ASHRAE Philadelphia Chapter

December 2025
Volume 61, Issue 3

INSIDE THIS ISSUE:

President's Message	2
Corporate Sponsor—Radius Systems	3
December Meeting Info	4
Happy Hour Info	5
Government Affairs News	6-7
Future City Philadelphia	7
October Meeting Photos	8
Membership	9
CTTC Article - *Pump Cavitation and How to Avoid it*	10-14

MEETING COSTS

Fees are based on online reservations and prepayment.

$50 Member
($60 with late fee)

$75 Guest
($85 with late fee)

$0 Life Member

Register before Wednesday, December 3, to avoid late fees.

Follow us on
LinkedIn



QUAKER CITY CLIMATE

Breakfast Meeting

Wednesday, December 10, 2025

7:30 AM to 9:30 AM

"Understanding A2L Refrigerants and Their Impact on VRF Systems "

presented by

Marty Brinton
LG Electronics

7:30 AM - 8:30 AM Breakfast
8:30 AM - 9:30 AM Presentation

Click here to register.

LOCATION
The Union League of Philadelphia
140 South Broad Street
Philadelphia , PA 19102
http://www.unionleague.org

For directions and parking, click here.

See page 3 for more information and the Union League Dress Code.

Holiday Happy Hour

Philly & Lehigh Valley ASHRAE, and Delaware Valley Chapter ISPE & PDA

Thursday, December 18, 2025
5:00 PM to 7:00 PM

Well Crafted Brewery
Lansdale, PA 19446

See page 5 for more information.

2025-2026

President
Tyler Holland

President-Elect
Anthony Rodio, PE

Vice President
Clay Boggs

Treasurer
David Morrison, PE

Secretary
Alexa Smith, PE

Senior Governor
Jason Trefz

Governors
Canaan Colwick
Hogan Cuny
Sam Hall

Attendance Committee
David Morrison, PE

Basic School Coordinator
James Lill, PE

Chapter Historian
Andrew Mondell, PE

Chapter Technology Transfer Committee Chair
Canaan Colwick

Electronic Communications
Mark Carbonaro, PE

Government Affairs
Andrerw Mondell, PE

Membership Promotion Chair
Blake Kiedrowski

Newsletter Editor
Hope Silverman

Program Committee Chair
Anthony Rodio, PE

Research Promotion Chair
Frank Kunze

Student Activities Chair
Hogan Cuny

Young Engineers in ASHRAE
Sam Hall

PRESIDENT'S MESSAGE

Dear Philadelphia ASHRAE Chapter Members,

I hope everyone had an enjoyable Thanksgiving. I am grateful to be part of such a strong Chapter supported by a dedicated Board and an engaged membership. We have had a great start to the Chapter year, and as we move into the final weeks of 2025, we are looking forward to keeping that momentum going.

We had an excellent turnout for the 2021 International Mechanical Code Updates Panel Discussion on October 27. Special thanks to our panelists John Rihl, Jason Siensa, PE, and Thomas Gormley, PE, along with our moderator Andrew Mondell, PE. The discussion was informative and the audience participation was outstanding. We plan to continue building this panel format for future events.

Our annual Breakfast Meeting at the Union League is coming up on December 10 at 7:00 AM. Martin Brinton will be presenting on A2L Refrigerants and Their Impact on VRF Systems. Space is limited, so please register early.

In the new year, keep an eye out for details on a social event and refrigeration tour at the Xfinity Mobile Arena, formerly the Wells Fargo Center. We have hosted many game -day socials over the years, but this will be our first opportunity to explore the mechanical systems behind the scenes. More information will follow.

As always, our success depends on the support of our volunteers and sponsors. We appreciate everyone who contributes to the Chapter, and we encourage anyone interested in getting more involved to reach out.

Thank you again, and I hope to see you at an upcoming event.

Sincerely,

Tyler A. Holland
Philadelphia Chapter President
c021@ashrae.net



Click here to register and join us at Caesar's Palace!

Corporate Sponsor Profile - Radius Systems

Radius Systems was founded in 2006 with the vision to be the market leader in customized HVAC/lighting control and physical security systems. We are committed to open systems/open protocols to provide facilities with flexibility and choice.

Our experienced and responsive workforce, the technical superiority of the Automated Logic Optiflex product line, and extensive knowledge of the building automation systems industry enable us to solve complex problems and be a trusted resource for our customers, helping them to make decisions that will deliver the most cost-effective long-term solutions.

We excel at integrating diverse facility systems, implementing innovative and complex energy savings strategies, and assisting customers with commissioning and energy evaluation services through our extensive expertise in facility automation.

