



## WELCOME Y'ALL

### Message from the Section Chair

I am very happy to be the Section Chairman this year; there are just some amazing things that are going to be happening this particular year. For some of the technical topics this year, we are going to get to look at some new breakthroughs in technology. We are expecting to have one of the most well attended ASNT National Conferences right here in Houston, Texas at the awesome Marriott Marquis Resort and George R. Brown Convention Center. We seem to be heading forward into a great economic future as of the time of writing this letter the employment rate had edged down to a record low of 3.8%. I hope to see these trends continue for the foreseeable future.

Also the ASNT Greater Houston section provides such a great networking opportunity for those in our industry and those people related to and utilizing NDT techniques in their processes. I have met so many people in my life who have opened doors for me, gave me great advice, and remained in my life both personally and professionally. After a while, networking does not feel like "networking". It's both serendipitous and unpredictable, and something that just naturally becomes part of your work life and personal life. The Greater Houston section and those who meet regularly want to invite you to come join us. No matter whom you are, or what company you work for, everyone is welcome to come share their ideas, network, and meet some really great individuals.

In our particular career field, it is of epic importance to become a mentor, inspire the younger generation, and to get people involved in NDT. Today more than ever, skilled trades and great careers like ours are not regularly seen in day to day life. There are not Netflix, Amazon Prime, or Hulu specials telling children and youth today about Non-Destructive testing, and it is up to us, the ASNT Society and the Greater Houston Section to spread that message. We need to encourage our membership to reach into Junior High and High School to start having these youth think about career fields that they have never seen before. We have to make it look interesting, let us bring in those advanced systems that incorporate phased array, corrosion mapping, and other automated techniques to show them that advanced careers await them and they are not necessarily behind a computer to develop applications or websites, but to drive inspection machines, manually and automated!

I want to take the time to really say how much I appreciate, and value, those section members that volunteer their time to serve on the board, fill a committee position, and volunteer regularly. It's the efforts of our membership and our volunteers that make the ASNT Greater Houston Section so great. I would like to encourage any of you that want to give back, volunteer and find yourself here at the section meeting and help the Industry that we all know and have grown to love.

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## JOHN HUFFMAN

GHASNT Section Chair (2018-2019)





# Water Based Penetrants: Advantages and Limitations

by Sam J. Robinson, Randal Goff, and Amos G. Sherwin\*

## Introduction

On March 13, 1998, the US Air Force issued a new qualified product (QPL). The new QPL-AMS- 2644-1 superseded QPL-25135-17, the inspection QPL that had been in effect since February 17, 1994. Included in the new QPL were water based (WB) penetrants, fluorescent penetrants that are diluted or extended with water instead of with a petroleum product such as a solvent or light oil. The newly approved WB penetrants are fluorescent (type I), method A (water washable), in sensitivity levels one (low) and two (medium).

These are the first fluorescent WB penetrants to be Air Force approved for general use since MIL-I-25135 version C was superseded on June 21, 1984, by the Dre vision. Until this recently published QPL, approved method A fluorescent penetrants were either undiluted surfactant ester formulations (biodegradable) or such formulas diluted with about 40 percent to 60 percent of a petroleum distillate or a glycol type solvent. WB fluorescent penetrants were not listed as Air Force approved.

## Benefits of Water Based Penetrants

Certain advantages of using water, an inexpensive, nonpolluting, and renewable resource, instead of a petroleum product as a diluent, are obvious. Environmental considerations forced paint manufacturers to substitute water for volatile petroleum thinners in many of their coatings. Cleaning compound manufacturers switched from petroleum solvent to aqueous cleaners. The benefits of using water as the diluent which represents approximately 50 percent of a penetrant are several and include:

- Lower costs: Light oils cost \$0.48 per L (\$2 per gal) and up. The savings in material costs on 55 gallons of penetrant diluted 50 percent with water would be 208 L (55 gal) or more.
- Sewer system acceptance: Waste treatment authorities accept water without question while petroleum oils resist biodegradation and, if accepted, are often subject to high disposal fees.
- Smell: Some grades of petroleum distillates have an unpleasant odor.
- Contamination: Petroleum distillates are a source of halogens and sulfur. Reduced fire risks: Although petroleum distillates used in inspection penetrant formulations are high flash point, they are combustible and fuel fire. Water does not.
- Lower shipping expense: A WB penetrant can be shipped as a concentrate, and the water can be added at the work site.

