NGV
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Natural Gas Fueling Station Technology Exchange XV

Summary of Proceedings
October 16 - 18, 2000
Orleans Hotel, Las Vegas, NV
Leo Thomason, NGVI, organizer
Hank Seiff, NGVC, secretary

Attending:

Tom Alexander, PG&E
Telesfor Barela, City of Mesa
Andy Brodehl, City of Monterey
Greg Dehl, Fleetstar
Chuck Dougherty, Puget Sound Energy
Mark Haught, Southwest Gas
Jared Hightower, Blue Fuels Group
Bob Johnsen, Peoples Energy
Jim King, Puget Sound
Gary Lengle, eFuels div of BC Gas
Dave Moniz, Providence Energy
Jerry Myers, SoCal Gas
Bob Reagan, WI Electric
Dale Sevy, Questar
Stan Sinclair, SoCal Gas
Jerry Smart, Trans Star Energy Co.
Terry Turner, INEEL
Clay Van Horn, BG&E
Carl Westenkow, Questar
Bruce Wilding, INEEL
Alan Wood, San Diego G&E
James Wood, AGL

Presenters (in order of presentation):

Rob Adams, Marathon Technical Services
Cliff Marsh, Anderson Greenwood Crosby
Anthony Pitts, Mercer Valve
Scott Leis, Detector Electronics
Larry Dobelbower, TGT
Doug Hume, Aztec Predictive Services
Hank Seiff, NGVC
Rajeana Gable, GTI
Tony Feger, Sulzer Compression
Neil Milburn, Henderson Intl. Technologies
Scott Spicer, Parker Hannifin/Finite Filter

Introductions

Leo Thomason explained that Technology Exchange allows organizations which own or operate networks of natural gas fueling stations to come together and share common issues of concern. Technology Exchange provides an organized way of melding together the knowl-

edge and experience of the industry, as well as providing an opportunity to build a network of contacts.
Technology Exchange has been funded by the Gas Research Institute (now the Gas Technology Institute – GTI) since 1995, allowing attendance with no costs or fees. Starting with this session, sponsorship is provided by the Natural Gas Vehicle Industry Infrastructure Working Group (IWG) which is funded by the Department of Energy and GTI and managed by GTI.

With funding from the Infrastructure Working Group we are able to record the proceedings of Technology Exchange meetings. They will be made available to attendees and to others, perhaps on the NGV Institute web site.

Attendees at the meeting introduced themselves and gave a short summary of their background and interest in NGV fueling stations.

Station Construction – Avoiding Major Pitfalls (See Attachment 1)

Attachment 1 provides draft Station Construction and Station Maintenance documents being prepared by Technology Exchange to assist fueling station designers, contractors, owners and operators to avoid problems in building and operating stations. The documents were drafted by Leo Thomason and the "Station Construction" document was revised at previous Technology Exchange meetings. A fourth "bullet" has been added on the first page to caution station designers to make allowances for incoming gas pressure to decline between the utility outlet and the compressor suction inlet (because of filters, dryers, length of pipe, etc.)

The group stressed the importance of station designers/builders working with the local utility so that their needs are understood and station components are specified based on actual inlet pressure, as that pressure can seriously affect station costs and efficiency. If possible, a guaranty of inlet pressure and/or flow should be obtained from the utility. Leo suggested publishing a Technology Exchange bulletin for station designers, spelling out what organizations should be contacted early in the design phase, what information should be collected, and, in general terms, how that information affects component specification and station design. Ultimately, all this information will be on the NGVI web site.

On the issue of adequate electrical service (primarily for electric motor driven compressors), the group suggested that station designers talk with the local electric utility before they start work. Extra conduits for future growth, proper conduit spacing to avoid electrical interference and proper grounding should also be considered.

Other issues discussed include the need for a final check to be sure everything is installed properly (before station startup), the level of information needed/wanted by code officials, and assuring that proper documentation of station components is provided to the owner/operator.

Leo will make appropriate changes and send a final draft to anyone who attended either of the last two Tech Exchange meetings. The group discussed ways the final document might be disseminated, including posting it on the NGVI and other web pages. Since the document is

being produced under IWG/DOE auspices, they will have to approve it and may also want to handle its distribution.

