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Date: 21/09/03
Ref.: Carton-210903

# *CARTON PLANT FIRE INVESTIGATION – 20/05/03*

# *FINAL REPORT*

## *INTRODUCTION*

As requested by the **Loss Adjusters** we are investigating the functionality of the fire protection system in fire that occurred in **Carton Plant** in 20/05/03 at about 19:40.

## *1. SYNOPSIS*

### Our conclusions are:

1. **Fire Loss & Damage:** Fire in **the Printing Plates** storage facility within the main CARTON PLANT's main production building consumed the storage and caused other allied losses as well as consequential loss.
2. **Cause of the extensive Damage:** the sectional valve of the sprinkler system protecting printed plates storage facility was closed.
3. **Details about the closure of the valve**: It is not possible to determine when the valve was last closed, by whom and why it was in this status.
4. **Supervision & Alarm:** the valve was not supervised. Nor was the flow switch downstream the valve connected to the FACP.
5. **Awareness:** the Insured's employees were not aware that the sectional valves exist.
6. **Liability of Contactors under contact with the Insured at the time of the Loss:** The sprinkler contactor and the safety manager consultant fail to acknowledge the existence of the valves and did nothing to improve the employees' awareness about the importance of the sectional systems.
7. **Liability of Previous Maintenance Contractor:** We believe that the unawareness noted above have continued from earlier time. The new contractor that started in 1-Jan-2003 just followed the same faulty route. The pervious contactor was Contactor #1.
8. **System Design**: our impression is that the design of the system was inadequate. However, we are of the opinion the fire would have been controlled if the valve was fully opened.
9. **The original sprinkler designer:** the system within the printing plates storage facility was designed and installed by **Contactor #1.**
10. **Certified Laboratory Approval:** No acceptance was looked for or required.
11. **Other Faults:** The location of the sectional valve was too closed to the protected risk.
12. **Liability of the System Designer**: even if the valve would not have been closed, it would not be possible to attach a significant liability to the designer.

# 2. THE CLOSED VALVE

**The following reasoning led us to the conclusion that the valve was indeed closed:**

1. **Final Valve Status**: The valve was found closed when we inspected the scene.
2. **Lack of act of valve closure:** No witness came forward and said that he closed the valve after the end of the extinguishing operations.
3. **No observation of flowing water:** The first employees responding to the fire did not feel **any water flowing.**
4. **Lack of white or gray smoke:** The first report about the fire described black smoke. When sprinklers are operating one would expect to see white "smoke" indicating a great deal of steam generation.
5. **FACP log report:** the first Flow Switch indication came form System #4. One would expect System #5 Flow Switch to initiate first, since the storage system is connected to System #5.

   System #4 responded first because the employees' first response was with a hose connected to System #4.
6. **Failure to use Storage System Hose:** Employees tried to use the hose connected to the storage sprinkler system. They opened the hose valve but no water came out of it. The hose is fed from the same valve.
7. **Metallurgical Findings**[1]**:** Change in the metal structure of pipe material indicates prolonged exposure to high temperature. This indicates lack of cooling effect of water.
8. **Valve Supervision:** The valve chain was found open. There was no awareness of the existence neither of the valve nor of any report of testing and maintenance.

   The employees responding to the fire were not aware of the possibility of "just opening of the valve" as the most effective fire fighting mean at their disposal.

***All the above evidence, witness reports, test and inferences lead to the conclusion that the valve was closed. No contradicting evidence has surfaced.***

The only contradicting shadow was the argument that water was found in the storage system hose. Then, if the valve was closed how come water filled the hose?

The water source is from the (static) water existing in the system. When the hose valve was opened, water drained from the system into the lower hose. Thus, end of "contradicting shadow".

[1] *Institute of Failure Analysis report Report #: EM0305030, 20/07/03.*

# 3. DEFINITION OF THE FAILURES

1. The system valve was closed.
2. The valve was not monitored and the flow switch above it not connected.
3. There was no awareness about sectional valves including the valve serving the "Printed Plates storage Sprinkler system".
4. The lack of awareness is best manifested when employees trying to use a hose connected to this system did not realize that the valve in front of their eyes is closed. This failure stems from poor training.
5. The valve station is too close to the risk. This created a stress that hindered the response of the employees.

