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

FAILURE OF SPRINKLER SYSTEM IN HIGH RISE BUILDING

I. INTRODUCTION

We have investigated the cause of **Failure of the gasket** at the bottom flange of a Filter unit located at the 18th floor causing damage to four (4) elevators

We visited the building again to determine the cause of the high pressure reported by the contractor downstream the pressure reduction station. As noted below, the contractor reported a pressure of 220PSI.

II. THE SYSTEM and PRESSURES

Relevant levels in the building:

Building lower basement:	**- 12.0 m**	**Lower Basement**	**Heads**
Pumps Room level:	+109.0 m	Floor #35	
Water Reservoir:	+111.6 m	Reservoir Floor	
Floor 18th	+ 54.90 m		54.10m (78psi) from pumps level
Floor 17th	+ 51.85 m		57.10m (83psi) from pumps level

The Pump Room:

The Pump	**Nominal Press**	**Max Press**	**Remarks**
The Fire Pump (PV):	64 PSI	86 PSI	To which we should add the head between the top level of the reservoir and the pump level, some 10-12 PSI.
The Jockey Pump (JP):	55M (80PSI)	60M (87psi)	We observed **98psi i**n the log

THE SYSTEM AND PRESSURES (Cont'd.,)

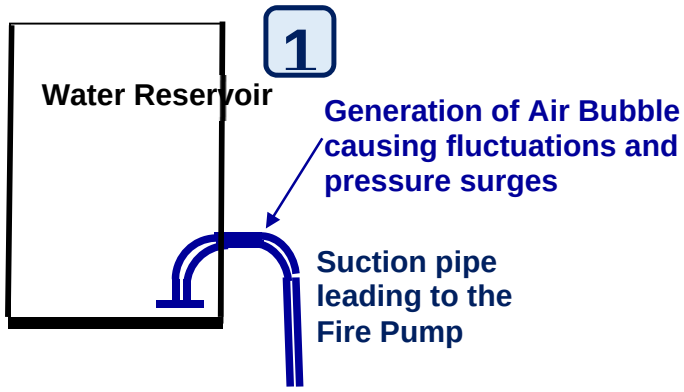
The Pressure Reduction Station (Photo 3, Pg. 4):

It is composed by two (2) parallel 6" pressure reducing valve, and a 2" pressure-releasing valve make "Dorot". It is located on the 17th floor (Photo 5, Pg. 7).

Thus, the pressure in the 17th floor is the max. Pressure at the pump room plus the head between the pump room and the 17th floor plus element of surge pressure

In the following Table, we calculate the static pressures in floors 18th and 17th based on the pumps max. pressure and the head between the floors and the pump room level.

Probable Disturbances in the Pumps operation (Photo 1): The suction pipes arrangement promote the generation of large air bubble not in accord with NFPA 20 (item 4.14.6.1).



4.14.6* Installation.