Our chosen technologies provide us with a wide array of highly sophisticated tools for:

- **Enterprise building management systems**: third-party integration of HVAC, lighting, generators, VFD's, chillers, boilers, elevators, and much more.
- **Energy management**: customized energy management and reduction sequences, demand curtailment, automated demand response, energy analysis.
- **Fault detection/diagnostics and analytics**: 100% data trending with proactive monitoring to identify persistent problems.
- **Facility security**: access control, intrusion detection, gunshot detection & lockdown, video surveillance, and mass notification.
- **Lighting control**: dimming, daylight harvesting, occupancy control, and full building automation systems integration.

Radius Systems
101 Ponds Edge Drive, Suite 201
Chadds Ford, PA 19317
www.RadiusSystemsLLC.com
Phone (610) 388-9940
Fax (610) 388-9945

Become a 2025-2026 Corporate Sponsor of the Philadelphia Chapter

Your firm's participation in this program would enable us to make a donation to ASHRAE's Research Promotion which includes over $1.9 million in local research funding.

Some of the benefits your company will enjoy as a Corporate Sponsor includes a listing on the Chapter's website with a link to your own website, five free log-ins to the Digital Directory, a $100 discount on an advertisement in the Digital Directory, and tickets to attend our dinner meetings which include quality educational programs.

We offer a few different levels of corporate sponsorship. Each level will receive the same types of benefits, with some differences in quantities and discounting.

Please contact Tyler Holland at c021@ashrae.net if you are interested.

Thank you for your support!

December Breakfast Meeting

Wednesday, December 10, 2025
7:30 AM to 9:30 AM

"Understanding A2L Refrigerants and their Impact on VRF Systems"

Click here to register.

Presentation Summary:

As the industry shifts to lower GWP A2L refrigerants, engineers must adapt to new safety standards and code requirements. ASHRAE Standard 15 has been updated to reflect the characteristics of these A2L refrigerants. This includes changes to refrigerant charge limit calculations, the addition of leak detectors and release mitigation controls, and the introduction to the concept of releasable charge. These updates affect variable refrigerant flow systems and how they are designed, manufactured, and installed. This meeting will cover the transition to A2L refrigerants and what it means for variable refrigerant flow systems.

Meet the Presenter:

Since 2009, **Martin (Marty) Brinton** is a Senior Applications Engineer with LG Electronics where he supports LG's Commerical Air Condiitoning field sales organization properly integrate VRF systems in commercial building design. He is a subject matter expert on variable refrigerant flow (VRF) technology, refrigerant cycle sequence of operation and advanced VRF system applications and design.

Mr. Brinton has been in commercial HVAC sales, engineering and applications business since 1982. Prior to employment with LGEUS, Mr. Brinton owned and operated a mechancial equipment applied rep agency for seven years focusing on data center environmental control.

LG Electronics USA, Inc; - Senior Applications Engineer VRF Heating & Cooling Solutions 2009- Present
Terracon Consulting Engineers & Scientists; – MEP Property Condition Assessor 2007-2008
Brinton Enterprises LLC; - Manufacturer's Representative Mission Critical Cooling Systems 2001-2007
The Trane Company, National Accounts Manager – U.S. Restaurant Sector, 1997-1999
The Trane Company; Operations Manager, 1998-1999
The Trane Company; Account Manager - Industrial & Manufacturing Sector, 1995-1997
Alcatel Network Systems; Plant Operations & Preventive Maintenance Manager 1991-1994
Rockwell International; – Collins Radio Division - Utility Systems Design Engineer, 1987-1990
Shepherd Sales & Service; - (Trane Company Sales Office), Applications Engineer, 1982-1986