# 4. FORMS OF LIABILITIES

The following liability forms are apparent in this case:

1. **What Starting the fire:** This part is outside the scope of this report.
2. **Adequacy of the sprinkler design**:

   Question: were there any factors that directly or indirectly affected the apparent results of the fire?

   The fact the valve was closed makes the subject redundant as far as the designer is concerned. However the question of what would have happened may have some significance for the other parties is an indirect effect.

   A direct effect may be attributed to the "too close position" of the valve station to the risk.
3. **Maintenance:** Violation of the maintenance standard regarding monitoring of the status of the valve. The subject is covered by I.S. 1928 (1997) that adopted NFPA-25 [2]. According to the standard the owner is responsible for the proper maintenance of the system. In this case the management has outsourced the maintenance to external contactors.
4. **Training:** Was there any operational fault in the behavior of the Insured's employees that may be attributed to poor training?

   Lacking of Preparedness and Awareness had a significant impact in this case.
5. **Fire Fighting:** Were there any mismanagement of the fire fighting operation of the fire services?

   This is outside the scope of this report.

[2] *NFPA- 25 - Testing, and Maintenance of Water-Based Fire Protection Systems*

# 5. RESPONSIBILITIES

## 1. THE SPRINKLERS DESIGNER:

***a.*** **The Designer:** Contractor #1**.**

***b.*** **Design and Installation Contracts:** No contacts specific to the relevant design was submitted. The only printed evidence is a Plan of the sprinkler system intended for two levels of the storage. The work no. is 5072/3 and is dated 02-Feb-1996. The named designer is Eng. Gilad Yakir.

The system was installed by a Contractor #1 but no approval or acceptance documentation was provided.

***c.*** **Compatibility between design and installation:** There are some differences between the original design and the actual installation:

**(1)** The design of the system feed was of the mid-side main, while the actual installation was of side feed. But this was compensated by larger side main, so that it is of no significant consequence.

**(2)** Under the design the riser was located beyond the fire wall at the adjacent eastern hall. The actual installation was very close to risk at the southern end of the storage area.

This has some significance in the fire, since there was difficulty approaching the valve station.

***d.*** **History of Sprinkler Installation:** quoting the Insured's letter dated 20-June-2003 the installation stages were:

**(1)** The first stage of the storage consisting of 2 levels was constructed in the first half of 1995. The sprinkler system was designed and installed in 1995 (according to the plan, the design date is 1996…).

**(2)** The second stage involved an addition of a third floor that was carried out in the first half of 1996. The design and installation was by Contractor #1. No printed substantiation including acceptance documentation was provided.

**(3)** An additional three (3) levels area leg was added vertically to the existing 3 levels area in the last quarter of 2001. The installation of the sprinklers in the new section was done in house under inspection of contactor personnel.

**End of relevant quote.**

**Remarks regarding item (3):**

- The actual construction was of 2 levels and not of 3 levels.
- Sprinkler was installed only in the ground level.
- This is a sub-standard installation in terms of too many heads on a 1" branch (over-extension of existing branch) and obstructions. This is clearly unprofessional installation.
- It would not have affected the fire outcome since the fire started elsewhere.

## RESPONSIBILITIES / Design & Installation Contactor, Cont-ed.,

***e.*** **Maintenance Contract:** The Insured provided a document of a maintenance agreement, Contractor #1 offer dated 10-Jan-2000.

Item 2 – Sprinkler System Service relates to **13 "operation stations"** (means "Risers" – D.A.). It is limited to two (2) inspections during a year.

It should be noted that are 14 such station and 2 sectional valves. Thus, the presentation of the system was inaccurate and may indicated omission of the sectional valves.

***f.*** **Maintenance Report:** Under the maintenance standard (IS 1928/NFPA-25), Contractor #1 has to submit inspection reports. The only report received from the Insured was dated 23-May-2001. According to this document the system was inspected according to IIS 1928 and found "in good order".

The standard requires a detailed report. None was provided. Thus, contactor did not provide the required report nor was he required to provide it.

An inspection reporting gap exists for the period of May-2001 until the end of 2002

**Conclusions:** It is rather possible that the status of the relevant valve is dated back to the period of maintenance provided by contactor #1. It is also possible that it was not inspected. Contactor #1 did not provide inspection report as required by the standard. Thus, the question of their liability for this omission is subject to legal consultation.

