:

The resin impregnated paper passes through a drying tunnel. The drying medium is air heated by internal ***steam radiators***. Range of temperatures is 110º to 170ºC. Circulating air (around 40,000NM^3/hr) controls the temperature, by a supply and an exhaust fan. The drier is kept under constant **vacuum** to prevent any escape of gases.

The hot air is injected by nozzles, directly on to the moving sheet that is impregnated with resin. Volatile components (such as water, methanol, formaldehyde, and phenol) diffuse into the air stream, thus completing the polymerization process of the resin impregnated paper.

The **exhaust fumes** are expelled to the **atmosphere** above the roof level. There is a plan to collect them in the future for incineration in the steam boilers burners.

The product at the end of the line is either in rolls or cut to sheets.

The whole installation is **explosion proof**.

The control system incorporates safety-interlocking systems to protect the line against eventual failures.

PROCESS HAZARDS / Impregnation Section (Cont-ed),

The two phenol resin impregnators are installed in a hall, next to each other with no fire separation. They have full control over the production of Formica. One of the two has been expanded in the last months.

In another building, there are three **Melamine impregnators and a lacquered paper impregnator**, installed next to each other, without any separations. The process is similar to that of the phenol tunnels. The drying temperatures are lower, about 120-140ºC.

The last of these lines was erected 8 months ago, in an extension of the existing building. This is the fastest and most versatile of the four lines.

It is worth pointing out that a serious fire in this production hall will bring to a standstill the whole plant (No Formica can be manufactured without these lines). The apparent fire load in this hall is low.

6. Pressing Section:

As mentioned earlier the presses are installed in six different locations (Press **No.2** and **No.3** are separated by a partition). The press itself is always installed indoors, whereas the respective energy center is always an outdoors installation.

The energy center includes high-pressure hot water generators (using live steam), hot water storage, high-pressure water circulation pumps, cooling water circulation pumps, cooling towers etc. In addition it has a complete air conditioning center for controlling the temperature in the Press hall.

The press is a massive vertical structure, between 12 and 20 layers high. Each layer is supported by a platform on to which the “sandwiches” are fed. The pressing process is an automatically controlled cycle, during which there is heating (130^0-140ºC), at high-pressure (up to 100 bar) phase, and a cooling phase. In the process, the pattern from the special polished stainless steel plates is embedded on to the melamine sheet.

Each press has a substantial hydraulic system that may create a flash fire hazard if a high-pressure tube is cracked or burst. The oil reservoirs are not impounded allowing spread of burning oil if the reservoir is involved.

The single press line is continuous. This ***Hymmen*** press is heated by oil from a thermal heater, located in a separate room, (about 25-m long piping). The oil temperature is about 220ºC. The end of this line yields cut sheets to any size.

XI. FIRE PROTECTION

1. Water Supply:

There is a separation between Process Water system and Sanitary system. There is however an emergency connection where by manually opening a valve, water from the sanitary system is introduced into the Process Water System.

The Sanitary system is protected by a “Cross Connection” (Backflow Preventer, UL listed).

The Process Water system is fed by 10” line that is fed by 6” connection from Mekorot public supply. Consumption is over 180,000 m^3/year.

The Sanitary water is fed from 4” line at 4 bars. Consumption is over 20,000 m^3/year.

Own Supply: The total reservoirs capacity is reported to be 2,000 m^3 at ground level and 250 m^3 at 25 m. head.

Water Mains:

The Process Water System serves also as the fire protection mains for both manual fire fighting (Hydrants) and for the supply to automatic sprinklers systems.

An electrical pump taking suction directly from the Mekorot supply line keeps the line pressure at about 2.2 bars.

The Mains is composed of various sizes piping, between 8” and 4”. The total length of the loop is about 1,340 m. The 8” (115 m) and 6” (140 m) sections supply the cooling towers. The 4” section, 920 m. encircles the S-E, S, W, N-W sides of the site. The eastern section is only 3” (170m)

Pressure in the Mains is boosted by a Petrol Driven Centrifugal Pump by means of a control systems.

The control system is configured to operate upon:

a. Flow Switch signal from any of the sprinkler system Risers. The operation of the switch will operate:

1) A control valve that shuts off the flow from the mains into the main cooling tower basin, allowing build up of pressure at the mains.

2) Opening a valve in the fresh water supply to the site.

3) Starting the petrol engine driven pump.

b. Push button at the pump house.

FIRE PROTECTION (Cont-ed),

2. *Testing of the Water Supply:*

We tested the whole arrangement we got the following results:

- ***a.*** The system as is: 500 liters/min at 2.5 bars.
- ***b.*** Fire Pump taking suction from the brackish water supply: 1900 l/m at 4 bar.
- ***c.*** Fire pump after opening the fresh water valve: 2,380 l/m at 3.5 bars.

