Welcome to the Fall 2013 Issue of the PEMD Newsletter! In this issue you will find articles that present topics ranging from technically specific considerations for selecting the right seal to the futuristically intriguing potential of technology and then some retrospective reflections of engineering in 1951. We hope you will find this issue relevant, informative and maybe even a little motivating. If you feel motivated to contribute some content in one of our future issues then please let us know.

The executive committee of PEMD is now into the second year of what has become a two year term. As such, next year will present leadership volunteer opportunities within the division. If you would like to volunteer please contact anyone on the executive committee. You can find our contact information at https://community.asme.org/pemd_executive/groupleadership.aspx.

As we traditionally point out in our newsletter, this division of ASME exists for the purpose of serving our professional community and our membership. Once again, we thank you and remind you to: Get Active and Get Involved by Volunteering!


Sealing for Safety
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There are literally millions of miles of piping in the world’s process industries that must be sealed safely to protect both the environment and profits. If safety is defined as “the condition of being safe from undergoing or causing hurt, injury, or loss,” then safe sealing is defined as “freedom from the danger of improperly performing seals.”

Attaining the sometimes elusive goal of safe sealing calls for proper product selection and installation. Not following safe sealing practices can result in dire consequences, including injury and even death. Leaks create slippery surfaces that can cause falls (Figures 1a & 1b). Above-ground seal installation can pose a falling hazard. Steam and corrosive chemicals can burn, and toxic gases cause acute and chronic health effects in people exposed to them.
Figures 1a & 1b: Lubrication stands before and after stopping leaks that pose both injury and fire hazards.

Leaks can shut down processes, resulting in downtime and lost production, so poorly sealed piping systems require constant attention and continuous maintenance. Inexpensive, lower quality seals have to be frequently replaced, which poses further risk of worker injury and ultimately costs more in terms of seals purchases, downtime and maintenance resources. Not following safe sealing practices also adversely impacts the environment, polluting the air, ground and water, harming human health and incurring substantial regulatory penalties.

The key to safe sealing is the selection and application of the best product for delivering the desired performance, and balancing this performance with the severity of the service. This can be achieved by diligence in the process of seal selection and installation.

Selecting the Right Seal
To optimize seal selection, service conditions and performance expectations must be defined, and published performance data read and understood. Balancing service and performance requirements simply means not using a low-performance seal for a critical service, and vice versa. It also means taking into account the total cost, not just of the product itself, but of the safety hazards, downtime, maintenance and lost production if it fails.

Best practices address both the application in which the sealing device is to be used and the service conditions to which it will be exposed.

A simple acronym, TAMPSS (temperature, application, media, pressure, speed and size) provides useful guidelines for selecting the correct seal for a particular application.

Temperature. The first consideration should be the continuous temperature to which the seal will be exposed, including high/low excursions as well as any regular thermal cycling inherent in the process. Note the frictional heat generated by rotating equipment will increase the temperature of the fluid contacting the seal. Temperature data will immediately limit the number of viable seals for an application.

Application. Knowing how the seal is to be used and the function it is expected to perform are also important in making the right selection. This type of information points out the anomalies of an application and the special requirements for optimal seal performance. Defining the parameters of a particular application requires information about where the seal will be installed.

Selecting the proper gasket for a flanged piping connection requires knowing the type of flanges involved, their material structure and physical condition, the grade of bolts used to secure them, and whether collectively these factors can provide sufficient compressive force to effect a leak-proof seal. This is extremely important, since more than 70 percent of gasket failures are attributed to insufficient load. If the application is a valve, selection of the compression packing will depend on the condition of the stem, whether its motion is reciprocating, helical or continuous, and whether a specific level of leakage must be attained to meet environmental regulations.
**Media.** Common chemical nomenclature or trade names are used to identify the media that will come into contact with the seal. Some processes employ secondary media that may not be addressed at this stage of inquiry. For example, a food processing line that is flushed once a day with a sodium hydroxide solution calls for a seal that is compatible both with this corrosive medium and the food being processed.

**Pressure.** This refers to the internal pressure a seal must contain. Most systems operate at fairly consistent pressure, but as with temperature it is important to know if the seal will be subject to pulses and other variations as a normal part of operation.

**Speed.** The speed of a rotating shaft or reciprocating rod must be considered when selecting oil seals, bearing isolators, mechanical seals or compression packing for dynamic applications. High speeds call for sealing materials that can withstand and effectively dissipate frictional heat.