## 2. THE SPRINKLERS SERVICE CONTRACTOR:

***a.*** **The Service Contractor:** Contractor #2**.**

***b.*** **Service Period:** Service Offer dated 20/Nov/2002. The service started at 01/Jan/2003**.**

***c.*** **Commitment and Compliance:** please refer to the table below.

| No. | Commitment | Compliance |
|---|---|---|
| 1. | Tests as per applicable standards.<br>For sprinklers- IS1928 or NFPA-25 | Not complied with due to failure to identify the sub-system valve. |
| 2. | All system will be operated every 3 months. | Failed to comply with own obligations due to the above reason. |
| 3. | "Regional Valve stations" will be inspected and report forwarded. | |
| 4. | Flow Switches – full report will be submitted regarding their status. | No report was forwarded. |

**Remark**: Item 4 – we did get forms of Plant that contain list of flow switches and 14 system valves to check. ***The storage sub-system is not mentioned.***

## RESPONSIBILITIES/ The Service Contactor- Cont-ed.,

**Conclusions:** The contactor was hired as a professional entity. He got the information from the Insured but failed to rise to its professional obligation to study, investigate all parts of the systems and identify all important items and potential problems.

## 3. THE SAFETY SERVICE CONTRACTOR:

***a.*** **Introduction:** The Insured outsourced the safety management.

***b.*** **Safety Contractor:** B&B

***c.*** **Employment:** Since 1997.

***d.*** **Scope:** The contactor provides in-situ 90 hours/month safety management.

In their offer dated 06-June-1999 their definition of the scope includes inter-alia: Communication with the Fire Services, Risk Survey, Training, preparation of fire emergency procedures, regular treatment of all types of fire fighting means (including sprinkler systems), periodical inspections with the help of external contactor, fire drills, collaboration with external agents such as the fire services and FMI, Getting knowing of the peripheral fire protection system, preparing plans with the existing means.

The company manager will perform inspections twice a week and will report to the workforce and security manager of the Plant.

***e.*** **Emergency Procedures:** An Emergency Procedure book dated 08/Aug/1996 was sent to us. Following our request for an update we have got a later version (1998) made by another company (This version was inferior to the original).

In a letter issued by M. Ashkenazi, the representative of ***Term*** in the site, they updated the "Plant File", but we did not get any such document.

***f.*** **Teams and Missions:** Page 9 of the book outlines the teams (forces) and their missions. In this table a Job defined as "Emergency Staff Head". His last mission, stage C, item #2 is setting up of an enquiry committee investigating the event. No report of such internal investigation was forwarded.

***g.*** **Fire Fighting Systems:** Appendix 8 deals with Fire Fighting Equipment. The appendix consists of 2 pages. It contains a general none complete and non-accurate description of the system.

The 2nd page contains a small outline of the sprinkler mains loop and main valves. It may be indemnified as a copy of the FM older layout when the printing plates' storage did not exist. As noted above no update plan was made.

***h.*** **The Printing Plates Storage:** This facility does not appear on the plan, although it should have been in view of the erection date and the book date. The last FM layout does note existence of a sub-system riser (see sketch next page).