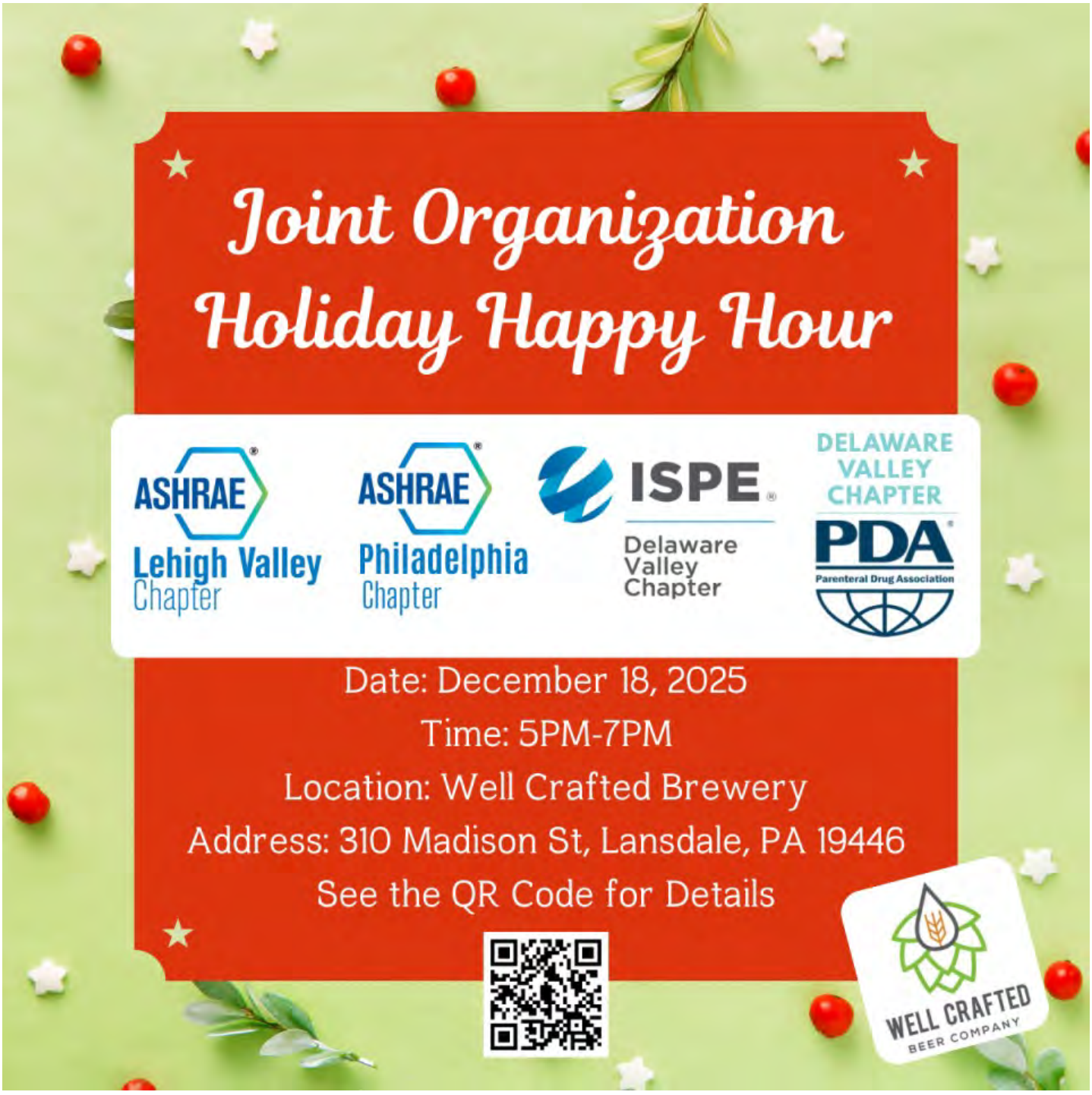
EIT, LEED-AP; BD+C, ASHRAE member

The Union League House Dress Code

The Union League reserves the right to refuse admittance to anyone not adhering to the dress code.

The Union League's Dress Code requires Business Casual Attire for ladies and gentlemen. Gentlemen are required to wear a collared shirt and slacks; turtleneck and mock-turtleneck shirts may be worn when accompanied by a suit jacket or sport coat. At no time are jeans, sneakers, athletic clothing, or shorts permitted on the first or second floor of The League House.

More information available here: https://www.unionleague.org/be-our-guest#club-policies-and-dress-code


Joint Organization
Holiday Happy Hour
ASHRAE Lehigh Valley Chapter
ASHRAE Philadelphia Chapter
ISPE Delaware Valley Chapter
DELAWARE VALLEY CHAPTER PDA Parenteral Drug Association
Date: December 18, 2025
Time: 5PM-7PM
Location: Well Crafted Brewery
Address: 310 Madison St, Lansdale, PA 19446
See the QR Code for Details
WELL CRAFTED BEER COMPANY

Government Affairs Committee News

Questions or comments? Contact:
Andrew Mondell, Government Affairs Committee Chair, Andrew.Mondell@AMZenergysystems.com
or Katherine Mahon, Government Affairs Committee Member, kem@ba-inc.com.

House Democrats Introduce Legislation to Revive Energy Tax Credits

On October 30, Democrats on the House Committee on Ways and Means introduced H.R. 5862, the "Energy Independence and Affordability Act (EIAA)." The legislation would restore energy tax credits that were created or enhanced under the Inflation Reduction Act and recently repealed under the One Big Beautiful Bill Act. In addition to restoring clean energy production tax credits, the bill would restore energy efficiency tax incentives including:

- 25C Energy Efficient Home Improvement Tax Credit
- 45L New Energy Efficient Home Tax Credit
- Section 179D Energy Efficient Commercial Building Tax Deduction

DOE Cancels Energy Projects

On October 2, the Department of Energy (DOE) cancelled roughly $7.6 billion in funding predominantly for energy projects in states represented by Democrats in the Senate. Affected states include Connecticut, California, Colorado, Delaware, Hawaii, Illinois, Maryland, Massachusetts, Minnesota, New Hampshire, New Jersey, New Mexico, New York, Oregon, Vermont, and Washington. The cancellations would also affect 136 congressional districts, including 108 held by Democrats and 28 held by Republicans. However, DOE may cancel additional grants. An unconfirmed list includes the already-terminated grants with roughly 300 more, including some in Republican-led states and districts. These grants were funded under regular appropriations, the Bipartisan Infrastructure Law (BIL), and the Inflation Reduction Act (IRA). The $2.8 million Resilient and Efficient Codes Implementation (RECI) grant ASHRAE secured is also included in this list. DOE has not made a final decision on which projects from this list will be terminated.