**Size.** There are standard sizes for ASME flanges, API valve stems, ANSI pump shafts and bores, etc. Non-standard sizes are best conveyed to the sealing manufacturer in the form of dimensional drawings. Some applications may require field measurements.

**Deciphering Published Information**

Table 1 gives the typical physical properties of three modified PTFE gaskets from a manufacturer’s catalog.

When evaluating the catalog information for a particular gasket product, take note of the following:

- Service temperature and pressure cannot exceed the continuous maximums, and the product of these two values must be less than the P x T factor.
- The manufacturer’s chemical compatibility with the media.
- If the nature of the media demands a tight seal, opt for lower sealability and permeability values.
- If the application cycles thermally, consider the lowest creep.
- If the flanges are non-metallic, worn or irregular, consider materials with higher compressibility.
- Overall the most important characteristics of a gasket are sealability, permeability and creep relaxation. It is the interaction of service conditions that direct the end-user to the right product for the application. It is always advisable to consult the manufacturer regarding the choice of product and selection logic.
### Table 1: Typical physical properties of three modified PTFE gaskets

For purposes of illustration, consider the following published specifications for a braided carbon fiber compression packing.

<table>
<thead>
<tr>
<th>Media:</th>
<th>Acids, strong caustics, hot oils, solvents, boiler feed, condensate water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equipment:</td>
<td>Centrifugal pumps, agitators, ball, globe, gate and plug valve stems, oil drilling and down-hole tools</td>
</tr>
<tr>
<td>Temperature:</td>
<td>-328°F to 850°F (-200°C to 455°C) atmosphere; to 1,200°F (650°C) steam</td>
</tr>
<tr>
<td>pH range:</td>
<td>0-14 (except strong oxidizers)</td>
</tr>
<tr>
<td>Shaft speed:</td>
<td>≥ 4,000 fpm (20 m/s)</td>
</tr>
<tr>
<td>Pressure:</td>
<td>to 500 psi (53 bar) rotary/centrifugal pumps; to 2,500 psi (173 bar) valves</td>
</tr>
</tbody>
</table>

Again, the highest and lowest temperature ratings should be noted to assure the product is suitable for use under the service conditions. The pH range should be regarded only as a general guide, not as a substitute for knowing exactly what chemicals will come into contact with the seal. Also provided are maximum shaft speeds and pressure ratings, which differ for rotary equipment such as pumps and quasi-static equipment such as valves.
Proper installation
Just as important as selecting the right seal is installing it correctly. In the case of gaskets, the key to effective sealing is proper compression, which must be both sufficient and evenly applied (Figure 2). Packing rings for valve stems and pumps must be properly seated and compressed. In addition, pump packing should be lubricated and run in carefully to avoid burning it. To assure proper installation of their products, many sealing suppliers provide training programs, including on-site demonstrations and practice sessions.

Figure 2: Gaskets in flanged connections must be properly installed and loaded to affect a leak-tight seal.

When the wrong seal is selected or the right seal is installed improperly, the result will inevitably be premature failure and leakage. Among the conditions leading to such failures are burned packing from excessive shaft speed (Figure 3); extrusion due to excessive equipment clearances (Figure 4); wear from contact with abrasive media (Figure 5); deterioration from chemical incompatibility (Figure 6); blowout due to inadequate or uneven loading (Figure 7); and crushing from overloading and application of grease (Figure 8).

Figure 3: Packing burned by excessive equipment speed.

Figure 4: Packing extruded due to excessive equipment clearances.
Figure 5: Packing worn by contact with abrasive media.

Figure 6: Gasket deterioration due to chemical incompatibility with media.

Figure 7: Gasket blowout due to inadequate and uneven loading.
Figure 8: Gaskets crushed by overloading and application of grease.

All of these can be avoided by adhering to good sealing practices. Safe sealing is best achieved by taking precautions to minimize risk and partnering with a supplier that can provide expert guidance and training for plant personnel. Set a plan for responsible selection and application of safe sealing products. The effort will be rewarded by greater worker and public safety, as well as economic and environmental benefits.

About the Author
Jim Drago, P.E., has worked in sealing technology for over 25 years, most recently for Garlock Sealing Technologies. His work has focused on applications, product engineering, engineering management and global business development. He has authored numerous articles and presented papers at technical symposia on sealing to meet fugitive emissions regulations and sealing product selection.

