AON SPRINKLER CERTIFICATION

Aon New Zealand
Aon Fire Protection
Building 3, 46 Maki Street
Westgate
Auckland 0814
Telephone: 0800-AONFIRE

Aon Sprinkler Certification Technical Note		
Note Number: TN-20-45	**Issue: 1.1**	Date: 19 August 2020
Subject	**Pump House Pipe Work**	
Notice: Aon Sprinkler Certification Technical Notes provide guidance notes which may be used in certification of sprinkler installations by Aon New Zealand. If sprinkler installations are being certified by any other Sprinkler System Certifier, these Technical Notes may not apply.		

Aon Sprinkler Certification have been alerted to a number of pump houses where the detailed design of the pump installation is somewhat lacking. This Technical Note outlines some of the issues that designers need to take cognisance of. This is especially pertinent in the larger pumps being installed to protect modern warehouses, where the potential for failure can be high. This Technical Note has been drafted to highlight some of the concerns we have seen, indicating where designers need to take more care.

As part of the certification process, Aon will require that for pumps with a highest rated design flow that exceeds 3,500L/min, that the design be submitted to Aon for review prior to the pipe work being fabricated and installed. The details that will need to be submitted include:

1) Plan and elevations showing layout.
2) Detailed design drawings of pipe work support and seismic bracing system.
3) For pipe work supported on pipework upstands, calculations indicating that the pull-out loads on fasteners have been evaluated.
4) If orifice plates are used in the pump test return, the calculated pressure at the plane of vena contracta confirming that the pressure loss is such, that cavitation will not occur.

We have attached examples of issues that we have sighted or have been alerted too, to illustrate issues that contractors need to address.

Chris Mak

MANAGER – AON FIRE PROTECTION

Aon New Zealand
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TN- 20-45 Back Ground Information

A. Bracing and Bracketing

The potential thrust loads from a pump can be extremely high. For example, the internal thrust loads generated on a 200mm pipe at 10bar is in the order of 30kN.

While roll groove joints are designed to restrain loads such as this, if the joints are installed with any gaps, at least some of the thrust load will be transferred to the structure on which it is supported. A 75mm by 100mm garage timber truss will not be designed to withstand such loads.

This photograph shows a pump installation of approximately 10 years ago, that was never certified. The issues with bracketing and bracing are numerous to most untrained eyes.

It is pleasing to see that after some publicity, we are seeing improvements in pump house bracketing. It is now common practice to support pump house pipework from floor mounted frames. However, the detailed design of the supports cannot be left to fitters. The design needs to consider the potential vertical loads on the supports but also the need to provide four-way seismic bracing.

This photograph shows bracing on a 200mm pipe in a pump house.

- The method of attaching the brace is best described as interesting. We are unaware of any published data showing the load capacity of a 45^{0}-malleable iron elbow.
- Under NZS4541:2020, the pipe clamp itself will require to be listed for seismic bracing.
- While not shown in the photograph, the pipework is not provided with any longitudinal seismic bracing.
- One could question why an investigation was not carried out to check if the lateral brace could have simply been fixed to the block wall.
- With a tall skinny column there is risk of buckling.

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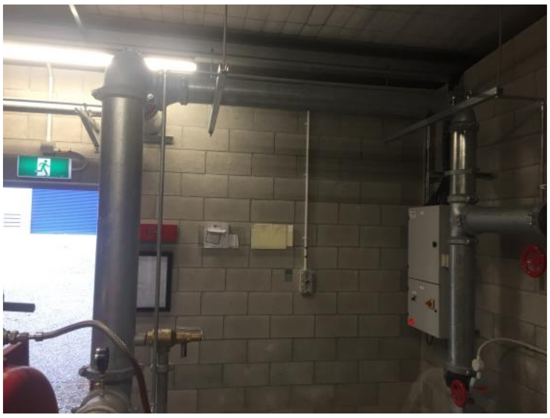

This photograph shows 150mm mains, sitting on a trapeze hanger.

