WHITE PAPER

Piping system design impacts safety in every phase of a project

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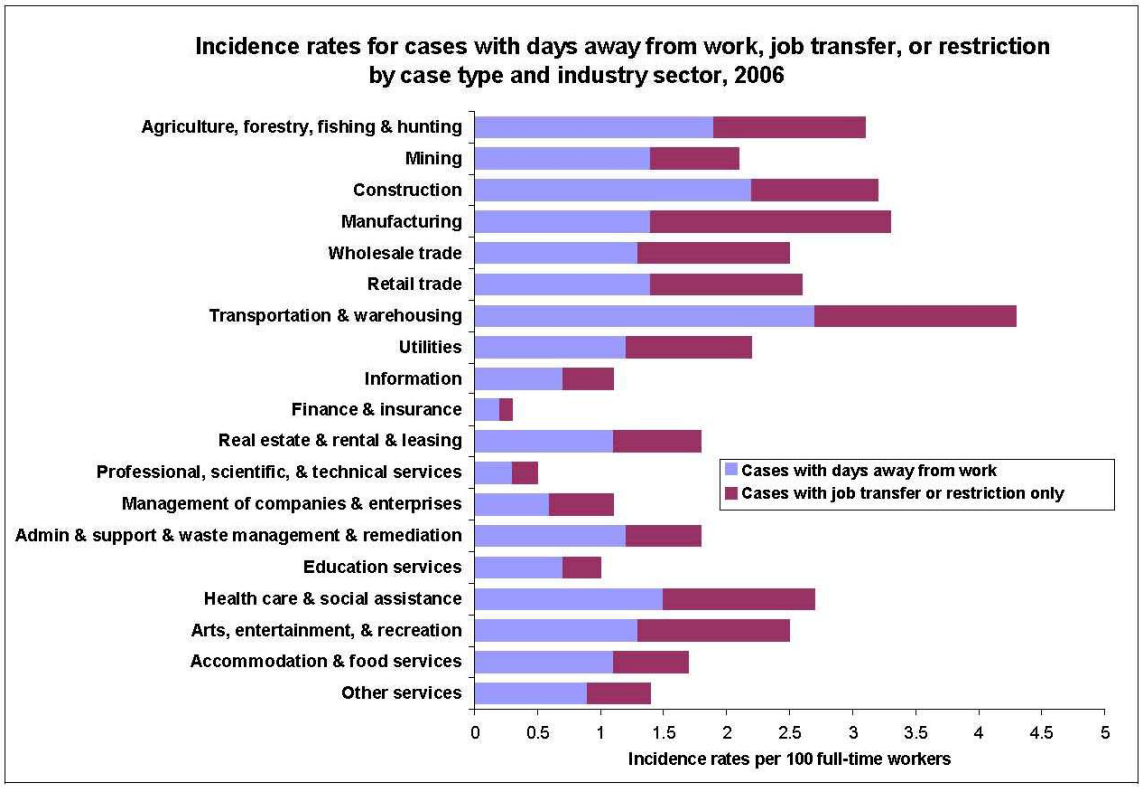
Under the ASME Code of Ethics of Engineers, it's the first of the fundamental canons: "Engineers shall hold paramount the safety, health and welfare of the public in the performance of their duties."

Due to the nature of the work, this is a major challenge in construction. According to the Bureau of Labor Statistics, the construction industry has the second highest incidence rates for cases with days away from work. (Refer to Table 1 below.) More specifically, statistics compiled by the Construction Industry Institute indicate the majority of construction injuries are suffered by pipefitters, welders, plumbers, and the laborers who assist them. (Refer to Table 2 below.)

Table 1



Of all the major industries, construction has the second highest incidence rates of cases with days away from work.

Table 2

COST RATIOS OF INJURIES BY CRAFT

Craft	Medical Cases		Restricted Activity or Lost Workday Cases	
	Cost Ratio*	Number of Injuries	Cost Ratio*	Number of Injuries
Boilermaker	5.49	(5)	12.5	(3)
Brickmason/Stonemason	.72	(2)	N.A.	
Carpenter	3.40	(51)	6.47	(15)
Cement/Concrete Finisher	4.46	(2)	N.A.	
Equipment Operator	2.31	(6)	12.44	(3)
Electric Power Installer/ Repair	3.14	(1)	N.A.	
Electrician	3.92	(25)	6.08	(10)
Insulation Worker	2.18	(3)	N.A.	
Laborer	3.24	(54)	9.98	(27)
Mechanic/Repair	6.34	(12)	5.68	(3)
Painter	2.18	(2)	8.20	(2)
Plasterer	2.10	(1)	N.A.	
Plumber/Pipefitter	3.23	(82)	8.02	(13)
Sheetmetal Worker	3.24	(18)	6.68	(2)
Structural Metal Worker	2.29	(12)	4.15	(4)
Supervisor/Foreman	2.00	(13)	11.86	(2)
Truck Driver	10.00	(1)	N.A.	
Welder	6.06	(16)	10.51	(8)
Other	3.07	(53)	7.90	(8)

Of all the leading crafts, those relating to piping systems have the highest rate of occupational injuries and illnesses.