Jim also has contributed to the industry standards of the American Petroleum Institute (API), American Society of Mechanical Engineers (ASME), Electric Power Research Institute (EPRI), and Society of Tribologists and Lubrication Engineers (STLE). Jim is a former member of ASME BPE Standard committees on sealing and polymers. He can be reached at 800-448-6688 or jim.drago@garlock.com.
It was just over 15 years ago, in 1997, when grandmaster Gary Kasprenov was defeated in a championship chess match against IBM’s Deep Blue computer. Until that point, many doubted the advanced capability of machines to outwit, out-smart or upend a chess grandmaster and World Chess Champion. In the past two decades, we have seen the tremendous growth of computing power in our desktops, PCs, mobile devices, and various shop-floor and factory systems that create the products and goods we consume.

Today, we stand at the doorstep of a new age in technology. Devices are certainly becoming smarter and now communicating directly with one another. Machines indicate their real-time status and needs and are able to self-regulate their performance. Simple mundane household appliances that were able to detect their operating state and turn themselves on or off, such as coffee makers or dishwashers, are now becoming intelligent devices. Taking this to the next level, we now see appliances emerge that talk with one another. I hear of a carton of milk, which expired requests its replacement from and the refrigerator communicator sends this information to your cell phone shopping list. The refrigerator also notes a recall on a package of bagged lettuce that was flagged for E. coli bacteria by the supermarket. New economical RFID devices embedded in consumer products will now relay vital information to the related household appliance. A delicate garment will speak with the washing machine on cleaning instructions and automatically set the dryer settings to low heat, all from the embedded chip in the garment label.

The most dramatic example today of advanced computerization in the consumer market has to be the connected vehicle. Our cars are far beyond modes of simple transportation, but now have become rolling family rooms in today’s modern society. Cars have evolved into entertainment centers, communications hubs, hot-spots, climate controlled comfort zones, and serve as mobile offices and technology centers for busy workers and families on the move. With motion detection precision, cars of tomorrow are being introduced with accident avoidance systems, self-parking, and soon, self-driving capabilities. Nissan announced recently the development of a vehicle that is self-driving and will be commercially available before the turn of the decade.

At the Growth Innovation and Leadership Conference (GIL) sponsored by Frost & Sullivan in San Jose CA (Sept 8-11, 2013), videos of the new self-driving car were shown. Technicians report over 500,000 miles on the self-driving cars with zero accidents. In one scene, a casual passenger sits in the car (“I got shotgun!”) and proceeds as the vehicle accelerates on its own on a marked driving course with traffic cones and straw barriers along the way. As the car picks up speed, the passenger becomes a bit more vocal as the car proceeds as if an Indy 500 racecar driver were at the wheel. The screams begin to elevate as the car makes turns that shifted most of the weight to the outside wheels. Needless to say, it was an impressive performance from a driving process we would have once considered to be unprogrammable. Each day, these driving situations are demonstrated by leading auto manufacturers in their TV ads. I’m sure you may have seen the commercial with child’s ball rolling into the street and the car coming to a safe stop a few feet before the child in the street.

What tomorrow will bring is certainly exciting. Next on the agenda at the GIL conference was a futurist from Intel, speaking on the future power of computers. He reminded us of photos taken 15 years ago that cost about $2 per shot with film developing costs. Today, the cost of that photo is near zero on our mobile phones. Major advances are being made in medicine with mobile sensing. The clothes of tomorrow will be chip embedded. This means that our garments will report on our heart rates, temperature, skin moisture and general health. Doctors will move from capturing 5 key vital signs to about 40 in the next decade. Our clothes will communicate thru our cell phones to our medical facility computer that will track and monitor our health real time. Before we know it, our doctors will be visiting our homes in a ‘back-to-the-future’-style silver gull-wing car. This future that was once just science fiction is becoming closer to reality as computing power costs drop dramatically. New injectable technology is being developed for entry into the blood stream. Blood
sensors will communicate with our personal medical server to match blood and cardiac contextualized algorithms to determine our best-health options. Imagine having a small sensor traveling in our bloodstream looking for artery lining maintenance opportunities to prevent heart attacks or strokes.

Many of us in engineering have seen robotics on a first hand basis, typically in paint booths and welding shops. With some exposure to automated assemblies, robotics will become R2D2s and C3PO’s of our daily lives. With the aging population, seniors will need assistance getting out of bed or doing household chores – such as vacuuming the floors. Affordable robotic assistants will be able to lend a hand to many.

At the 2013 OpenWorld event, Oracle’s annual conference that attracts over 60,000 participants from all over the world, dedicated sessions and keynotes will focus on the Internet of Everything (IoE). Addressing many of the topics mentioned above. Global executives will both hear and discuss how the cloud, computer capability and low cost storage will impact the advent of intelligence in ordinary mundane items.