However, the main problem was that the arrangement of automatic starting of the pump failed. From the moment of operating the ITC (inspection test connection) of the sprinklers system of one of the roll paper storage building until we got the performance of **"c"** above it took over 30 min.

That means that should a fire occurred during our test, any sprinkler systems would have been overtaxed.

Update 26/11/99: It was reported that the pump, driver and control were overhauled. An additional shut off valve was installed as well to increase the system reliability.

According to a timing test we required, it was reported that the **fire pump** reached 8 bars, 90 sec after the operation of the ITC (a sprinkler simulator).

Thus, the Insured fulfilled our temporary measure i.r.o. the Fire Pump.

3. *Opinion regarding the Water Supply:*

The Fire Pump arrangement is not standard as per NFPA 20 in every respect. The standard arrangement requires not only approved equipment, but also contains several rules to ensure reliability.

This arrangement whereby the automatic sprinkler systems are fed from the plant water mains is not reliable, particularly when the **Mains** discharges freely into a basin. It is not possible to operate a fire pump unless this discharge is shuts off. To get a reasonable suction it is also necessary to open a valve from the fresh water supply.

Adding poor testing and maintenance caused the failure realized during our testing.

One of our recommendations was to perform weekly test to ensure availability of the system in a reasonable time and to report to the Insurers accordingly.

Update 26/11/99: See item **2** above. It will be necessary to test the pump after the overhaul.

We suspect that even after this improvement, the system capacity is far from the demand required to protect "paper roll storage". Please refer to **Section V – Long Term Recommendations**.

4. *Hydrants:*

About 95 hydrants are installed on the Process Line System. There is a great deal of hoses.

The hydrants are installed on the plant water system just like the sprinkler systems. Therefore, both are based on the same capacity.

FIRE PROTECTION (Cont-ed),

5. *Automatic Sprinklers:*

The main systems are installed in the:

a. The Local Market storage hall (part of the main building),

b. the Resin preparation shed (chemical department adjacent to the main building) and

c. Two separate Paper Roll Storage buildings.

There are two additional systems that are less significant.

Subject\System	**System #1**	**System #2**	**System #3**	**System #4**
Building	**Paper Roll Storage Bldgs.**		**Chemical Depart.**	**Formica Sheet Stg.**
Location	S-E corner		Eastern side of the Main Building.	Northern Section of the Main Building.
Exposure	None, separate buildings.		C.B. wall separation with impregnation hall.	Press #4, Melamine Impregnation hall.
Area	900 m^2.	2 x 450 m^2.	300 m^2	4,000 m^2
Ceiling Height	Double Pitch roof, 6-8 m. high.		2,3 levels 2.5, 6-7, 9-10 m.	Saw Tooth Type, 5 to 9 m.
Fire Load	Paper Roll, see Remark [2] below.		Phenol, Formaldehyde and some Methanol	Formica sheets storage on wooden pallets.
Storage Type	On end storage, closed, standard and open array.		Vessels, Piping, Pumps.	On racks, large proportion of pallets.
Riser Size	4" used for the 2 buildings.		4"	6"
Design Type	0.18/2500,		Ordinary Hazard 2	Ordinary Hazard 2
Estimated Capacity	450 gpm at 3 bars.		400 gpm at 3 bars.	400 gpm at 4 bars.
Required Capacity	See Below, Remark [3]		See Below, Remark [4]	See Below, Remark [5]

---

[2] Roll Paper stored on end up to 5 m. high. Storage ranges from heavy to medium weight paper. Craft Paper is usually steel banded and stored at "close to standard" array. Medium paper are unbanded and usually stored at standard array.

[3] Banded rolls and close array reduces the risk considerably. The lowest risk involves closed array heavy grade paper, requiring 600 gpm. The highest risk involves unbanded medium paper rolls in open array storage, requiring 1,350 gpm.

[4] Chemicals, such as Phenol and Formaldehyde, that are combustible liquids and a small amount (3%) of Methanol – a flammable liquid. Demand according to NFPA 30, would be 900 gpm.

[5] Melamine Formaldehyde and Phenol Formaldehyde is Classified "Plastic Class C" material. In terms of caloric value the laminates are similar to wood. Initiation of burning is very difficult, but when exposed to other burning combustibles, they are expected to contribute their full caloric value. When we look at this storage we see a large proportion of wooden pallets. We may have here a combination of the power of burning of pallets together with obstruction to sprinkler spray cause by the laminates.