This is not practical when a petroleum distillate is the diluent.

- Aqueous cleaner compatibility: WB penetrants are compatible with water based cleaners, e.g., hot alkaline, which for environmental reasons have replaced petroleum solvent and vapor degreasers. Being compatible with the cleaner, WB penetrants have tolerance for rinse water carry over. Also, flaw entrapped water is less likely to impair the inspection process, such as would happen when flaw entrapped water repelled a petroleum based penetrant.

When 50 percent of the diluent is water rather than the conventional petroleum distillate, cost savings are realized in the areas of waste disposal, shipping, storage and materials. Further, using water means a more pleasant and healthier work environment free of petroleum vapors. So, the questions regarding the use of WB penetrants are "Why haven't penetrant manufacturers switched from petroleum diluents to water diluents, and why haven't WB penetrants appeared earlier on the QPL?"

## Overcoming Technical Problems

There is more than one good reason why WB penetrants have not appeared on the QPL before now. First, petroleum distillates, which are used to dilute both water washable and nonwater washable penetrants, contribute to penetrant performance in several ways. Second, water has inherent negative properties in a penetrant formulation. Furthermore, under current specification restrictions, petroleum distillates function as diluents in both water washable and nonwater washable (method B and D) penetrants, whereas water's use is restricted to water washable (method A) penetrants.

As a diluent, a light petroleum distillate has desirable characteristics; it dissolves light organic soils on surfaces and in flaws, and it assists crack penetration with its low surface tension and affinity for metal surfaces. Also, petroleum distillates naturally fluoresce a light blue color and, in a minor way, contribute to penetrant brightness.

This contrasts with water, which, by itself as a penetrant diluent, does not dissolve organic soils. Water's high surface tension, if not corrected, adversely affects penetrant performance. Furthermore, water does not have intrinsic fluorescent properties, and, while there are water soluble fluorescent dyes, none have been found which give the needed brightness. Moreover, using water soluble dyes may not be a practical approach; when a water based penetrant is placed on a surface in a thin coat, the water evaporates relatively rapidly and, theoretically, will cause water soluble dye to precipitate, diminishing the fluorescence of the penetrant.

*(continued on page 3)*



### Water Based Penetrant and Evaporation

The typical light oil used to dilute conventional penetrants is relatively non-volatile, and evaporation loss is a concern. On the other hand, water in WB penetrants will evaporate, and simple, but regular, testing with a refractometer is necessary to measure the loss. Periodic water additions are part of the maintenance criteria for WB penetrants.

Monitoring water loss with a refractometer is not new to the penetrant industry. Currently, hydrophilic emulsifiers, which typically are diluted with about 80 percent water, must be monitored, and water content must be restored to a minimum level. Water loss in hydrophilic emulsifiers results in more concentrated and more active solutions, a cause for overemulsification with resultant failure of the penetrant process. In contrast, water loss with a WB penetrant results in a more concentrated and more sensitive penetrant.

### Passing Qualification Tests - A Balancing Act

Qualifying a penetrant at a particular sensitivity level, among other things, requires two tests performed by the Air Force. One test is to quantify the brightness of the flaw indication produced by the candidate penetrant with instrumentation. The other test is to measure the degree of fluorescent background left on the surface after the penetrant removal step. Insufficient flaw indication brightness is cause for nonapproval of the candidate penetrant. A too-high level of background fluorescence is also cause for rejection because intense background fluorescence obscures the fluorescing flaw indication.

These requirements are at cross purposes. Penetrant lodged in a surface flaw must resist overwashing, while penetrant remaining on the surface must wash readily. As a WB penetrant's diluent is water, balancing its formula to resist overwashing from

flaws while washing readily from part surfaces is difficult.

To accept water as a diluent, the penetrant formula must be hydrophilic. It must readily accept water. If the formula too readily accepts water, the flaw entrapped WB penetrant will too readily accommodate rinse water. The flow entrapped penetrant will then be diluted and displaced, weakening or eliminating fluorescent flaw indications. A near perfect balance must be struck.

