

Pressure injection injury: pressure of 7 bar risk

Version 1.0

Context

FAME H&S Notices are real-world examples of incidents, provided anonymously by FAME members, which highlight learning opportunities for the sector to improve our health and safety working. However, these notices are not designed to replace existing guidance.

Background

A pressurised pipe, even with low pressure, can still shoot liquids at very high speeds through a pinhole leak; the velocity of liquids increases as the diameter of what it travels through reduces i.e., a 10cm pipe with a 1mm pinhole = 10,000x increase in velocity. At high speeds, streams of liquid can penetrate the skin, causing serious hurt, disabilities (usually amputations) or kill individuals by pushing bacteria deep into the body, potentially poisoning from the liquid or causing compartment syndrome. The kinetic energy of these streams can dissipate quickly, and the literature has found a strong correlation between severity of the injury and the distance of the body from a pinhole opening. Even a few centimetres distance can prevent injuries. As archaeologists do not regularly use pressurised equipment the likely greatest risk for pressure injection injury is from direct contact between one's body and a pinhole opening in a pipe i.e., running one's hand over a pipe to clean it of soil during an excavation.

While conducting research for the FAME H&S Safety Notice on pressurised water pipes we reviewed the risk of pressure injection injury. A common statement in the literature on the subject of this kinetic pressure is that 'Fluid or high pressure air injected under the skin at pressures **as low as 7 bar (100 psi)** can cause crippling injuries or even death...'

Research

However, upon further research we have found no data that backs up this statement. Most literature does not cite a source for the this statement.

Following the citation trail¹, of those that did cite sources, led to a paper in the *British Journal of Dermatology* (Macaulay 1986) that made no such claim about liquid penetrating the skin at 7 bar. A different trace of citations² led to a 1983 article (Scott) that just states, 'The force required to break the skin is not as great as might be imagined and a pressure of $7 \times 10^5 \text{ Nm}^{-2}$ is sufficient to do so, that is about 7 atm.' (7 bar). But no citation or evidence is given as to how the number was reached. Others have made this same observation (Pappou and Deal 2012). Another publication cited a 1967 (Waters, Penn & Ross) publication but that mentions the compressor was run at 100 psi (~7 bar) and that the nozzle amplified that 30-fold.

We have found no evidence to back up this 7 bar statement.

Key Take Away

Archaeologists conducting work around pressurised pipes or equipment, should not use lower pressures as an indication of safety. Without knowing what can penetrate human skin there is no way to calculate the risk of pinhole leaks from pressurised pipes and equipment. All pressurised pipework and equipment should be considered as a risk of pressure injection injury. Risk Assessments should be adjusted accordingly.

Resources

HSE (United Kingdom): Hydraulic injection injury

<https://www.hse.gov.uk/safetybulletins/hydraulic-injection-injury.htm>

<https://www.hse.gov.uk/research/rrhtm/rr976.htm>

¹ Verhoeven, Hierner 2008 -> Tempelman, Borg, Kon 2004 -> O'Sullivan, O'Donoghue, O'Connor 1997-> Macaulay 1986

² Vasilevski , Noorbergen , Depierreux, Lafontaine 2000 -> Neal 1991 -> Scott 1983. (others just directly cite Scott)

References

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