Station Maintenance – Avoiding Major Pitfalls (See Attachment 1)

This is a document designed to answer the question "What do I need to be concerned about in the maintenance area?" for owners/operators of fueling stations. Leo feels it needs to be further fleshed out and then discussed and improved, as was the "Station Construction" document. He stated that point No. 6, on having at least some of the maintenance done by in-house staff, is to ensure someone in your shop has some familiarity with the facility. He suggests one should not entirely trust maintenance to an outside contractor, but should take some degree of "ownership" of the facility.

The group suggested adding the following items:
- have a basic understanding of CNG
- check your safety shutdowns periodically
- communicate with others involved (e.g., vehicle users, gas utility, maintenance personnel)
- keep a maintenance log
- provide appropriate training for maintenance personnel and others involved

Bid Specifications (See Attachment 2)

Attachment 2 provides sample CNG station equipment specifications, including a one-page performance requirement, a more detailed spec mixing both performance and design requirements and a very detailed transit station spec. The Technology Exchange stresses that these are to be considered as samples only! Leo asked the group to submit a more complete performance spec which he can use as a sample. There will be no identification of the origin of any sample spec provided by Technology Exchange.

Fueling Station Best Practices (See Attachment 3)

Rob Adams of Marathon Technical Services reported that his organization has been awarded the Infrastructure Working Group (IWG) (see p. 11 below) contract to develop "CNG Fueling Station Best Practices." Attachment 3 lists the Tasks and Deliverables of the contract.

The objectives of the contract are to develop:
- natural gas industry CNG fueling station reference guides for a) cost-effective design and construction and b) generally accepted operation and maintenance, and
- materials documenting CNG fueling station code and regulation best practices for use by fire marshals and other code officials.

The project should be completed in an 18-month time frame.

Rob indicated he plans to use the Technology Exchange as advisors in the project. IWG will also appoint a project manager to work with Marathon to narrow and define the scope and format of the final documents. He asked what the group felt should be the topics listed in the

Design and Construction volume's table of contents and the following were suggested (listed in the order they were mentioned):

- underground stainless steel tubing in conduit – procedure
- origin/nature of NG
- codes and standards
- safety
- permitting process
- certifications
- limits of scope of document(s)
- resources for more information
- site plan/space requirements
- gas and power availability (talk to utilities)
- communicate with code people
- sizing/growth plan
- fill times/windows/recovery times
- fuel management
- definitions/glossary of industry-specific terms
- temperature compensation
- interface with operations personnel
- emergency plans
- IT involvement
- issues involved
    - sizing
    - contracts
    - components
    - construction
- Engineering firm
    - references
    - history
    - financials
- transit – very specialized
- how to contract for fuel purchase
- document
    - review process required to design station
    - section on construction, sizing, commissioning
    - section on on-site fleet
    - flow chart to guide users
    - remote located stations
    - special considerations
    - disclaimer
    - support companies
    - graded approach
- project flowchart (see BC Gas pipe procedure)
- defueling/venting

It was also suggested that Rob ask potential "Best Practices" users what might make their jobs easier.

The group suggested that a handbook and video or CD/DVD for fire marshals and code officials be based on NFPA 52 (CNG Vehicular Fuel Systems Code). It should also include requirements of the Uniform Fire Code, NFPA 30A (Code for Motor Fuel Dispensing Facilities and Repair Garages) and appropriate information from the earlier tasks.

The group felt that a specific CNG facilities maintenance upgrades handbook should also be a product of the program.

The following suggestions were made for the table of contents of the Operating and Maintenance Volume:

- no proprietary logic/controls
- thorough training
- technician selections
    - job description
    - responsibilities
- technical resources
- calibration procedures
- logs
- define required training
- lockout/tag out sop
- compressor maintenance
    - purging
    - venting
    - repressurization
    - restart
    - test
- pressure test
    - when it is needed
    - how
- safety audit

Pressure Relief Valves – Testing and Maintenance

The group discussed current practices in testing and/or rebuilding fueling station pressure relief valves (PRVs). The group generally agreed that PRVs are rebuilt and/or re-certified at least every five years. Re-certification of PRVs every five years is a requirement in California, according to Cal OSHA standards. No one could pinpoint any requirement for this practice outside California.

Some organizations indicated that, provided one has the proper skills and equipment, the valves can be tested and rebuilt in-house. They stressed the importance of keeping proper documentation that the work had been done. Others send PRVs out for testing or rebuilding because of liability concerns, even when it would be relatively easy to do the work in-house. $80/valve was mentioned as an estimate of the cost of having a valve rebuilt outside.

Tom Alexander stated that California no longer allows locking out the PRV to allow removal for rebuild or to check the valve without venting down the cylinder.