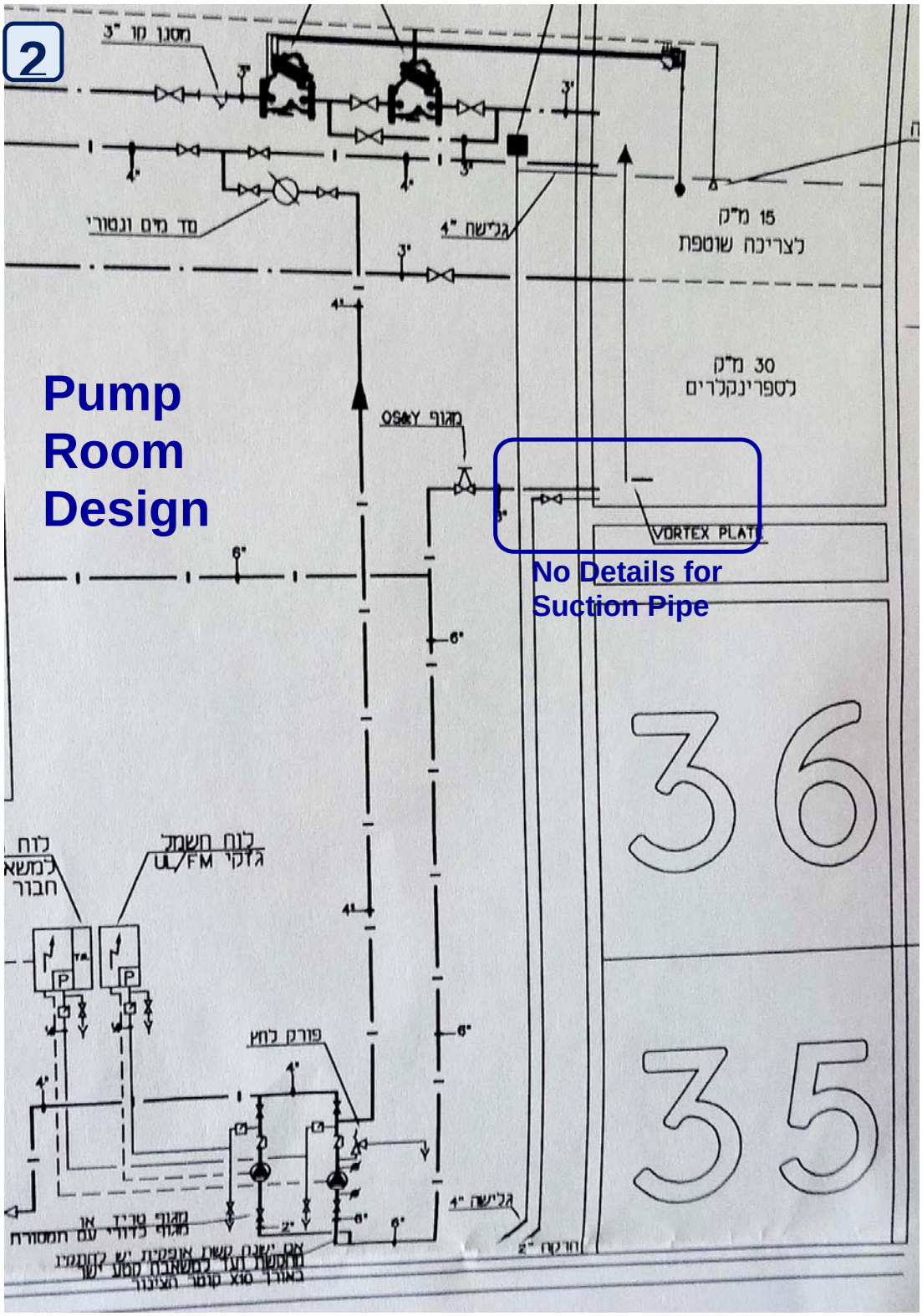
4.14.6.1 General. Suction pipe shall be laid carefully to avoid air leaks and air pockets, either of which can seriously affect the operation of the pump.

The air bubble may generate pressure surges in the pumps operation.

Pressures at levels	Pressure	Max allowed Pressure	Remarks
Pressure at the pumps level:	**98 PSI**		**Too High!**
Pressure at floor 18th:	**176 psi**	175psi	Pressure exceeding Max.
Reduced Pressure at 17th.	**125 psi**		Based on a Gauge on the Press Relief Valve
Excess Pressure at 17th	220 psi		Reported by Contractor.

The designer plan of the Pump room and the reservoir is presented in the following page (**Photo 2**). The details of the suction pipe arrangement is poor.

THE SYSTEM AND PRESSURES (Cont'd.,)



THE SYSTEM AND PRESSURES (Cont'd.,)

Summary Regarding Pressures:

1. There is an inherent excess pressure in the pumps room.
2. The pressure we calculated at floor 18th is slightly above the allowed maximum. However, the system is subject to transient pressures that may exceed the calculated pressure.
3. The contactor reported a pressure of 220 psi downstream the pressure reduction system. The calculated pressure at 17th is just 191 psi.
4. The cause of the excess pressure downstream the pressure reduction system is the wrong setting of pressure relieving valve. We found that it was actually set near the closed end, instead of 45 psi. At the times of our visits, the setting was 120 psi.
5. Whatever the setting of the pressure-relieving valve, the system is subject to pressure surges originated at the pump room due to excess pressures of the pumps and the wrong suction arrangement.
6. Furthermore, when the water supply is elevated, any flow downward may cause surge pressures whenever any valve downstream is closed (waterfall effect).

III. THE EXCESS PRESSURE

We found a pressure of **98PSI** at the Pump Room located at +101m.

The "Pressure reduction station" (see photo above) is composed of 2x 6" pressure reducing valves" and a 2" Relief Valve" with 1.5" drain section.

To get a proper operation of the "pressure reduction" station, it is necessary to set the "opening pressure" of the pressure relief valve. It appears that the setting was **125 psi** instead of just **35 psi.**

Another problem was the low sizing of the 1.5" pipe downstream of the "pressure relief valve" that connects it to the main drain pipe (Photo 5).

During the process of draining of the Riser up-stream the "pressure reduction station" and then restarting the pump, the pressure downstream the station indicated 175 psi.

So, how the pressure reached 220PSI? This is due to pressure surges caused by the Fire Pump" together with the watershed effect.

Following setting of the valve made by the Mfg's technician, the pressure downstream of the "pressure reduction" station was reduced to 50 psi.

There was indeed a fault is one of the pressure reduction valve but it had no bearing on the generation of excess pressure.