DOE Proposes to Accelerate Energy Connections to Data Centers

On October 24, Secretary of the Department of Energy (DOE), Chris Wright, directed the Federal Energy Regulatory Commission (FERC) to initiate rulemaking procedures with a proposed rule to rapidly accelerate the interconnection of large loads, including data centers. The proposed rule would allow customers to file joint, co-located load and generation interconnection requests. The administration argues this is necessary to address the unprecedented electricity demand associated with data centers and for the U.S. to remain a leader in technological innovation. More information on the proposed rule can be found here.

15 Governors Announce New Non-Partisan State Public Health Alliance

On October 15, the governors of 15 states announced a new initiative focused on protecting public health across the U.S now that federal public health agency programs, funding, and staff have been drastically reduced. The Governors Public Health Alliance is intended to serve as a communication and coordination hub for governors and state public health officials to assist with emergency preparedness and response, as well as public health guidance and policy development. Participating states and territories include Washington, Hawaii, Massachusetts, New York, Oregon, Connecticut, Rhode Island, Delaware, Maryland, New Jersey, California, Colorado, Illinois, North Carolina, and Guam.

(continued on next page. . .)

Government Affairs Committee News *(continued)*

Oregon, New Jersey, and Michigan ASHRAE Members: Ask Congress to Defend the Energy Codes Workforce

On September 30, the Department of Energy formally announced the termination of 321 grants, totaling roughly $7.5 billion, that were primarily intended to support energy projects. Shortly after, a second list of proposed cuts leaked. On this list, and slated for elimination, is a $2.8 million "Resilient and Efficient Codes Implementation" (RECI) grant ASHRAE secured to develop and deliver free energy standards and codes trainings, along with workforce development courses in New Jersey, Oregon, and Michigan over a three-year period. This federal investment in these states is designed to grow the energy workforce, develop a pipeline of experts capable of training American workers on building codes and standards, and ensure officials are well equipped to implement energy codes including ASHRAE Standard 90.1, *Energy Standard for Sites and Buildings Except Low-Rise Residential Buildings*. Congress has multiple avenues to defend this federal investment in Oregon, New Jersey, and Michigan. ASHRAE members in these states can use our VoterVoice tool to email their members of Congress.

Future City Philadelphia

The Philadelphia Chapter of ASHRAE is a proud sponsor of this event!

When: Saturday January 24, 2026

Where: Archbishop Carroll High School
211 Matson Ford Road, Radnor, PA 19087

Future City Competition Theme: Farm to Table

The Students' Challenge:
Design a city that eliminates food waste from farm to table and keeps your citizens healthy and safe.

Visit https://www.futurecityphilly.org for more information and to volunteer (engineers preferred).

Our Chapter Digital Directory is available!

The link to the Directory of Manufacturers' Representatives in the Philadelphia Area is on our home page on the website, or you may click here to advertise or purchase access to the directory!

Panel Discussion Photos

"2021 International Mechanical Code Updates"

October 27, 2025

Special thanks to our panelists John Rihl, Jason Siensa, PE, and Thomas Gormley, PE, along with our moderator Andrew Mondell, PE.













The Philadelphia Chapter
of the
American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc.

994 Old Eagle School Road
Suite 1019
Wayne, PA 19087-1866
P 610-971-2169

Visit
our web site at:

www.ashraephilly.org

Follow us
on LinkedIn

Republication of material contained herein is expressly forbidden without official Chapter authorization. The Chapter does not speak or act for the Society. Any member with material to submit for inclusion in the *Climate* can send the information to:

Hope Silverman
P 610-971-2169
hope@mmco1.com

Material can include letters to the editor, member news, upcoming events, comments on chapter programs or issues, etc.

New Philadelphia Chapter Members

Olivia Grace Watson
Patricia Leshinskie
Sean Herbert
Jacob L Meyer
David Gibbons
Susan Ellen White
Connor W Fulbright
Jeffrey W Miller
Gavin Cooney
Thomas Gormley
Ebenezer Owusu
Edwin Carrasco-Ruiz
Joe Hana

What are the benefits of paying Philadelphia Chapter *dues** ?

Discounts:

- $200 Discount for Basic HVAC Design Class
- Discounts on Monthly Chapter Meetings
- Free access to the Digital Directory
- And much more!

* Note that Philadelphia Chapter Membership Dues are $50/year.

To receive discounts, please remit you Chapter dues when renewing online or applying for a new membership. Feel free to upgrade online by clicking here or contact c021@ashrae.net for assistance.