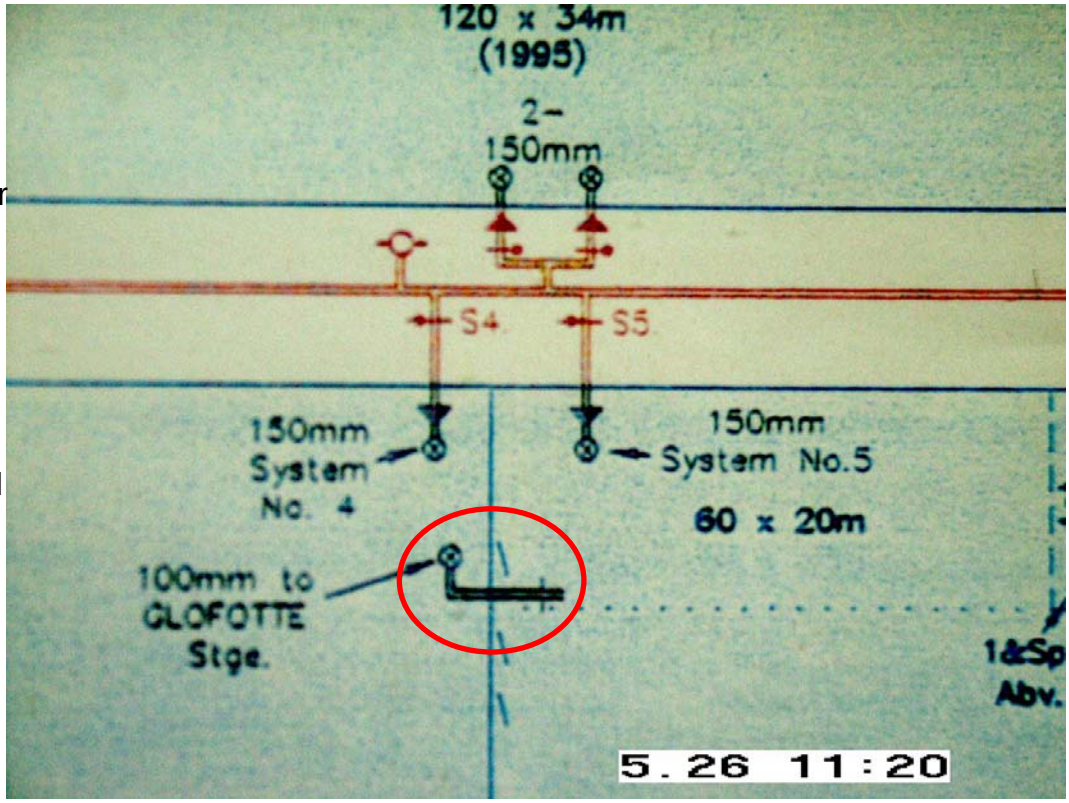
***i.*** **Changes Procedure:** This is major item is missing from the emergency procedures book. Its roll is to make certain that changes do not compromise safety. During the period of their service they did not register the erection of the storage of the printing plates and further additions made in later periods and made no studies of risks involved, the hazard classification and meaning of sub-section valves.

## RESPONSIBILITIES/ The Safety Service - Cont-ed.,

Part of FM sketch that show a 100mm extension for storage.

The actual extension is 80mm.

It has not been incorporated in any fire safety plan.




***j.*** **Relevant Procedures:** Just before the conclusion of this report we got some procedures prepared by the Safety Managers. One procedure is i.r.o. inspection of the sprinkler system. The date of procedure is 01-July-2003, 6 weeks after the fire. Even this "after the fact" procedure does not define the specific systems valves and sectional valves.

A list of valves to be inspected is also included with no date stamped. We could not identify the sectional valve that is the subject matter of this investigation.

**Conclusions:** The contactor was hired to provide safety management for the Insured, including Fire Safety. It is evident that they have a shortcoming in grasping the subject of fire risks and the importance of monitoring of systems.

The contactor failed to define the severity fire hazard existing in different areas of the Plant. We heard their manager saying that the fire hazard in the plant is alike.

They certainly did not grasp the fire hazard associated with significant plastic storage amidst the production area of the plant. The storage existed when they were hired (1997), but then they failed to ascertain the operability of the storage specific fire protection system.

Furthermore, not realizing the risk, they failed to arrange the proper training of the employees, so that when the test came the employees did not comprehend the importance of the sectional valve at looked at it as so it did not exist.

The maintenance service contactor at the time of the loss did provide report as per IIS 1928. However, the preceding contactor, Contactor #1 did not provide any report as per the standard. The safety service contactor did not ascertain that such report is submitted. As we noted above it seems that the fault had a "long beard".

# 6. ADEQUACY OF DESIGN

In order to provide a proper sprinkler design a study should be made of several important factors such as:

- Material classification.
- Storage configuration.
- Storage height,
- Ceiling height,
- Obstructions.

The system was defined by Contactor #1 as "Ordinary Hazard 2".

According to MSDS we got from Dupont and BASF, the materials are "Acrylates and Methacrylate monomers coated on Polyester substrate.

The material classification is Plastic Class A. In fact, the configuration of thing plastic sheets hanged vertically with space of 35 mm between the sheets should further upgrade the classification to ***"Expanded Class A" plastic.***

According to NFPA-13 (1994), table 1-4.7.4.2, for storage height between 1.5 to 3.0 m and up to ceiling clearance of 1.5m. the occupancy is defined as ***Extra-Hazard-2***.

However, if the storage height is below **1.5 m**, Ordinary Hazard – 2 applies.

In our case there are various sizes of plates, some of them exceed the size of 1.5 m but none exceeds 1.8 m.