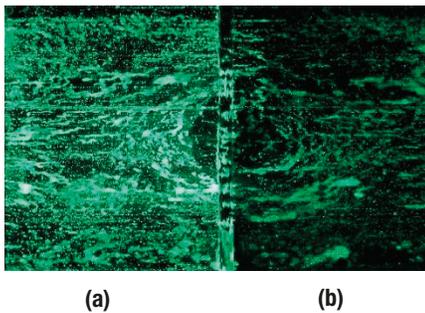
It is possible to vary the hydrophilic/lipophilic balance (HLB) to reduce water acceptance and retard flaw mark weakening. However, in so doing, the product becomes more resistant to washing from rough surfaces. The result is success in meeting sensitivity or flaw indication brightness but failure in meeting low background requirements. The HLB must be precise. The penetrant must resist over washing while being sufficiently free rinsing to meet the low fluorescent back ground requirement.

### Water Based Penetrants and Dry Powder Developer

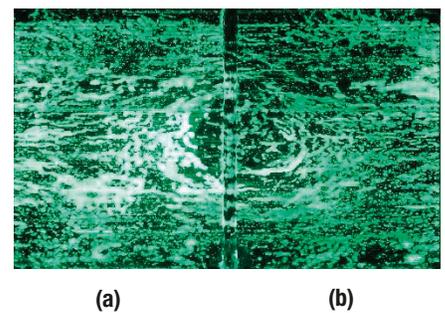
Another major obstruction to Air Force approval of water based penetrants is the hydrophobic character of dry powder developers.

The processing procedure for QPL qualification of a method A penetrant includes a five minute penetrant dwell, a plain water spray wash, oven drying, and application of a dry powder developer by immersion of the test piece. The powder intensifies and adds brightness to fluorescent indications. Crack retained penetrant is attracted to the powder. It coats the white, reflective powder surfaces. Ultraviolet light shines through the penetrant layer, activates its fluorescence, hits the white powder reflective surfaces, and bounces back through the penetrant layer, reactivating it and generating a high cascading effect. Powder developer increases the brightness of the penetrant indication.

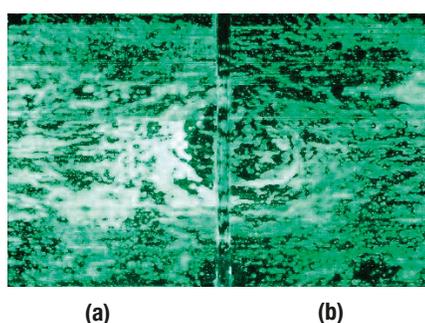
**Figure 1** - Ten minute dwell without developer; (a) WB level 2 penetrant; (b) biodegradable level 2 penetrant.



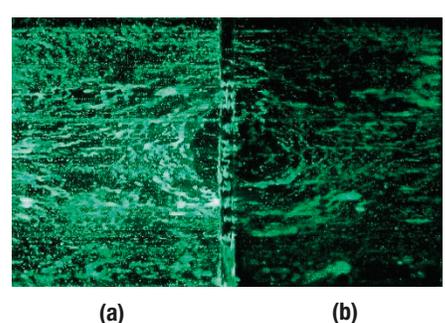
**Figure 2** - Ten minute dwell with powdered developer; (a) WB level 2 penetrant; (b) biodegradable level 2 penetrant.



**Figure 3** - Thirty minute dwell with powdered developer; (a) WB level 2 penetrant; (b) biodegradable level 2 penetrant.



**Figure 4** - Thirty minute dwell without developer; (a) WB level 2 penetrant; (b) biodegradable level 2 penetrant.



(continued on page 4)



Dry powder developers must be hydrophobic; they must repel water. If they were otherwise, they also would be hygroscopic and attract moisture from the air, resulting in a damp, lumpy, and ineffective developer. This is unfortunate for WB penetrants.

WB penetrants are necessarily hydrophilic while dry powder developers are hydrophobic. Thus, they repel one another. Dry powder developers' contribution to increased WB penetrant brightness, therefore, is substantially less than its contribution to petroleum based penetrant brightness. Even though WB penetrants seemingly are incompatible with dry powder developer, the recently QPL listed water based penetrants did pass the qualification tests using dry powder developer as the specification mandates.

### Water Based Penetrants and Dwell Times

As mentioned, the penetrant dwell time under test conditions is five minutes, whereas MJL-STD-6866 and ASTM E-1417- 95n specify a minimum dwell of ten minutes. In practice, dwell times are usually longer than ten minutes.