The inherent dangers of installing and maintaining piping systems increase the importance of the mechanical engineer's role in designing for safety and accident prevention – both during the construction of the project and throughout the lifecycle of the facility. There are three fundamental areas where mechanical engineers can positively affect safety: one, system constructability, two, best practices for training construction and inspection, and three, system maintainability.

By specifying safer technology and methods in greater detail, an engineer can minimize the impact of, or possibly even eliminate the potential for, certain types of accidents and injuries. Although most injuries on jobsites and in the workplace occur from material handling, perhaps the most significant risks, in terms of potential impact on people and business, are the fire and fume hazards associated with welding, brazing and soldering on the jobsite.

Safety in constructability: The mechanical pipe joining advantage

In the piping systems environment, mechanical pipe joining removes a number of major hazards from the jobsite. The most obvious of which are the fire and toxic fume hazards of welding, brazing and soldering. When grooved, stab (plain end) or press pipe joining technologies are used, there are:

- No open arcs, sparks or flames
- No volatile tanks
- No lead lines to trip over
- No exposure to hazardous fumes

By specifying mechanical pipe joining, an engineer can reduce these risks in the design phase, and thereby make a powerful contribution to reducing an owner's risks, costs and potential liability. Furthermore, in keeping with the fundamental canon of "holding paramount the safety, health and welfare of the public", that engineer can help create a safer environment for all involved.

For example, in addition to the inherent risks of fire, potential health risks associated with welding have been cited in studies and include:
- Irritation of the eyes, nose, chest, and respiratory tract
- Nausea, headaches, dizziness
- Metal fume fever
- Lung cancer
- Urinary tract cancer
- Heart disease
- Kidney damage
- Parkinson's disease

Depending on the project environment (I,e., new construction vs. expansion/retrofit), these hazards can become a risk to not only the construction worker, but also to the occupants of the existing structure and surrounding facilities. The initial use of traditional joining technology can also limit the maintenance options for, or efficiency of, future repairs, replacements and retrofits.

Although there are established procedures and requirements for fire prevention and fume ventilation during welding, unfortunate incidents involving welding are not uncommon in the news. Consider the potential risks to a hospital or school retrofit project, where occupants may not be easily evacuated or protected from these risks. Consequentially, to protect people from these hazards, construction schedules often must be rearranged and extended to allow off-shift work at the times when the buildings are unoccupied. Eliminating hotwork where possible reduces risk for the client, occupants and contractors.

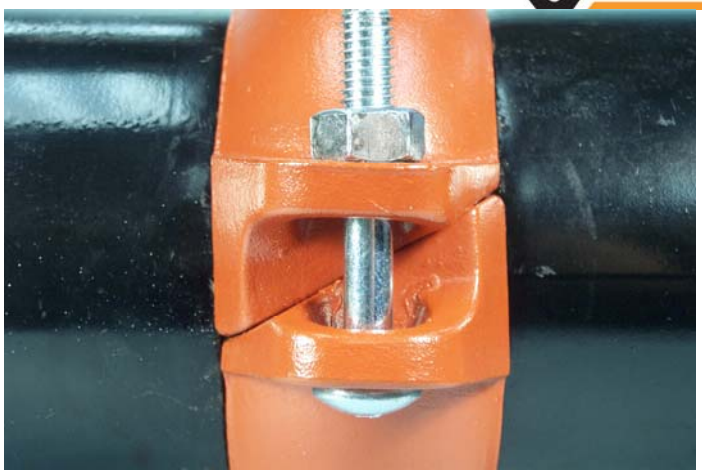
Grooved installation-ready coupling
Mechanical pipe joining requires no flame to join pipe, and involves no exposure to hazardous fumes. The grooved mechanical pipe joint shown above installs in four simple steps. Lube it. Stab it. Join it. Drive it.

Safety in practice: Increasing safety by specifying procedures

In addition to enhancing safety by specifying safer pipe joining technology, an engineer can further contribute to a safe environment by defining best practices in product selection, training, installation and inspection. Performance-based specifications typically provide a good general scope of acceptable product and system performance requirements. In addition, engineers can also name specific manufacturers that they consider to be acceptable for the service and for high quality. Although it is often perceived that "three manufacturers" for a product or system must be specified to ensure an engineer's non-biased objectivity, the fact is that legal precedents have been set at the District Court level which support the specifier's right to issue a proprietary specification that designates a sole supplier in certain situations. The principles of the Massachusetts District Court Case, Whitten vs Paddock (1974), established that 1) proprietary specifications do not violate antitrust laws; 2) Few brands of products are exactly alike and specifiers who want to limit choices have every right to do so; 3) Other brands qualify as "or equal" only when the specifier says so; 4) The specifier may waive specifications in order to obtain a more desirable product for the end user, but the specifier is the only one who can determine if the product is more desirable; 5) The burden is on the not-specified manufacturer or supplier to convince the specifier that the product is equal for the purpose of the particular project. This provides specifying engineers with even greater control over the project, while also enabling them to ensure the highest quality and system performance for their clients.