There are no FM guidelines for similar configuration. Table 3.3.7.4(f) of data sheet 8-9 has ***note 2*** below, stating: Storage up to 1.5 m high in buildings higher than 4.6 m can be protected with standard sprinklers designed for 12/186 mm/min.

In this case the "ceiling" height is only 2.1 m. It is therefore reasonable to define the hazard as ***Extra-Hazard 1***.

The next problem is the 46cm required clearance from sprinkler to top of storage. In our case the clearance is less than 20 cm.

We looked at NFPA-13 (2002) item 8.14.9 regarding Library Stack Rooms:

**8.14.9 Library Stack Rooms.** Sprinklers shall be installed in accordance with one of the following:

**(2)** Where the 18 in. (457 mm) clearance between sprinkler deflectors and tops of racks cannot be maintained, sprinklers shall be installed in every aisle and at every tier of stacks with distance between sprinklers along aisles not to exceed 12 ft (3.7 m) in accordance with Figure 8.14.9(a).

The problem is that the maximum breadth is not defined above.

Given the breadth of the shelves (230cm) It appears that in addition to the clearance problem, there is a significant obstruction for the sprinklers not allowing water spray to enter the narrow space above the plates (Just 13 cm) and into the spaces between the plates.

It is outside the scope of this report to suggest a proper solution. However we strongly suggest designing the storage together with the sprinkler protection.

It seems that in this case, the design of the sprinklers was done **after** the storage erection was made.

## ADEQUACY OF DESIGN, Cont-ed.,

### Actual Design:

The actual layout was sent to the Insurers earlier together with the hydraulic calculations.

The sprinkler spacing is 3.50x2.40m.

**We calculated the flow and pressure as follows:**

| No. | Flowing Area | Demand |
|---|---|---|
| **1.** | Level 2.1 m all 19 heads including 3 SW sprinklers+ 190 lpm Hose. | 2,347 lpm @7.62 bar |
| **2.** | Level 2.1 m as above + 6 heads from level 4.2 m | 2,442 lpm @7.50 bar |

**Minimum density:** 12 mm/min.

**Pressure is calculated at the loop PIV connection.**

In the first version we calculated the flow of all the sprinklers in the ***"ground level"*** (where the fire is believed to have started) ***+ 190 lpm for hoses.***

The second version includes the ***"ground level + 6 heads"*** in the aisles on both sides of the upper level with no allowance for hoses (Water for hoses are available from other systems).

Information about the pump pressures received from **Eng. Shai Segev:**

| No. | Discharge @ no flow (PSI) | Flow (GPM) | Pressure @ flow (PSI) | Demand as per Calc #1 above | Demand as per Calc #2 above |
|---|---|---|---|---|---|
| **A** | 110 | 1,050 | 105 | 620 gpm @ 111 | 645 gpm @ 109 |
| **B** | 150 | 636 | 144 | | |
| **C** | 150 | 569 | 140 | | |
| **D** | 113 | 892 | 110 | | |

Thus if Pump B or Pump C are set to start first than the demand as we defined is met with ease.

If pump A is set to start first then, there is some shortage.

**ADEQUACY OF DESIGN, Cont-ed.,**

## SUMMARY:

1. In terms of hazard definition, the demand is marginally met. The bottleneck is clearly the size of the feed – 3". It should have been 4" feed and alarm station.
2. The sprinkler layout versus the hazard configuration gives rise to a great deal of obstruction.
3. Our opinion is that if the valve was opened, the fire would have been finally controlled with the help of hoses. The aisles would have flooded with water spay and the steam created would have displaced the air necessary for burning. Most of the printed plates would have been saved.
4. The valve station was too closed to the risk. It is not possible to tell if the employees would have grasped the importance of the valve if it was located in an accessible area.
5. The fact is that the people managing the fire fighting on behalf of the Insured were unaware about the operation or failure to operate of the sprinkler system within the storage.
6. In the Ceiling system, some 70 sprinklers initiated. The fire wall be

## *7. GENERAL SUMMARY*

1. The 40,000 $m^2$ building was protected by a ceiling sprinkler designed to demand of 0.30 gpm/$ft^2$ system over 2000$ft^2$.
2. The system was based on ½" sprinklers K5.6.
3. The hazard included heavy paper rolls up to 6 m high under a 9 m roof as well as corrugated cardboard machinery and finished goods.
4. The Printing Plates storage section was located within the manufacturing section.
5. The Printing Plates had its own roof. The sprinklers were installed within 3 tiers rack storage. The plates were stored vertically.
6. The water supply consisted of 2 supplies to a common 8" loop:
   - **a.** 2500 GPM at 100 PSI Diesel Pump taking suction from 1200 $m^3$ Reservoir
   - **b.** 2x1000 GPM Diesel and 1000 GPM Electrical at 110PSI Pumps taking suction from 900 $m^3$ reservoir.
   - **c.** 80 m3/h Public Supply to the Reservoir.