When a WB penetrant is applied in a thin layer over the surface and allowed to drain dwell, the water evaporates and the penetrant becomes concentrated. Sensitivity increases with concentration. In fact, with a 30 minute drain dwell, an Air Force test found that an approved WB penetrant's sensitivity increased from level two to level three. A short dwell time works to the disadvantage of WB penetrants, whereas the longer dwell time increases their effectiveness.

### Water Based Penetrants Compare Favorably with Conventional Penetrants

By virtue of their meeting ASTM E-1417 specifications and their having been tested by an independent third party, WB penetrants compare favorably with conventional penetrants.

In Figure 1, a level two WB penetrant was applied to the left section (section A) of a cracked aluminum block, while a conventional level two was applied to the right section (section B) of the block. The penetrants were Sherwin Inc. S WB-200 and HM-3A, respectively. No developer was used. In Figure 1, after a 10 minute dwell, it is clear that the water based penetrant has superior self developing properties.

The remaining figures show similar comparisons between WB-200 and either HM-3A (conventional) or HM-602 (surfactant based) when tested using either cracked aluminum blocks, as in Figures 2-4, or using the Twin KOS Panel, as in Figures 5-7. As indicated by the figures' captions, the varied parameters include the specific penetrants used, application of developer, and dwell times. The results clearly indicate that water based penetrants are superior or equal to already approved conventional or surfactant based penetrants.

### Conclusion

The principal drawback of water based penetrants is that they require monitoring to maintain the correct water proportion. Nevertheless, QPL approved' water base penetrants should find a wide range of applications. They are more environmentally friendly than traditional penetrants; additionally, they generally cost less, conserve resources, are more compatible with water based cleaners, have self-developing properties, and, in concentrate form, are less expensive to ship and store than traditional penetrants.

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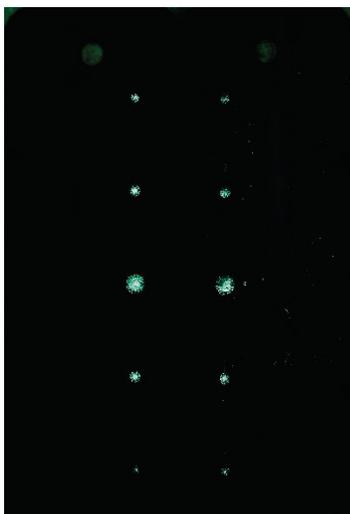


Figure 6 - Dry developer; (a) WB level 2 penetrant; (b) biopener level 2.

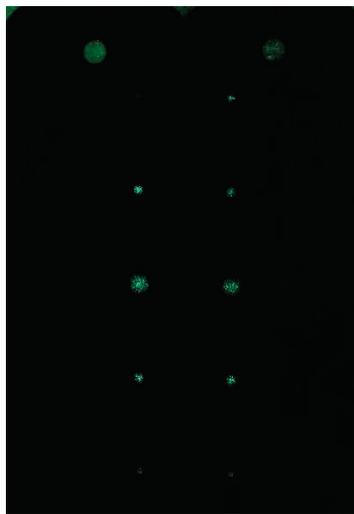


Figure 5 - Dry powder developer; (a) WB level 2 penetrant; (b) Oil Based level 2 penetrant.

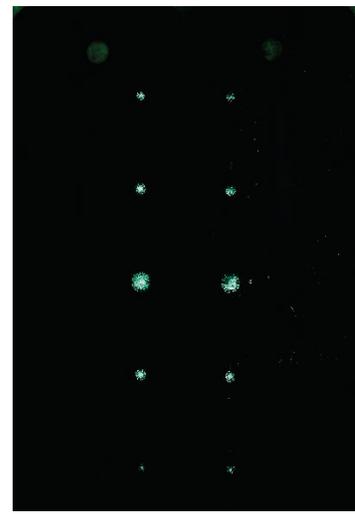


Figure 7 - Nonaqueous developer; (a) WB level 2 pe11etm11t; (b) biopener level 2.