Pressure Relief Valves - Anderson Greenwood Crosby (See Attachment 4)

Cliff Marsh, Regional Manager for Anderson Greenwood Crosby, explained that Anderson Greenwood and Crosby merged about two years ago, hence the new company name. Attachment 4 provides a comprehensive guide to PRV terminology, design and usage.

Cliff said there is no ASME (American Society of Mechanical Engineers) requirement for PRV retesting. OSHA requires that one have some established testing program, but gives no specific requirements. The valve manufacturer cannot tell the user what to do, as it depends on the individual situation (dirty or clean gas, how often it operates, etc.)

Section VIII of the ASME code covers “unfired pressure vessels.” This includes the requirements for fueling station storage vessels and pressure relief devices. Forty-two of the 50 states have adopted section VIII as law. Cliff said that “Section VIII is the law and the National Board (of Boiler and Pressure Vessel Inspectors) is the cops.”

Cliff provided the following definitions:

Pressure Relief Valve – An all encompassing term for reclosing pressure relief devices. This includes “safety valves” (a reseatable valve designed for compressible fluid, gas or vapor service), “relief valves” (for non-compressible fluid, i.e., liquid), and “safety relief valves” (can be used for both gas and liquid). A “pressure relief valve” is a reclosing “pressure relief device.”

MAWP – Max allowable working pressure. A PRV can’t be set above this.

Later discussion with valve manufacturers and others failed to identify any requirement (other than CalOSHA) for retesting or recertification. See Anderson Greenwood Crosby and Mercer Valve presentations below.

MAOP – Max allowable operating pressure. A DOT term meaning pretty much the same as MAWP

Blowdown – The difference between the points at which the valve opens and then recloses. Rated in percent. If it opens at 50 psi and blows down to 47 psi, it has a 6% blow down. The less blowdown the less product you lose when the PRV relieves. There are adjustable and fixed blowdown valves.

Simmer is audible leakage prior to valve opening

Back Pressure is pressure on the discharge side of the valve.

All ASME adjustable valves will have a lock wire around the adjustment. ASME Section VIII says the PRV set pressure tolerance is plus or minus 3% for valves over 70 psig. Relief valve sizing information can be found in the catalog provided at the meeting.

Cliff demonstrated all of the valve types shown in Attachment 4, using a pressure tank, gauges, etc. He was assisted by Joe Steaffino of Blair-Martin, the local sales representative for Anderson Greenwood Crosby.

Safety Relief Valves – Mercer Valve Company (See Attachment 5)

Attachment 5 discusses the installation, design, testing and usage of Safety Relief Valves.

When discussing valve installation, Anthony Pitts, Application Engineer at Mercer, with assistance from Kirk Taylor, National Sales Manager, stressed the importance of keeping the outlet clear of liquid build up. He suggested a quarter inch weep hole in the elbow at the outlet, stating that some valves have their own drain holes drilled in. He also made the point that inlet and outlet piping to and from the relief valve must be at least as big as the inlet and outlet fitting. Restricted flow can lead to valve chatter when the valve cannot relieve as quickly as its design would allow.

Anthony also reminded the group to keep reaction forces in mind, particularly in outlet piping. When piping goes through a 90 degree bend, the flow of gas causes substantial reaction forces at the bend that could break the length of pipe off at the PRV. One must remember to properly support the outlet piping against these forces. A good idea is to put a “T” outlet at the top of the pipe, rather than an elbow, so reaction forces are neutralized.

Anthony indicated his valves would operate 50-100 times. If a valve starts to chatter, that number of cycles can be used up quickly.

Relief valve sizing software can be found on the Mercer Valve web site: www.mercervalvecompanyinc.com

On the issue of testing frequency, Anthony said no one has clear advice on preventive maintenance of relief valves. ASME says they have to be tested on regular intervals. OSHA’s 1910

policy talks about safety of people and manned work environments. It says retesting must be done at "documented intervals." He recommends testing in manned locations at least once a year. An organization he considers to have a very good test procedure tests at unmanned stations every two years, and at manned stations every year. In special cases (e.g., near a school) they test every six months. After three tests they look at each valve to see if valve/system needs to be tested more or less often. For example they review the valve appearance, history of past problems, etc. He would only recommend rebuilding the valve if it fails a test.