## GENERAL SUMMARY, Cont-ed.,

**7.** About 70 sprinklers were initiated and the water supply was close to depletion.

**8.** The Fire Wall separating between the manufacturing section and the finished goods was about to collapse but it did not.

**9.** This was an example of internal hazard that was actually not protected due to a closed valve.

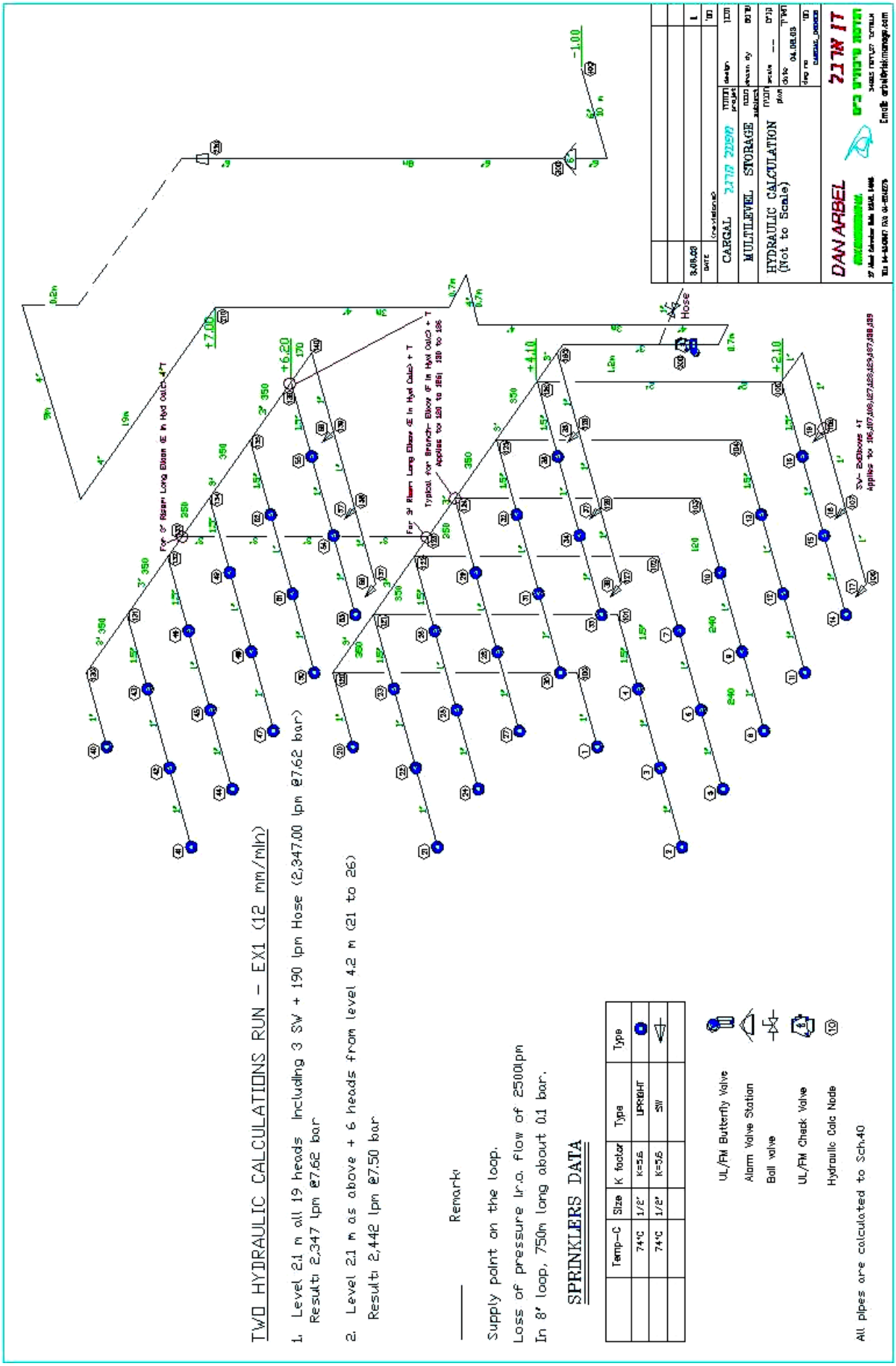
**Encl. :**

- Sprinkler Layout
- IS 1928 (NFPA-25) – excerpts.
- Photo indicated fire temperature.