Cisco defines IoE as bringing together people, process, data, and things to make networked connections more relevant and valuable than ever before—turning information into actions that create new capabilities, richer experiences, and unprecedented economic opportunity for businesses, individuals, and countries. Cisco addresses IoE as a $14.4Trillion market over the next decade as we shift from a fixed computing model into mobility, then to the Internet of things and eventually the internet of everything. Cisco identifies 5 key drivers to produce this value-benefit in the following areas:

- **Asset Utilization** - lower overheads, reduced cost of goods sold, better business processes, capital efficiency
- **Employee Productivity** - higher efficiency in the hours we work
- **Supply Chain & Logistics** - improved process efficiencies, load balancing, higher forecast accuracy, more efficient storage, transfer and decision points for information
- **Customer Experience** - higher lifetime values with segmented approach
- **Innovation** - rapid time to market, new revenue streams.

It’s amazing to think that 99% of the various objects in this world are still not connected to the web. This will certainly change as connectivity becomes ubiquitous and communications costs continue to plunge. One can think that the cost for most communications today, like photography, is nearly zero. On the shop floor, we see a greater degree of synchronization of both discrete and process systems. Machines are now communicating with one another. They are beginning to coordinate push-pull activities and automate quality inspections. Dimensions and critical factors are flagged on the spot in order to minimize production line disruption. With finer tuned line processes, inventories can be better planned and sequenced. With reduced reject rates, costs are lowered and automated assembly functions in the 48 contiguous states can better compete with lower foreign Pacific Rim labor markets. Envision the day where nearly every item is connected to the web, even to determine its location or ownership identification. Looking for your lost pair of glasses or missing favorite shirt may only take a quick search on your mobile phone. The possibilities are nearly endless. With the internet now 40 years old, it’s just amazing that almost any city in the world can be contacted via Skype or FaceTime for free. The same applies for our factories of tomorrow. The day is approaching where subcontractors constantly feed sub-components and sub-assemblies into feeder bins based on demand-tags that drive production configurations. Users will be able to self-configure their product selection based on variable setups. Colors, sizes, dimensions all profiled to the buyers requests. Think of having clothing specially manufactured for you at commodity product pricing.

In closing, we need to be prepared for the next chapter in our new computerized economy as devices and more simple objects become smarter. Intelligence will proliferate as computing costs drop and the power of the computer becomes embedded in the simple things of our lives. We as a society and as design engineers, need to be prepared for these dramatic changes that are to take place, to embrace these disruptive technologies and to deploy them in a productive manner. They are here to stay.
About the Author
Stephen Slade is the Senior Director of Industrial Manufacturing Marketing at Oracle Corporation.

References
1. White paper “Embracing the Internet of Everything to Capture your share of $14.4T market” Bradley, Barbier and Handler, Cisco. 2013
2. “Thanks to IoE, the Next Decade Looks Positively ‘Nutty’” Cisco blog, Dave Evans, Feb 2013
During an interview, I was asked by a committee member, “Can you design a foundation for a pump?”

A story from a long time engineer…

William L. Dean, PE, FASME

It was in the spring of 1951. I had applied with countless other young engineers throughout Britain for the position of assistant water engineer of a municipally owned water department. The city was known for its large chemical industry, also the England’s last operated transporter bridge and this town had a nationally respected rugby league team.

For these public agencies the positions are advertised nationally and my written application had placed me in the position to be interviewed by the town water committee. The elected councilors and aldermen were all local residents, consisting of tradesmen, publicans, craftsmen and businessmen. This interview group consisted of the complete committee membership plus the engineer and manager. Eleven people were taking part in the hiring of an assistant engineer.

These interviews consist of the applicant (me) sitting in a seat at the end of a large table practically surrounded by the esteemed councilors and aldermen of the town. After the interview had taken place for all preferred candidates (usually four) the successful candidate is invited to return to the committee room. I was asked to return to the committee room and was then asked to take the interview seat. The chairman of the water committee then stood up and said to me, “Mr. Dean, the gentlemen on this committee have decided to offer you the position of assistant water engineer for our town.” I replied, “Thank you very much sir, and I accept this position with the hope that I will justify the committee’s choice.”

The chairman was an elderly man who possessed a well-trimmed beard and looked most distinguished. He replied to me that he hoped that my having secured this position with his town that I would make my mother proud of me. I said my thanks began to take my leave. All of a sudden one of the committee men said, “Young man can you scrape a bearing?”

I immediately replied, “Yes sir, but I did not know that this position as a water engineering assistant would require me to fit bearings.”