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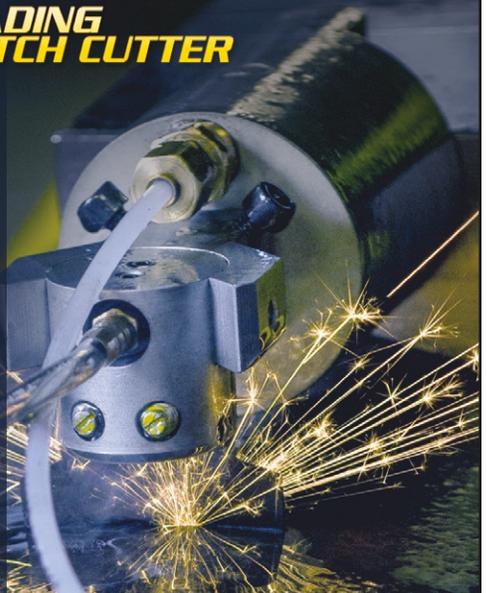
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9:00 AM MOTORCYCLE RIDE: THE WOODLANDS TO SAN ANTONIO

#### FRIDAY, OCTOBER 26TH

9:00 AM GOLF & TENNIS @ MEMORIAL PARK

#### SATURDAY, OCTOBER 27TH

8:00 AM - 4:00 PM FALL EDUCATIONAL @ SAN JACINTO CENTRAL

#### SUNDAY, OCTOBER 28TH

11:00 AM - 1:30 PM COMPANION QUILT RAFFLE OPENS

4:00 PM - 5:00 PM SECTION LEADERS NETWORKING

5:00 PM - 8:00 PM EXHIBIT HALL OPENING

#### MONDAY, OCTOBER 29TH

9:00 AM - 2:00 PM DAY OF STEM

10:30 AM - 2:00 PM COMPANION TOUR & LUNCH

6:00 PM - 9:00 PM OKTOBERFEST SOCIAL

#### TUESDAY, OCTOBER 30TH

9:00 AM - 11:00 AM COMPANION ASTRONAUT BREAKFAST

#### WEDNESDAY, OCTOBER 31ST

8:00 AM - 8:15 AM COMPANION QUILT RAFFLE DRAWING

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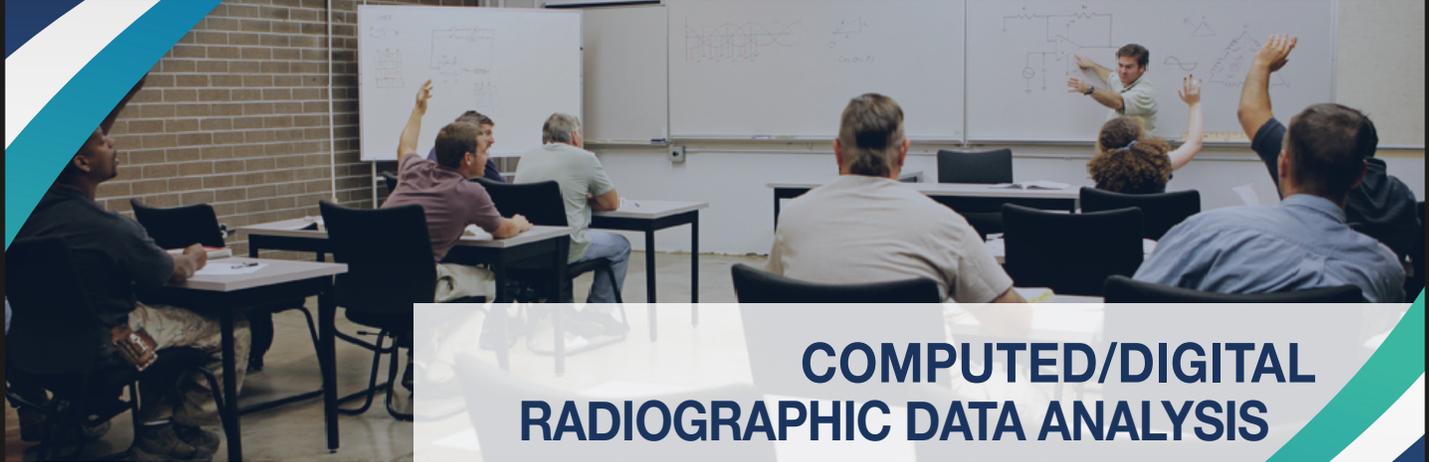
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FOR MORE INFORMATION & TO REGISTER, VISIT [www.asnthouston.com/fall-educational](http://www.asnthouston.com/fall-educational)

**SATURDAY, OCTOBER 27, 2018**

8:00 AM -4:00 PM

Spencer Highway, Pasadena, TX  
San Jacinto College | Central Campus, Building 26

We encourage any supervisor or mentor who knows of a deserving Level I, Level II or Level III working technician to nominate him or her. If you think you could be the Technician of the Year, you are invited to apply yourself as well! Not only is it a great honor to be acknowledged with this award, but it's an excellent opportunity to further advance your NDT knowledge, receive recognition and a chance to be nominated for ASNT National Technician of the Year representing the Greater Houston ASNT section.