Yours faithfully,

Dan Arbel

**DAN ARBEL RISK ENGINEERING Ltd.**


TWO HYDRAULIC CALCULATIONS RUN – EX1 (12 mm/min)
1. Level 2.1 m all 19 heads Including 3 SW + 190 lpm Hose (2,347.00 lpm @7.62 bar)
Result: 2,347 lpm @7.62 bar
2. Level 2.1 m as above + 6 heads from level 4.2 m (21 to 26)
Result: 2,442 lpm @7.50 bar
Remark:
Supply point on the loop.
Loss of pressure in a flow of 2500lpm
In 8" loop, 750m long about 0.1 bar.
SPRINKLERS DATA
Temp-C
Size
K factor
Type
74°C
1/2"
K=56
LFR16HF
74°C
1/2"
K=56
SW
UL/FM Butterfly Valve
Alarm Valve Station
Ball valve
UL/FM Check Valve
Hydraulic Calc Node
All pipes are calculated to Sch.40
MULTILEVEL STORAGE
HYDRAULIC CALCULATION
(Not to Scale)
CARGAL 2210 22590
DAN ARBEL

## NFPA -25 / EXCERPTS

**3.3.19 Inspection.** A visual examination of a system or portion thereof to verify that it appears to be in operating condition and is free of physical damage. [**820:**1.5]

**3.3.20 Inspection, Testing, and Maintenance Service.** A service program provided by a qualified contractor or qualified owner's representative in which all components unique to the property's systems are inspected and tested at the required times and necessary maintenance is provided. This program includes logging and retention of relevant records.

**3.5.1* Control Valve.** A valve controlling flow to water-based fire protection systems. Control valves do not include hose valves, inspector's test valves, drain valves, trim valves for dry pipe, pre-action and deluge valves, check valves, or relief valves.

**A.3.5.1 Control Valve.** Experience has shown that closed valves are the primary cause of failure of water-based fire protection systems in protected occupancies.

**4.1 Responsibility of the Owner or Occupant.**

**4.1.1*** The owner or occupant shall provide ready accessibility to components of water-based fire protection systems that require inspection, testing, or maintenance.

**4.1.2*** The responsibility for properly maintaining a water-based fire protection system shall be that of the owner of the property.

**4.1.2.1** By means of periodic inspections, tests, and maintenance, the equipment shall be shown to be in good operating condition, or any defects or impairments shall be revealed.

**4.1.2.2** Inspection, testing, and maintenance shall be implemented in accordance with procedures meeting or exceeding those established in this document and in accordance with the manufacturer's instructions.

**4.1.2.3** These tasks shall be performed by personnel who have developed competence through training and experience.

**4.1.2.4** Where the owner is not the occupant, the owner shall be permitted to pass on the authority for inspecting, testing, and maintaining the fire protection systems to the occupant, management firm, or managing individual through specific provisions in the lease, written use agreement, or management contract.

**4.1.3** The owner or occupant shall notify the authority having jurisdiction, the fire department, if required, and the alarm-receiving facility before testing or shutting down a system or its supply.

**4.1.3.1** The notification shall include the purpose for the shutdown, the system or component involved, and the estimated time of shutdown.

**4.1.3.2** The authority having jurisdiction, the fire department, and the alarm-receiving facility shall be notified when the system, supply, or component is returned to service.

**4.1.3.3** Where an occupant, management firm, or managing individual has received the authority for inspection, testing, and maintenance in accordance with 4.1.2.4, the occupant, management firm, or managing individual shall comply with 4.1.3.

**4.1.4*** The owner or occupant shall promptly correct or repair deficiencies, damaged parts, or impairments found while performing the inspection, test, and maintenance requirements of this standard.