Another way for the engineer to influence the quality of installations is by ensuring that those individuals installing the systems are educated in the proper installation requirements in accordance with the manufacturer's published instructions. Specifications can be written to include a section requiring installing contractors to obtain training directly from a manufacturer's employees, in order to further ensure proper installation of their piping products and systems.

The final way an engineer can ensure that an acceptable system is delivered to the client is by detailing mandatory inspection and test procedures in the mechanical specifications. Selecting products and systems that are easy to install and inspect further increases the chances of having a successful start-up. For example, some grooved coupling manufacturers provide for quality control through easy visual confirmation of complete coupling installation. Complete joint installation is easily verified because the coupling is designed so that the completed joint achieves metal-to-metal bolt pad contact. Welding, on the other hand, requires x-rays for quality inspection. System testing is an important practice that is typically detailed in specifications to ensure system performance. Specifying that manufacturers' product (couplings, valves, specialties, etc.) performance ratings allow for proper hydrostatic system testing (typically 1.5 times the system operating pressure).helps to further ensure system integrity.



Grooved coupling allows for easy visual inspection, as proper installation can be confirmed simply by checking that pad-to-pad contact is made.

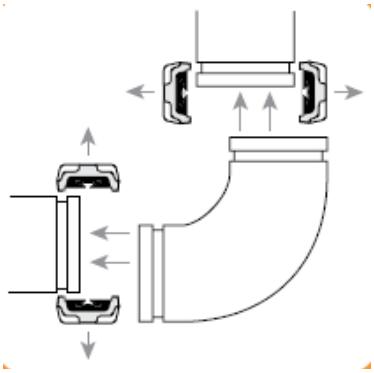
Safety after completion: Improving the safety of ongoing maintenance

Over the operating life of a facility, its piping system will require three basic categories of maintenance. These are: routine periodic inspection, physical changes or expansion, and unscheduled repairs. Due to its intrinsic design qualities, grooved mechanical pipe joining makes maintenance and system access easier, faster and safer minimizing downtime and the negative impact of any maintenance event

The advantage over welding and other methods in this area is self-evident. When pipes are welded together, they have no union point between them. In effect, they become a single, extended piece of metal. On the other hand, a grooved coupling provides a union at every joint, which allows for easy access to the system and flexibility for future system expansion. To access the system all a maintenance worker need only to unscrew one or two nuts and drop the section out. There are no torches, no saws and no welding machines needed. Even with flanged, lug or wafer type valves and accessories, the compression of flanged connections create significant maintenance challenges that dramatically increase the time and manpower needed for replacements and repairs. Components are difficult to remove, and often even more challenging to reinstall.

In contrast, grooved joints provide a true union and eliminate many of the challenges associated with traditional weld/flange systems. When the maintenance is complete, a mechanical coupling makes it easy to quickly get the system up and running again. The gasket is reinstalled, the coupling is placed back on the pipe, fitting or component, and the two bolts are tightened. In a welded system, repairs and maintenance demand that workers actually cut out the damaged pipe section and weld it back together: causing potential

operational issues and safety hazards that are of particular significance in existing facilities and occupied spaces.



Coupling disassembly provides easy access for maintenance or system expansion.

As with any engineering challenge, all system characteristics and design options must be thoroughly considered to find the optimal solution. There are applications such as steam services, for example, for which grooved piping systems are not suitable and weld/flange systems are required. It is imperative that the performance capabilities of the systems and products meet the system performance requirements. For example, the proper gasket material and design selection is one of the most important elements to ensure the safe, long-term performance of a grooved mechanical system. Advances in elastomer technology partnered with innovative coupling and gasket designs provide performance in water applications with temperatures up to 250 degrees F and pressures from absolute vacuum up to 1000psi. However, all gaskets, couplings and components are not necessarily equal in performance and the capabilities of each manufacturer and product must be evaluated individually to confirm system and client requirements are met.

The engineer has a vital role in improving safety at every stage of a project's lifecycle: from initial design, to installation, to ongoing maintenance. By specifying mechanical pipe joining solutions and their associated procedures, an engineer can have a powerful and positive impact in creating a safer environment that minimizes risk, increases efficiency, and brings greater value to owners, contractors and occupants. For over 80 years, mechanical pipe joining has been used in the world's most demanding applications because of its ability to provide a wide range of design solutions to the engineer, however, nothing is more paramount than the safety, health and welfare of the public and grooved mechanical piping systems provide safety at every phase of a project.