**IF YOU HAVE SOMEONE IN MIND OR IF IT'S YOU,** please give Roger Jordan a call at (713)-263-4303 or download the application at [www.asnthouston.com/tech-of-year](http://www.asnthouston.com/tech-of-year). Applying is easy enough and we can help you get through the steps quickly.



# DO YOU KNOW OUR NEXT TECHNICIANS OF THE YEAR?

We know he or she is out there & we're guessing you know who it is!

**Deadline: February 15, 2019**

### AWARDS

**LEVEL I - \$1,500 + Plaque • LEVEL II - \$1,500 + Plaque • LEVEL III - Plaque**

**Disclosure:** The money awarded must be used for NDT training or educational purposes only and within one (1) calendar year.

FOR MORE INFORMATION OR TO APPLY: VISIT [www.asnthouston.com/tech-of-year](http://www.asnthouston.com/tech-of-year)



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# THINKING BIG IN OUR SMALL WORLD

Date	Event
October 10, 2018	GHASNT Monthly Meeting & Speaker: Republic Grill (Deer Park, TX)
October 24-25, 2018	Pre-Annual Conference Event: Motorcycle Ride (Houston to San Antonio, TX)
October 26, 2018	Pre-Annual Conference Event: Tennis & Golf at Memorial Park (Houston, TX)
October 27, 2018	Fall Educational at San Jacinto College: Computed/Digital Radiographic Data Analysis
October 29, 2018	Annual Conference Event: Oktoberfest at Saint Arnold's Brewery (Houston, TX)
October 28-31, 2018	ASNT Annual Conference: George R. Brown Convention Center (Houston, TX)
November 14, 2018	GHASNT Monthly Meeting: Bechtel Welding and Applied Technology Center (Houston, TX)
December 12, 2018	GHASNT Holiday Party: South Shore Harbor Resort (League City, TX)

FOR MORE INFO, PLEASE VISIT: [WWW.ASNTHOUSTON.COM/EVENTS](http://WWW.ASNTHOUSTON.COM/EVENTS)

## DON'T MISS THESE!

Upcoming GHASNT-Sponsored Events Proudly Held in Conjunction with the 2018 ASNT Annual Conference



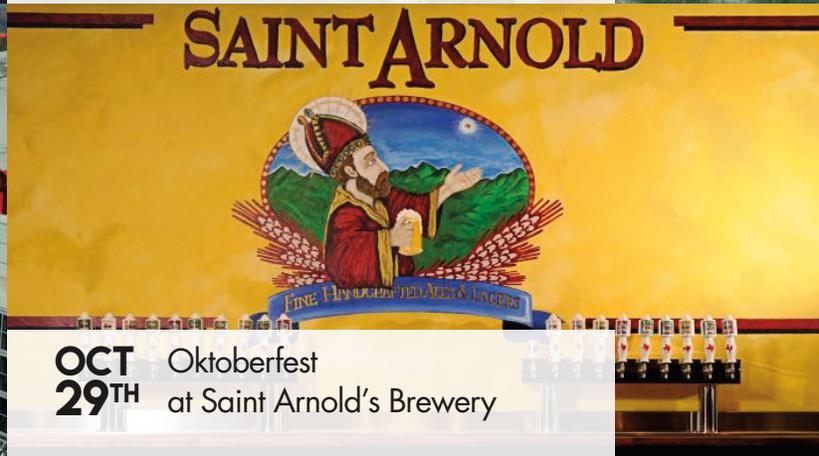
**OCT 24-25<sup>TH</sup>** Motorcycle Ride  
Houston to San Antonio, TX



**OCT 26<sup>TH</sup>** Tennis & Golf  
at Memorial Park



**OCT 28-31<sup>ST</sup>** ASNT Annual Conference  
George R. Brown Convention Center - Houston



**OCT 29<sup>TH</sup>** Oktoberfest  
at Saint Arnold's Brewery



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