Membership Advancement

If you are currently an ASHRAE Associate Member, becoming a full Member is easier than you think! The following count toward the required **12 points** to advance to full membership status. You must update your ASHRAE online biography and send an email to membership@ashrae.org to advance.

Non-accredited degree = 4 points	Accredited degree = 6 points
PE = 4 points	Industry experience = 1 point/year

Pump cavitation and how to avoid it

Best practices in pump system design

Presented by: Xylem Applied Water Systems

Cavitation is not a new phenomenon that can impact a pump system, but it is an issue that is growing. While no official figures exist, it is not misleading to say that in the last five years, cases of pump cavitation have increased markedly.

Often the pump itself is unfairly blamed. Pumping system problems, including cavitation, often manifest themselves at the pump but are rarely caused by it. In fact, nine out of 10 pump problems are not caused by the pump itself but by issues such as cavitation, poor system design and lack of maintenance.

Additional issues caused by cavitation, such as vibration, can be severe and may lead to mechanical damage to the pump. Cavitation related problems also have the potential to reduce pump life from 10-15 years, down to just two years in extreme cases.

Why is cavitation on the increase when 20 years ago it was a more isolated occurrence? One of the causes may lie in the fact that design engineers in the water industry are now expected to understand a wide range of different technologies. It is impractical for these professionals to be experts in several areas. Cavitation is primarily due to poor pump system design and a lack of awareness about how cavitation is caused.

This paper investigates the causes and effects of cavitation and the process to be followed during the design stage. Potential solutions for installations with cavitation issues are discussed; some of these can be expensive and disruptive. The good news is that cavitation and the downstream impact on maintenance and repair costs can be avoided.

What is cavitation?

Cavitation can have a serious negative impact on pump operation and lifespan. It can affect many aspects of a pump, but it is often the pump impeller that is most severely impacted. A relatively new impeller that has suffered from cavitation typically looks like it has been in use for many years; the impeller material may be eroded and it can be damaged beyond repair.

Cavitation occurs when the liquid in a pump turns to a vapor at low pressure. It occurs because there is not enough pressure at the suction end of the pump, or insufficient Net Positive Suction Head available (NPSHa).

When cavitation takes place, air bubbles are created at low pressure. As the liquid passes from the suction side of the impeller to the delivery side, the bubbles implode. This creates a shockwave that hits the impeller and creates pump vibration and mechanical damage, possibly leading to complete failure of the pump at some stage.

What is vapor pressure?

At a specific combination of pressure and temperature, which is different for different liquids, the liquid molecules turn to vapor. An everyday example is a pot of water on the kitchen stove. When boiled to 100o Celsius, atmospheric pressure bubbles form on the bottom of the pan and steam rises. This indicates vapor pressure and temperature have been reached and the water will begin boiling.

Vapor pressure is defined as the pressure at which liquid molecules will turn into vapor (see **Figure 1.0)**. It should be noted that the vapor pressure for all liquids varies with temperature. It is also important to understand that vapor pressure and temperature are linked. A half full bottle of water subjected to a partial vacuum will begin to boil without the addition of any heat whatsoever.

Constant pressure acting on liquid (atmospheric pressure)

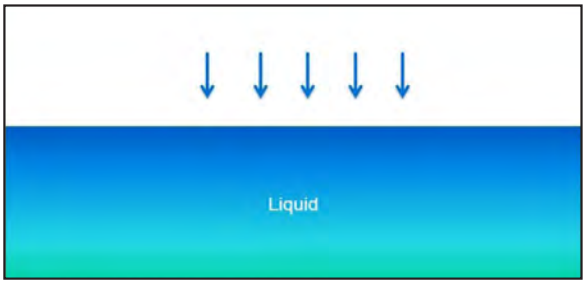


Figure 1.0

Properties of water at different temperatures
By regulating the pressure at which water is subjected its vapor pressure can be changed and it will eventually boil at room temperature. **Figure 2.0** illustrates a tabulation of temperatures from 5 to 100oC with variations in vapor pressure, density and specific gravity for water.

Temperature Degrees C	Vapour Pressure N/m^2	Density kg/m^3	Specific Gravity
5	871.9	999.9	0.9999
10	1227	999.7	0.9997
15	1704	999	0.999
20	2337	998.2	0.9982
25	3166	997	0.997
30	4242	995.6	0.9956
35	5622	994	0.994
40	7375	992.2	0.9922
45	9582	990.2	0.9912
50	12330	988.1	0.9881
55	15740	985.2	0.9852
60	19920	983.3	0.9833
65	25010	980.4	0.9804
70	31160	977.5	0.9775
75	38550	974.7	0.9747
80	47360	971.8	0.9718
85	57800	969	0.969
90	70110	965.3	0.9653
95	84530	961.5	0.9615
100	101325	957.9	0.9579

Figure 2.0

At 5°C, the density is 999.9, which an engineer will round to 1000. The specific gravity is 0.9999, or 1. At the bottom of the table one can see that at 100°C the density has changed to approximately 958, a significant but not a big change. If one looks at the specific gravity, it has changed from 1 to approximately 0.96.