FIRE PROTECTION, Automatic Sprinklers (Cont-ed),

Further Observations:

Water Supply Capacity:	According to information contained in the Plant Safety File, the pump capacity is 175 m^3/h. We found 140 m^3/h at 3.5 bars, but since then the pump was overhauled and we don't have an updated results.
Sprinkler Type:	In the Roll Storage, spray type, ½" heads, temp rating about 70^0C. In the Sefanit Storage area a mismatch of various types: Old type, Spray type, temp. rating – 60 to 70^0C. All of the above - not favorable for high demand type of risks.
Water Tests:	**See item 2 above.**
Roll Paper:	At the most favorable storage arrangement, the required demand for heavy weight paper is 2,350 liter/min. At the most unfavorable arrangement (unbanded open array) the demand is 6,700 liter/min. The corresponding demand for medium weight paper is 9,000 liter/min. Using new technology ESFR sprinklers allows the reduction of demand to 5,000 liter/min to all types of configurations. At any rate, the present arrangement is not sufficient even for the most favorable arrangement.
Laminates storage in the local market storage hall and Idle Pallets:	The storage of Formica sheets involves a large proportion of ***wooden pallets*** on racks up to **5 m.** high. For ***"idle pallets"***, NFPA 231 requires a demand of 24 mm/min at 432 m^2. This means a huge system (10,000 liter/min). On the other hand, the laminate layers block the "stack effect" and thus hinders vertical fire spread. We would therefore define the hazard as ***Class IV*** commodity on racks up to 5 m. high. It is clear that the existing system is insufficient.
Incomplete Systems	Sprinkler system had to be complete. There is an unprotected office wooden made hut within the local market hall. In the event of fire within any of the office rooms and involvement of the whole hut, the fire may spread throughout the storage hall, overtaxing the sprinklers.

It may be more important to discuss the unprotected areas. It must be clear that all the roll paper storage areas within the main building have to be protected by automatic sprinklers. This should be done to check the exposure of the production facilities.

Please refer to the **Recommendations Section V.**

FIRE PROTECTION (Cont-ed),

6. Detection and Automatic Gas Extinguishing:

The Telefire 2000 FACP located in the Gatehouse controls the following systems:

1) Electrical Boards of Presses # 1, 2, 3, 4 & 8 (Distribution and MCC).

2) Electrical Board of Reactor 15 tons.

3) Resins Electrical Board, 2nd floor.

4) Flow Switches of sprinkler systems at the Roll Storage buildings, the Sfanit storage hall and the Dust Silo.

We asked the Insured to provide acceptance testing from the Israeli Standard Institute inspection lab. as well as detailed checkout as per IS 1220, part 11 that deals with testing and maintenance of detection systems.

7. Other Equipment:

1) Dry Chemical Extinguishers: 2 x 250 kg and 5 x 50 kg carts, 80 x 6 kg portable units.

2) Gas Extinguishers: 25 x 6 kg CO_2 + 25 x 3kg BCF.

3) Self-Sustained Breathing equipment: 3 units.

4) 2" Hoses and Nozzles: 50 units.

5) Various demolishing equipment.

6) Shovel Tractor.

8. Passive Protection:

We address hereunder the fire rating of the construction and separations.

The main building block, about 20,000 m^2, contains most of the production facilities, resins preparation and raw materials storage including 5 m. high roll paper storage.

a. There is no full standard fire rated walls separating the various risks. Therefore, the whole main building is "one fire area"

b. That does not mean that fire may spread throughout the area. There are partial fire rated partitions, non-fire rated partitions and empty spaces that would hinder fire spread. See also **"e"** below.

c. The walls are made of concrete blocks, but there are also laminate partitions.

d. There is no specific smoke venting (see "**e**" below).

e. The typical roof is covered with corrugated asbestos panels on steel structure. Under fire, these panels disintegrate early and contribute to the release of products of combustion. In some areas, the roof is saw tooth type, with northern glass windows that serve the role of smoke release.

FIRE PROTECTION / Passive Protection (Cont-ed),

f. Air-Conditioned halls such as the paper preparation hall and layers preparation rooms near the presses have suspended ceilings. Some ceiling areas are composed of metal panels with mineral mats above, some are made of combustible particle boards and the newer ones are made of aluminum faced EPS.

The last two gives rise to concern, particularly the EPS panels. We approached the suppliers, ILIT Aluminum Israel-USA Ltd., to get fire-rating information for this product.

We got two types of test reports:

1) A report dated July 21, 1994 issued by UL, as per UL 1715 "Interior Finish Material" (also known as UBC 17-5). The test is a "corner test" known as a severe one. According to the report, the product passed the test.

2) A test report of the Israeli Standard Institute Fire Lab, i.r.o. the EPS material as per IS 755 performed as per DIN 4102. The material passed the "B2" categorization criteria.

In spite of those positive reports, we don't feel confident with this material. UL acceptance requires annual confirmation and this cannot be done here.

Encl.:

- Process Charts.
- Cad plans showing the main elements and the location of the main storage areas.

Yours faithfully,

Dan Arbel

DAN ARBEL RISK ENGINEERING Ltd.