Relief valves can fail by blowing out the O-ring and then leaking. Mercer valves are designed without O-rings to avoid this. Other valves can fail when the guide system locks up especially if the valves are not mounted vertically. Pilot valves are famous for failing closed. Dirt can get past the filter screen into the pilot portion, which is a small area, and then the pilot can stick in normal position. Therefore, when a pilot valve is used, one must be sure it's in clean service. Mercer and others have a filter as standard equipment for pilot valves. If a filter is not provided, the user should be sure to install one.

Flammable Vapor Detectors – Detector Electronics Corp (Det-Tronics) (See Attachment 6)

Attachment 6 covers the application of flammable vapor detection and safety response systems, and the design, advantages and disadvantages of optical and catalytic detectors.

Scott Leis, Regional Sales Manager for Det-Tronics, recommended the use of the newer infrared optical gas detectors, which are more reliable and require less maintenance than the older catalytic bead technology as well as providing a "fail safe" solution. Optical detectors sense the presence of hydrocarbon gases, which are opaque to infrared light. These detectors do not require routine maintenance but should be checked with a gas in the light beam every year. Both point detectors and open path detectors are available. An open path detector's receiver and transmitter can be separated by up to 100 m (line of sight). Open path detectors are much more expensive than point detectors but can take the place of a number of point detectors. A proper shop system could include both types of detectors to be sure that potentially dangerous gas concentrations are not missed and to provide the most cost effective solution. Infrared optical systems have become less expensive over time and are now more popular than catalytic bead detectors.

Catalytic detectors should be maintained (calibrated) four times a year, as the catalyst wears out over time and may require recalibration. They also are not "fail safe" detectors. If a catalytic gas detector fails, the only way to verify that it has failed is to apply gas to the sensor. Therefore, it is likely that a failed sensor will go undetected until the next calibration takes place. Based on quarterly calibrations this could be as long as three months. The catalyst in the sensor generates heat, changing the resistance in the active element, when it comes in contact with a hydrocarbon gas. The hot catalyst has a flame arrestor to avoid an explosion. The devices are subject to impact damage when hit or dropped.

Water or ice can block the optics of an optical infrared detector, so they are designed with baffles to make a blockage difficult or impossible. An optical point detector is approximately 20% more expensive than a catalytic point detector.

Det-Tronics "Eagle Quantum" is a "total hazard management system" combining fire and gas detection with programmable logic incorporating hazard warning with a response system of the users' choice.

Station Operations – Tulsa Gas Technology (See Attachment 7)

Larry Dobelbower, Technical Specialist for TGT, provided Attachment 7 on his company's dispensers, but stated he was here to talk about station operation, not dispensers. He added that TST can assess your entire station, and troubleshoot your entire site.

Larry stressed that for new stations, one should specify good products. Specify what you need or the person who designs it for you may provide "stuff you don't want." He stressed "keeping things simple - don't come up with new ideas, go with what you know works."

Following the outline found in the attachment (underscored items are the outline topics), Larry stated that, with Fast-Fill, when storage is down you can directly fill from the compressor. The only true Direct Fill sends all volume directly from the compressor to the vehicle and only after the vehicle is filled can gas go to storage. Some "direct fill" systems don't do this – they send fill to storage and the vehicle at the same time, taking longer to fill up a vehicle. Direct Fill with No Storage means your system only starts up when a vehicle needs filling. If you fill a large number of vehicles at one time each day and you need little or no storage, this may work for you. Slow Fill is the most efficient, least cost method if you have vehicles stored at the same place for a period of time each day. If it fits your needs, "it's the way to go." How Many, When? – With fast fill the system has to be sized for the busiest period. A Combination of slow fill and fast fill may be best solution for your needs. It can provide a priority system handling fast fill first, then move to filling up storage with slow fill as the lowest priority.

Larry mentioned that "new" PRD regulations (introduced in the 1995 edition of NFPA 52) require a PRD in the dispenser to activate at 125% of service pressure. He stated that a 4500 psi PRD in a 3600 psi system will trip when high storage pressure hits it. Therefore "new" service stations subject to this requirement may need a regulator between storage and the vehicle if the PRD is regularly activated.

Discussing What Type of Compression Systems? it was pointed out that an Auto Alternation system is made up of two or more compressors which automatically alternate in use when both are not needed. Some people feel a need for Full Backup which provides total redundancy.

Larry was unable to locate a Compressor Sizing computer program, but indicated that it can be worked out long hand. Most people say that 35-40% of storage is the most that is normally used, at least with three banks. However, a lot of this utilization depends on the sequencing algorithm. Some systems won't take anything from the low-pressure cylinder if it's down to 2000 psi, but an empty vehicle can get a lot of gas from 2000 psi storage.