We mentioned above "Pressure Surges". The probable cause of it is the way the pumps' suction pipe connection to the water reservoir is installed. Large "air bubble" are created due to violation of the NFPA-20 instructions (see sketch in Pg. 2). This causes intermittent disturbances in the operation of the fire pump.

IV. THE CAUSE OF FAILURE OF THE GASKET

The contactor made a repair before we had a chance to inspect the scene.

The failed gasket was not presented to us. Therefore, we cannot determine the direct cause of failure of the gasket.

We were informed that it was reinserted with an addition of another gasket and the flanges were re-bolted. This is not the right method. It is necessary to install a good quality gasket suitable for 35 bars service.

We believe the failure of the flange is due to the use of a wrong type of gasket and uneven bolting of the flanges.

Photo 4 below present the flange after the repair.

THE CAUSE OF THE FAILURE (Cont'd.,)

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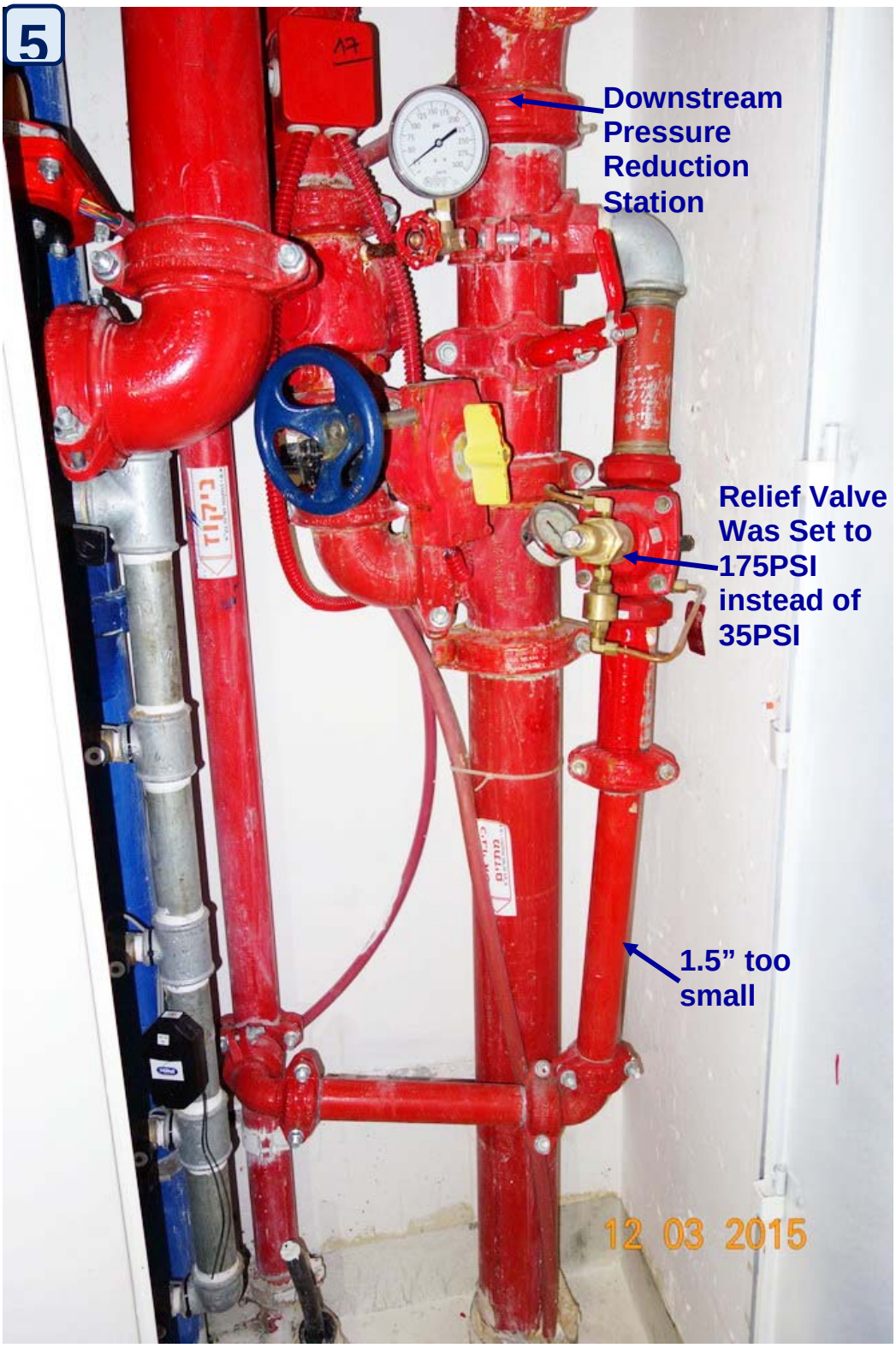
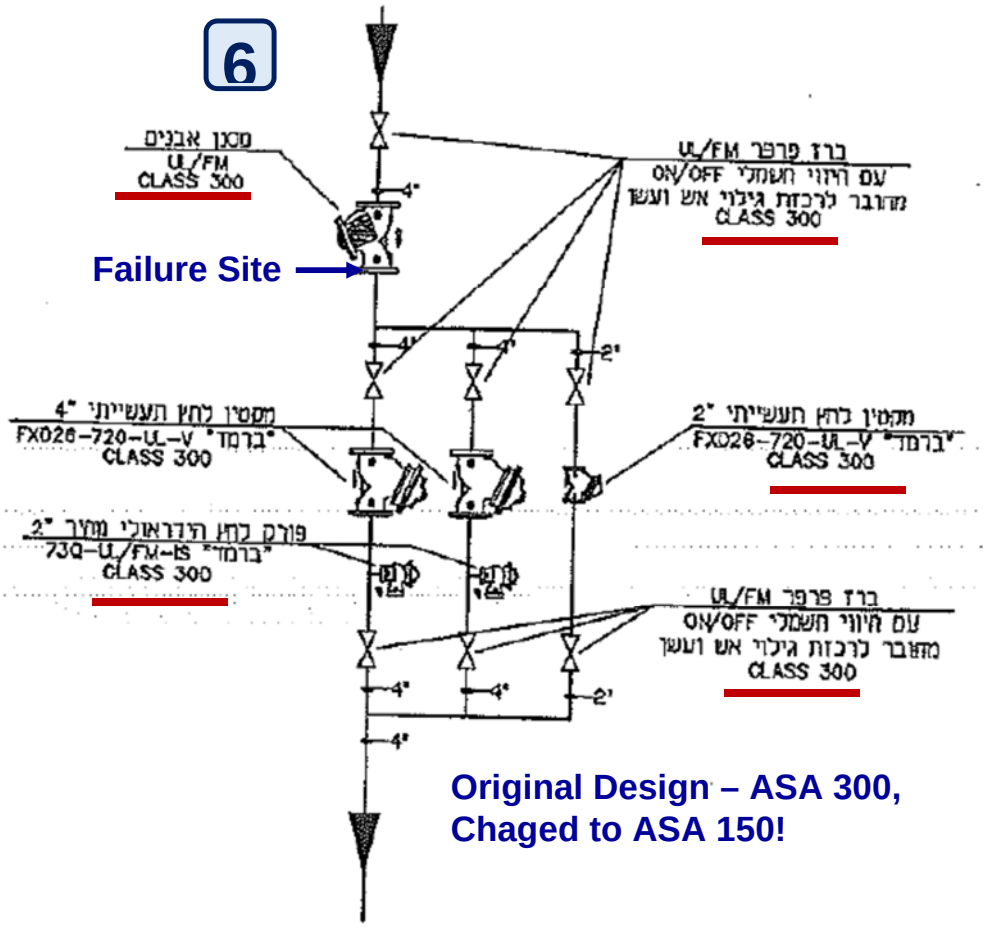