The variability of vapor pressure
At 5°C, water vapor pressure is 872 in round figures, but at 100°C it is 101,000 which is a major change in pressure. This means that for any combination of pressure and temperature in the table, the water will begin boiling and turn into vapor (see **Figure 3.0**). For example, a glass of water subjected to a pressure of 2337 N/m2 at 20°C will begin boiling.

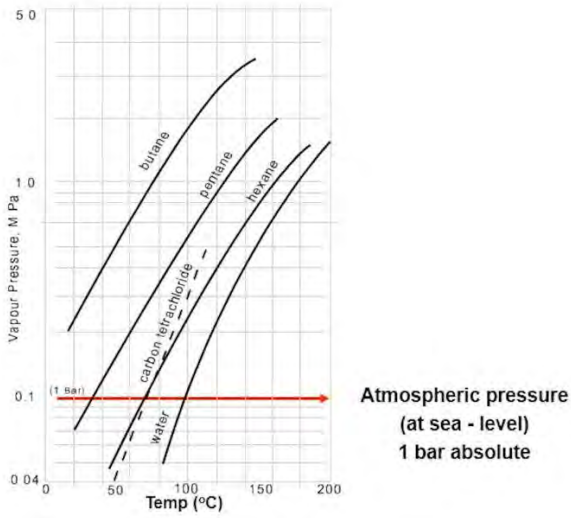


Figure 3.0

At 100°C the vapor pressure is 101325 N/m2, which is atmospheric pressure. With cavitation one must deal with absolute pressures, not gauge pressures. By regulating the temperature and pressure, it is possible to boil water at different points. Other liquids have similar charts, but the values will be different.

The influence of atmospheric pressure
Outlined in **Figure 3.1**, water will start to boil at 100°C atmospheric pressure (1 bar) at sea level. Other liquids such as hexane, carbon tetrachloride, pentane and butane are very different and will boil off at much lower temperatures than water. Butane, for example, will start to boil at negative temperatures.

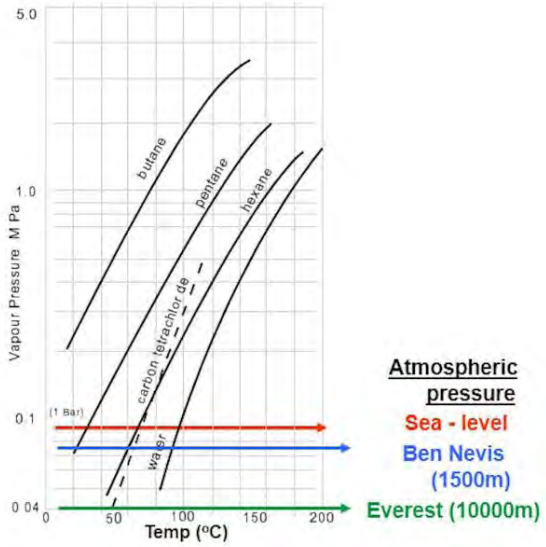


Figure 3.1

Pressure is dependent on altitude. In **Figure 3.1** a line is plotted for the top of Ben Nevis, the highest mountain in the United Kingdom at 1,344 meters, and a line for Mount Everest in Nepal at 8,848 meters. The table demonstrates that at the top of Ben Nevis the vapor pressure of water has dropped sufficiently to allow it to start to boil at 80°C. While it is unlikely that pumps will be installed on the top of these mountains, it is the case that pumps will be used in various locations around the world with similar altitudes, including Johannesburg, South Africa, which is approximately 1,700 meters above sea level. In such places it is important to determine the change in vapor pressure for that location.

The impact of cavitation on a pump
Cavitation causes pump performance deterioration, mechanical damage, noise and vibration which can ultimately lead to pump failure. Vibration is a common symptom of cavitation, and many times the first sign of an issue. Vibration causes problems for many pump components, including the shaft, bearings and seals.



Hole in pump impeller vane.



Impeller damage.

These photographs show cavitation damage to an impeller with segments chipped away and severe mechanical damage.

How to avoid cavitation
Assuming no changes to the suction conditions or liquid properties during operation, cavitation can be avoided most easily during the design stage. The key is to understand Net Positive Suction Head (NPSH) and take it into account throughout the design process. In order to understand this term more easily it is helpful to break it down:

- Net refers to that which is remaining after all deductions have been made
- Positive is obvious
- Suction Head refers to the pressure at the pump inlet flange.

NPSH is defined as the difference between the pressure available at the pump inlet and the vapor pressure of the liquid. Vapor pressure is different for different liquids and varies with pressure and temperature.

The pressure available at the pump inlet is what remains after friction loss, velocity head loss and inlet and outlet losses have been taken into account within the suction pipework of the pumping system. Because of this, during the design phase, it is necessary to calculate these losses and process unit losses in the suction pipework and then deduct those losses from the suction head available to the pump. By doing this, at the point where the pump is installed, one is left with net pressure remaining and available for the pump.