Is Your Compressor Utilized Properly? – If you normally fill up a certain size tank you have set your system up for that. Therefore it may be slow filling a bigger tank and overfill a small tank. If you have a need to regularly fill vehicles of various sizes, you could have two dispensers, for example, one for transit bus volume and one for pickup truck volume. If you try to fill all size tanks from the same dispenser there may be over- or underfills on off-size tanks.

The group suggested cut-off points between 70 and 120 hp for choosing an Electric Motor vs. Gas Engine Compressor Drive. Much depends on the relative cost of the prime mover, electrical service, hook up costs, and use cycle. It was stated that, if your compressor starts and stops often, you may be better off with an electric drive. Gas engines may require auxiliary heaters for fast start up and operation in cold conditions. Time fill may be a good use for a gas engine since the engine doesn't need to get up and running right away. In California permitting for gas engines can a problem because of emissions.

Larry said that he personally advocates Murphy equipment, for Control Systems and Operation. Various operational systems and methods of changing out one system to another were discussed. Larry feels that, for competent operations and maintenance people, complete, simple and usable access to the control program is most important, so that needed changes can be made. However this can be a disadvantage for inexperienced station operators.

Larry stated that "everybody" has a Fill Routine to try to achieve full fill, many of them modeled on GRI's Accufill. To properly work, Accufill requires that vehicles have in-tank pressure and temperature sensors to provide information to the dispenser. The group discussed the pros and cons of various filling algorithms and whether it was worth the cost to add tank sensors when necessary to most effectively utilize systems which require that information.

Larry said that we're seeing people get away from station Operations Strategy where they do all of their own maintenance. Often they do not have people on staff to handle major work or find that contract maintenance is more effective or less costly. The advantages and disadvantages of various levels of "self maintenance" were discussed.

The group also discussed the merits of Owner Operator vs. Purchase, that is, whether it is best to build and own your own station or contract with someone like Trillium, Pinnacle, or Pickens to build and operate the station, subject to a "take or pay" contract where you agree to purchase a minimum amount of fuel at a given cost.

Vibration Monitoring – Aztec Industrial Bearing and Supply (See Attachment 8)

Attachment 8 provides "A Basic Introduction to Vibration Analysis." Doug Hume of Aztec Predictive Maintenance stated that vibration analysis can be used to predict problems with any kind of rotary machine. A little over a third of bearing failure is caused by fatigue and much of that is caused by vibration. He suggested contacting an SKF distributor to get the catalogues: SKF Maintenance Tools – 711-639, and Bearing Installation and Maintenance 140-710.

Doug demonstrated a small hand-held unit, the SKF Marlin, which can be used to measure vibration and infer bearing damage. The Marlin uses a "stinger probe," or headphones can be plugged in and it can be used as a stethoscope. It measures acceleration envelope, acceleration and velocity. Settings for different frequency ranges can detect different problems. To determine when a vibration problem is leading to bearing failure, readings from a number of similar machines can be compared or periodic readings can be taken on the same machine, and "outliers" identified.

The complete Marlin kit is around $1100. Doug suggesting taking readings where there are bearings on rotating machinery (for example, at both ends of the main shaft on bearing end caps). Radial vibration readings should be taken on the bottom third of the bearing as that part sees most of the load. Axial vibration readings should be taken near the outside center of the bearing end cap. This analyzer can detect vibration-caused misalignment of machinery and is often used for that purpose by Aztec.

In reply to a question about how much lube should be put in a bearing, Doug responded that one should avoid relubricatable bearings. Bearings can fail from over lubrication as well as under lubrication. He mentioned a study showing 300% longer life from non-lubricatable bearings. Potential problems include using the wrong amount or type of grease and introducing dirt into the bearing.

Recent Incidents/Codes and Standards Update (See Attachment 9)

Attachment 9 summarizes four recent NGV "incidents," provides a brief update on NFPA and IFC codes, and summarizes four cases where LPG vehicles were fueled with CNG (with catastrophic results). Hank Seiff, Technical Director of the Natural Gas Vehicle Coalition, discussed four NGV "incidents" which had taken place since the last Technology Exchange meeting. They ranged from a PRD leak on a transit bus with no injuries or damage to the explosion of a vehicle being prepared for crash testing by a Transport Canada contract lab in Blainville, Quebec with three fatalities. This tragedy was apparently caused by using compressed air (rather than an inert gas) to purge a cylinder, allowing an explosive mixture to be ignited. Fueling stations were not involved in any of these incidents.