THE CAUSE OF THE FAILURE (Cont'd.,)

It appears that the Designer specified equipment (valves, pressure reducers and filter) as per ASA Class 300 that is suitable for high-pressure service.

However, the designer accepted lower pressure Class 150 accessories suitable for low-pressure service (**photo 6**).



V. SUMMARY

1. A flange connection failed in the 18th floor.

2. We conclude that the Contractor is responsible for the failures.

3. The pump suction arrangement is not in-line with the standard requirement. The design plan is vague, namely, no details were provided by the designer.

4. The failure of the bolted flange connection of the Filter at the 18th floor is due to improper mounting by the contractor or use of Filter unsuitable for the pressure . The flange had to be specified “ASA 300”.

5. Indeed, the original specification of the designer called for ASA 300 accessories. However, he approved the contractor suggestion for ASA 150 accessories.

6. The Contractor reported that the original seal was made just of rubber. He added another rubber seal to the failed seal, a procedure that would promotes the recurrence of the failure.

7. The designer is responsible for either wrong specifications and/or acceptance of pumps having excess pressures and/or lack of supervision and/or acceptance procedure and/or failure to specify pressure reducing valves on the discharge side of the pumps.

8. The designer is responsible for accepting lower pressure accessories (see item 5 above) in contrast with his original specification for high-pressure equipment.

9. The accepting lab (The Standard Institute Hydraulic Lab) noted that the maximum pressure should not exceed 12 bars. However, the system by design will inevitably cause excess pressure, which might be considered as an oversight on the part of the Lab.

Yours faithfully,

Dan Arbel

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