We would question whether the loads on the structure is adequate to support the loads?

Lack of seismic bracing?

If fixing pipes to pump-house walls, the load capacity of “Unistrut” type cantilever brackets needs to be checked. These standard “of the shelf brackets” have limited load capacity. In addition, the pipe may require additional bracing to deal with longitudinal loads.

This photograph shows a pipe support which appears to be fabricated out of “Unistrut” type channel.

Intuitively, it appears to be too light to act as a column and is probably being supported by the pipe.

A support such as this should be designed by an engineer, accounting for gravity, seismic and thrust loads.

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There are a number of issues with this pipe upstand:

1) The fixtures have been drilled and installed on an angle
2) Missing fixtures. Is this as per design, or have the fitters missed this.
3) Use of a flange does not allow the separation distances mandated by the fastener manufacturer's data sheet to be met.

Use of a socket welded to a piece of flat steel would have allowed:

1) The holes to be drilled perpendicular to the floor
2) The minimum distances between fasteners to be met.

The following analysis should be completed on brackets in fire pump rooms:

- Bending moment of the bracket
- Turning moment being applied to the fixing.
- Column buckling

B. Water Hammer

The consequences of getting it wrong can be horrendous. This photograph shows the result of a poorly designed test return, where the butterfly valve failed and slammed shut resulting in water hammer. The water damage from the split pump resulted in a six figure insurance claim.

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C. Exhaust Systems

Even minor details such as exhaust runs can be problematic. This exhaust pipe is intimate with the timber framing and is exhibiting signs of pyrolysis.

We are also noting that other trades may fix their services near exhaust pipes. It is common to sight lights and conduit in close proximity to a hot exhaust.

We have sighted pump test results, where the pump could not perform, as the exhaust back pressure exceed manufacturer's limitations, thereby not allowing the engine to develop its rated power.

D. Tank Connections

This photograph shows damage caused by rigidly welded pipework entering the top of a tank following the 2010 Christchurch earthquake. This could have probably been avoided if:

- Flexibility was introduced into the pipe work; and
- The pipe entered the tank at the bottom rather than the top.

Please refer to Aon's Technical Note TN-20-46 for further information on this topic.

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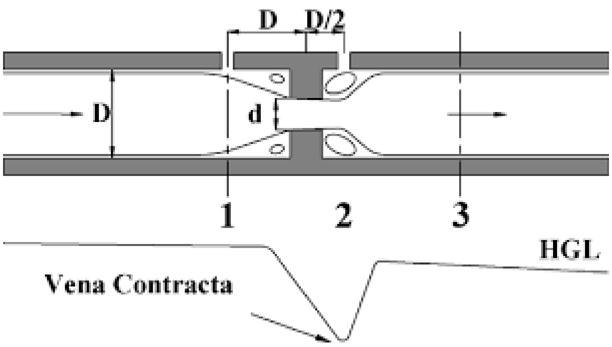
E. Orifice Plates

Bernoulli's equation states that the total energy in a fluid is the static energy plus kinetic energy plus potential energy, which is constant. Increase in one form of energy results in a decrease in another form of energy. This means that at the plane of vena contracta[1], as the velocity pressure increases, the fluid pressure decreases.

The drop in fluid pressure can be considerable, especially if the fluid velocity is high, and the orifice is small. This can lead to cavitation, which will result in damage to the pipe work and valves. The theoretical losses can be determined using Bernoulli's equation.

To avoid this, it may be necessary to install multiple orifice plates, which will require straight lengths of pipe work between them.

Installation of pressure gauges upstream and downs stream of an orifice plate will assit to validate performance.



[1] The area A of the **vena contracta** is smaller than the area A_o of the orifice because the velocity is higher there (converging streamlines). For a sharp-edged, or "ideal" circular orifice, $A/A_o = C_c = \pi/(\pi + 2) = 0.611$. C_c is called the coefficient of contraction.