He replied, “No but I had to ask.”

As I then made my way out of the committee room the engineering manager said, “Mr. Dean, can you design a foundation for a pump?”

This was my reply! “Gentlemen I have never designed a foundation for a pump. But with my practical training to be a craftsman and my theoretical knowledge I can assure you that I will be able to design a foundation for a pump.”

I left that room very nervous as I had told the committee that I would be able to design a foundation for a pump and I did not know how to even start to design one.

I then returned to my home. The ride home I kept thinking, “Today, I committed myself to say that I can design a foundation for a pump, and I have no idea how to do it.” I awoke several times that night thinking, “How am I to quickly learn how to design a foundation for a pump?”

The next morning I visited our local suburban library in an effort to find a technical book that would describe “Pumps and their Foundations.” I suddenly realized that suburban libraries do not have technical books. The only books available were novels and children’s learning books.

I then decided that I must get on a street car to the city of Liverpool and search the city’s great library which is situated next to the Museums and Art Galleries. A most distinguished center of learning. I went to the inquiry desk of the library and spoke with a trained information officer. He then took me to the engineering section of this huge library and he climbed ladders and looked and looked for a book

on pumps and their foundations. After some time he told me that this library did not contain the information that I sought.

I exited this great edifice and stood on the steps looking over this interesting city and thought that I was nothing but a phony person in telling the water committee members that I would be able to design a foundation for a pump. I even thought as I saw the multitudes of people walking to and from their places of business that many of them must know about foundations and here I am a supposed engineer who has not one clue on how to design a foundation for a pump. I felt that I had to know this requirement prior to commencing the position of assistant engineer in the coming week! What a plight that I found myself in!

As I stood on the top of the multiple steps of this magnificent library building I looked past the art gallery and could see the Liverpool Senior College of Technology which was another distinguished building. I thought perhaps I might go to the college that I had attended for many years and ask the engineering department head, Dr. Grundy, if he could advise me on how to design a foundation for a pump.

I was most hesitant to go to Dr. Grundy’s office because I always thought that he should be named Dr. Grumpy! He was small in height and had a permanent red face and wore thick glasses. He looked at you as though he was bothered and gave me the feeling that he disliked talking with tall people (I am 6’2”).

On arrival at Dr. Grumpy’s office I asked the receptionist if I could talk with the professor. She then requested that I speak with his secretary. I told the secretary why I needed to see the professor and she replied that she would ask him if he would see me.

Dr. Grundy came out of his office to the counter were I stood. He wore his thick spectacles and held several papers in his hand as though he was immensely busy. He then said, “Who are you, were you a student at this college?”

I replied, “Yes Dr. Grundy, 1942 to 1951.”

He then said, “What can I do for you?”

I then went on to explain that I had accepted the position as the assistant engineer of a town’s water department and they had asked me during the interview if I could design a foundation for a pump. I came here doctor to ask you if you have any information on the design of foundations for pumps.

He retorted, “Good heavens no. I do not know how to design a foundation for a pump.”

“Wow!” I immediately thought, “The great Dr. Grundy tells me that he cannot design a foundation for a pump.”

Dr. Grundy was an educator and he was not to be outdone! He said to me, “Wait here” whilst I go down to the archives in the basement of this college and see if I can find a reference to this subject of pumps and their foundations.

I waited and eventually Dr. Grundy returned holding a small vintage type book. “Aha!” he said. “Dean’ I have found a book that tells us about foundations for pumps.” He carefully opened the book and turned to a page and then read out to me, “Foundations for Pump. Use one cubic foot of reinforced concrete for each pump horsepower.”

“Eureka!” I wanted to say, “We found it!”

I thanked Dr. Grundy. I left the outside steps of the college thinking, “I am now ready to start this new job and like everybody else in engineering I now know how to design a foundation for a pump.”

This episode happened in my life over sixty years ago. To this day nobody has yet to ask me to design a foundation for a pump, but thanks to Dr. Grundy I was forever confidant that I knew how to
design a foundation for a pump. Even though once cubic foot of reinforced concrete per pump horsepower is totally wrong, I had the solution and the confidence to start at the water department!

Editor's note: a more accurate rule of thumb for pump foundation design is 3x the weight of a centrifugal machine and 5x time weight of a reciprocating machine. This would give a 10,000lb, 300HP OH2 style pump a foundation size of around 200 ft³ (7.5 cubic yards), rather than the 300 ft³ (11.1 cubic yards) Dr. Gundy would have recommended.