Net Positive Suction Head Available (NPSHa)
Net Positive Suction Head available (NPSHa) has nothing to do with the pump; it is a system value specific to the system design being considered. NPSHa is the head available at the pump suction flange pipework connection for the pumping system in question, and is completely independent of the pump to be installed there. It is the actual difference between the pressure at the pump inlet flange and the vapor pressure of the liquid for the installation and is determined by the design, configuration and relative levels for the suction side of a particular system.

NPSHa = P pump inlet ¬– vapor pressure (m)

Pressure available at the pump inlet is that which remains after allowances have been made for all the losses as described above.

Net Positive Suction Head Required (NPSHr)
Net positive suction head required (NPSHr) is a pump characteristic that is not related to the system. All pump NPSHr's are different and the values can be obtained from the pump manufacturer.

What causes cavitation?
Cavitation occurs in a pump when the temperature and pressure of the liquid at the suction of the impeller equals the vapor pressure. It can happen at low pressures and normal operating temperatures. Locally, it results in the liquid turning to a vapor and creating very high temperatures and pressures, which can reach circa 10,000K and 1GN/m2.

Bubbles form during cavitation. As the pressure in the pump increases, those bubbles collapse in the form of an implosion – equally as violent as an explosion. The implosion causes shockwaves to travel through the liquid and hit the impeller causing mechanical damage.



Impeller damage.

NPSHr is defined as the difference between the pressure at the pump inlet and the vapor pressure required for the pump in question. This value should not be taken as sufficient to ensure that cavitation will not occur, because it is measured at during testing when the pump is just starting to cavitate. The onset of cavitation is measured as being the point at which the delivery head on the pump drops by 3 percent.

It is therefore necessary to ensure that NPSHa is greater than NPSHr, and for that, a margin must be built in to the equation.

NPSHa ≥ NPSHr + margin

The golden rule is to ensure that there is always sufficient margin to avoid cavitation. The value of the margin is often specified in-house by design consultants, but pump manufacturers will always offer advice. Typically, a margin of approximately 1.5 meters will be sufficient.

NPSHa is a characteristic of the system design that can be controlled. Every effort should be made at the design stage to ensure that there is sufficient NPSHa within a system. The consequences of not doing so may prove to be costly and disruptive.

Understanding Cavitation

Figure 4.0 illustrates a cross section of a piece of suction pipe and the impeller in the pump. It identifies five positions. Considering liquid flows through the pump from positions 1 to 5, it is obvious that this is equivalent to a continuous pipe flow system, and the flow rate at every position from 1 to 5 must be constant.

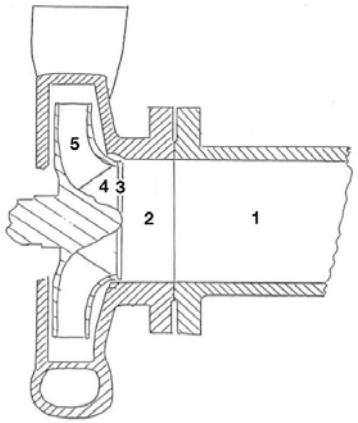


Figure 4.0

By definition, because there is a large cross section at position 1, going down to a very small cross section area, the velocity is much higher at the eye of the impeller than in the suction pipe.

As the velocity in a pipe system increases, the pressure is reduced, and as the velocity decreases, the pressure increases. The reason for this is that a higher velocity creates head, which is wasteful energy. Ideally, pressure is desired – not velocity head. The effect is similar to squeezing a garden hose. The flow rate of the water is the same, but the velocity can be increased by squeezing the end of the hose. The water leaving the hose has high velocity head but is at atmospheric pressure.

Figure 4.1 shows the pressure at different positions within the pump. It demonstrates that the pressure through the impeller drops and then recovers as it leaves the pump. This is due to the fact that the diameter of the eye of the impeller is small compared to the suction pipe, and the pump impeller is adding energy to the liquid, thereby increasing its pressure.

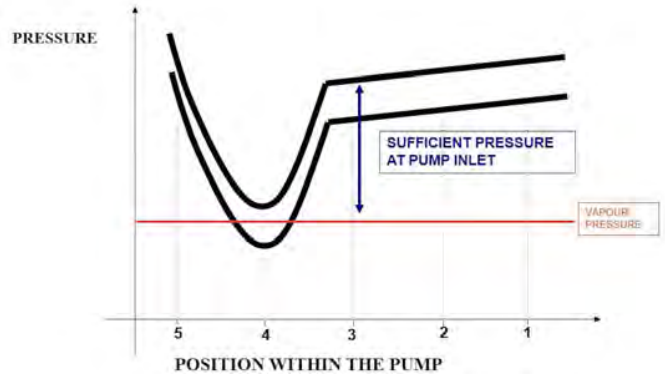


Figure 4.1

Good and bad pumping system graphs

Figure 5.0 illustrates the pressure variation through an impeller with two lines drawn, one red and one green, to represent the vapor pressure of different liquids being pumped.