**4.1.4.1** Corrections and repairs shall be performed by qualified maintenance personnel or a qualified contractor.

**4.1.4.2** Where an occupant, management firm, or managing individual has received the authority for inspection, testing, and maintenance in accordance with 4.1.2.4, the occupant, management firm, or managing individual shall comply with 4.1.4.

## NFPA -25 / EXCERPTS, Cont-ed.,

**4.1.2*** The responsibility for properly maintaining a water-based fire protection system shall be that of the owner of the property.

**A.1.2** History has shown that the performance reliability of a water-based fire protection system under fire-related conditions increases where comprehensive inspection, testing, and maintenance procedures are enforced. Diligence during an inspection is important. The inspection, testing, and maintenance of some items in the standard might not be practical or possible, depending on existing conditions. The inspector should use good judgment when making inspections.

**A.1.3** An entire program of quality control includes, but is not limited to, maintenance of equipment, inspection frequency, testing of equipment, on-site fire brigades, loss control provisions, and personnel training. Personnel training can be used as an alternative even if a specific frequency differs from that specified in this standard.

**4.1.5*** The building owner or occupant shall not make changes in the occupancy, the use or process, or the materials used or stored in the building without evaluation of the fire protection systems for their capability to protect the new occupancy, use, or materials.

**4.1.5.1** The evaluation shall consider factors that include, but are not limited to, the following:

(1) Occupancy changes such as converting office or production space into warehousing

(2) Process or material changes such as metal stamping of molded plastics

(3) Building revisions such as relocated walls, added mezzanines, and ceilings added below sprinklers

(4) Removal of heating systems in spaces with piping subject to freezing

**4.1.5.2** Where an occupant, management firm, or managing individual has received the authority for inspection, testing, and maintenance in accordance with 4.1.2.4, the occupant, management firm, or managing individual shall comply with 4.1.5.

**4.1.6** Where changes in the occupancy, hazard, water supply, storage commodity, storage arrangement, building modification, or other condition that affects the installation criteria of the system are identified, the owner or occupant shall promptly take steps, such as contacting a qualified contractor, consultant, or engineer, to evaluate the adequacy of the installed system in order to protect the building or hazard in question.

**4.1.6.1** Where the evaluation reveals a deficiency causing a threat to life or property, the owner shall make appropriate corrections. All requirements of the authority having jurisdiction shall be followed.

**4.1.6.2** Where an occupant, management firm, or managing individual has received the authority for inspection, testing, and maintenance in accordance with 4.1.2.4, the occupant, management firm, or managing individual shall comply with 4.1.6.

**4.1.7** Where a water-based fire protection system is returned to service following an impairment, the system shall be verified to be working properly.

### 4.2 Impairments.

Where impairment to a water-based fire protection system occurs, the procedures outlined in Chapter 14 of this standard shall be followed, including the attachment of a tag to the impaired system.

## NFPA -25 / EXCERPTS, Cont-ed.,

**4.3 Records.**

**4.3.1*** Records of inspections, tests, and maintenance of the system and its components shall be made available to the authority having jurisdiction upon request.

**4.3.2** Records shall indicate the procedure performed (e.g., inspection, test, or maintenance), the organization that performed the work, the results, and the date.

**4.3.3** Records shall be maintained by the owner.

**4.3.4** Original records shall be retained for the life of the system.

**4.3.5** Subsequent records shall be retained for a period of 1 year after the next inspection, test, or maintenance required by the standard.

**4.4* Inspection.**

System components shall be inspected at intervals specified in the appropriate chapters.

**A.4.4** Inspection and periodic testing determine what, if any, maintenance actions are required to maintain the operability of a water-based fire protection system. The standard establishes minimum inspection/testing frequencies, responsibilities, test routines, and reporting procedures but does not define precise limits of anomalies where maintenance actions are required.

Substandard conditions, such as a closed valve, subnormal water pressure, loss of building heat or power, or obstruction of sprinklers, nozzles, detectors, or hose stations, can delay or prevent

**4.5 Testing.**

**4.5.1** All components and systems shall be tested to verify that they function as intended.

**12.3.2 Inspection.**

**12.3.2.1** All valves shall be inspected weekly.

**12.3.2.1.1** Valves secured with locks or supervised in accordance with applicable NFPA standards shall be permitted to be inspected monthly.

## TEMPERATURES

The disappearance of the sprinkler from the fittings indicates temperature exceeding $900^0$C.