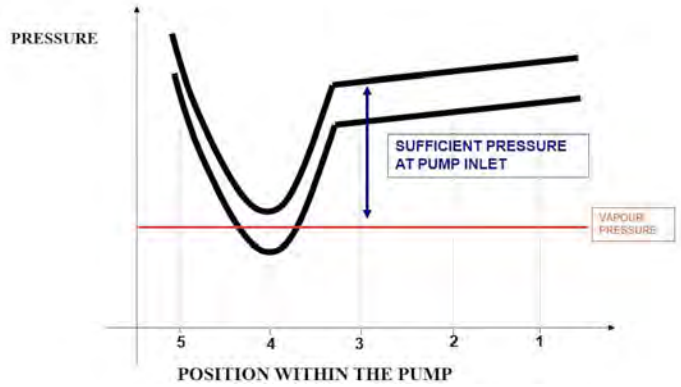


Figure 5.0

In the case of the red vapor pressure line, the curve cuts across the line signifying that at the position shown, the pressure will be lower than the vapor pressure of the liquid. This means that the system, in which the pump is installed, is not providing sufficient NPSHa, and by definition, cavitation will occur.

For the green vapor pressure line, the curve does not cut across the line at any point. This shows that there is sufficient NPSHa and the pressure will not drop below the vapor pressure of the liquid. This system has been correctly designed, and cavitation will not occur.

Avoiding cavitation

As discussed above, it is critical to ensure sufficient NPSHa is available so that the liquid remains above vapor pressure.

The pump cavitation test carried out by the manufacturer determines the NPSHr for each pump. During the design phase, the manufacturer will be able to supply the NPSHr for any pumps being considered.

Per **Figure 6.0**, the pump NPSHr curve is obtained through a test by starting the pump and running it at a given head and flow. The delivery head and flow are measured and the suction pressure is also measured. The suction to the pump is then throttled, simulating a reduction in NPSHa until the pump delivery head drops by 3 percent. At this point, the suction head is recorded along with the flow rate, and this becomes one point on the NPSHr Q-H curve. The test is repeated for different flow rates and heads until sufficient measurements have been taken to plot an NPSHr curve.

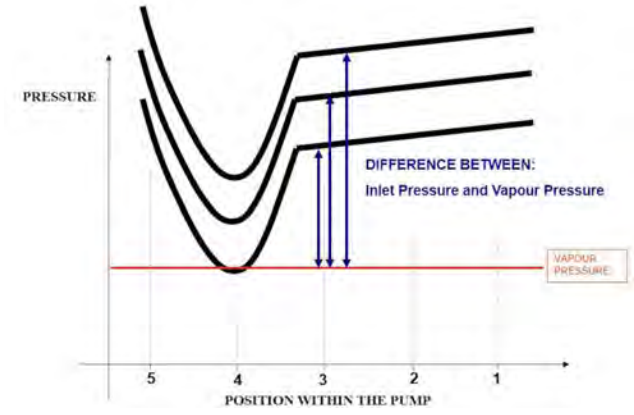


Figure 6.0

Conclusion

There is no alternative to getting pump system design right in order to avoid cavitation. During design, the value of NPSHa (which is independent of the pump to be selected) can easily be determined. The NPSHa can then be compared to the NPSHr for the types of pumps being considered. If there is insufficient NPSHa, it is much easier to make changes to the system design, rather than after construction and installation. It is strongly recommended that any changes necessary are made at the design stage as any additional costs incurred will be much lower compared to the costs of rectifying an installation with cavitation problems.

In the event that pump cavitation is a problem on an existing installation, there are essentially only two routes that can be followed to resolve the issue. The first is to increase the NPSHa to the pump or decrease NPSHr by the pump.

Options available to increase the NPSHa will depend upon the nature of the system in question. This can include increasing the pressure on the suction end of the pump, or reducing the friction losses in the pipework to make more pressure available to the pump. Increasing supply pressure can be achieved by raising the static head of the supply, applying pressure to the supply vessel, using a booster pump, or reducing friction losses in the pipework by using larger diameter pipes, or fewer components and fittings. Pressure could be supplied to the supply vessel with the use of a booster pump.

However, these are rarely viable options for an existing installation and are nearly always impractical due to space issues, cost and potential disruption. Similarly, it is rarely practical to replace the suction system pipework with a larger diameter.

The second option for resolving pump cavitation in an existing installation is to replace the damaged pumps with pumps that have a lower NPSHr, or install parallel pumping using multiple pumps.

In many cases the above options may not be viable, and in all cases they may involve considerable cost and disruption.

Good design to avoid cavitation is always the best option.

© 2015 Xylem Inc.