The 2000 edition of NFPA 30A, now named "Code for Motor Fuel Dispensing Facilities and Repair Garages" has been published. Whereas the old 30A did not apply to stations dispensing gaseous fuels, the 2000 edition applies when both gaseous and liquid fuels are dispensed at the same station. In response to a question, Hank assured the group that an earlier proposal to require a 20-foot separation between gaseous and liquid fuel dispensers had been removed from the standard.

Hank mentioned that an OEM representative had expressed concern about the limited number of public CNG stations available to fuel its light duty vehicles. He also wondered if there was a need for formal courses on the proper design of NGV maintenance facilities or changes necessary when these facilities are opened to NGV use.

Finally, Hank pointed out that there had been four international incidents this year where LPG vehicles had been fueled with CNG, with the predictable result that the LPG tank exploded. Although an LPG receptacle will not accept a CNG nozzle, some in the group knew of cases in the US where people had tried to fuel propane vehicles with CNG. The group discussed potential ways to discourage those who were determined to ignore posted notices that CNG was being dispensed and use adapters specifically designed to thwart safe connector designs. They agreed to monitor the situation to determine if this becomes a potential problem in the U.S.

GTI Sponsored Fueling Station Projects (See Attachment 10)

Attachment 10 explains the restructuring of GRI and IGT into GTI, reviews good and bad times for NGVs in the past 12 years, and discusses GTI's commitment and program strategy. The attachment also reviews specific NGV programs underway and planned by GTI.

Rajeana Gable, GTI's Director of Natural Gas Transportation Technology, explained the merger of GRI and IGT into the new entity GTI. She brought a message from GTI management to the committee, stating GTI's full commitment and support to organize the industry's agenda for NGV R&D and R&D funding, to maintain, grow and invigorate the transportation program. This work will be done under the leadership of Bill Liss as Rajeana is leaving GTI soon.

In response to a question, Rajeana said that the "Best Practices" for NGV fuel systems documents are being completed by Battelle and should be published very soon.

Information on the Infrastructure Working Group (IWG), which is a joint GTI/DOE activity, can be found on the IWG web site, www.gri.org\iwg. Many of the programs of greatest interest to Technology Exchange attendees are being performed by the IWG. A list of these programs can be found in Attachment 10.

The ***Directory of U.S. Natural Gas Vehicle Fueling Stations*** will continue to be updated with IWG funding and be published and available on DOE's AFDC web site. The Directory will most likely not be published elsewhere, unless the NGVC chooses to provide hard copies.

Next Meeting Location and Agenda Focus

Leo Thomason had originally scheduled the next Technology Exchange meeting for February 26-28, 2001, in Las Vegas. However, after some discussion it was decided that we would try to have the meeting near that time in Dallas to allow tours of fueling station facilities in the area. Leo will follow up on the large number of potential agenda items the group suggested.

Sulzer Compression and Fueling Station Equipment

Tony Feger, Product Support Manager for Sulzer Compression, reminded the group that Sulzer is a compressor packager as well as a manufacturer of specific products, such as compressors, dispensers, controllers, coolers, Henderson heat exchangers, etc. Sulzer Compres-

sion is a division of a Swiss company which makes weaving equipment, controls, medical equipment, industrial valves, and rotating machinery (incl. compressors).

Sulzer manufacturers “W” configuration “CU” and “CT” compressors with capacities of up to 400 and 1000 cfm respectively. At the Richardson, Texas plant NGV products and packages are assembled and valves are remanufactured. Tony also mentioned that the FuelMaker compressor was originally a Sulzer design.

Tony stressed that Sulzer systems are Met Lab certified. This can avoid hassles from inspectors on electrical issues. The compressor is now certified and Sulzer is about 30 days from achieving dispenser certification. The dryer, which is purchased from Xebec, does not have the Met Lab mark, but eventually all dryer manufacturers will have that too. The certification concerns mainly shock hazards but also includes NFPA 52 as well as NFPA 70.

Sulzer compressors generally use one more stage than is really necessary. This adds cost but lowers gas temperatures and therefore valve temperatures and ultimately lowers wear.

In response to a question, Tony said it was standard operating practice to have both high and low voltage inside a control panel. Their panels have a touch screen for on-site settings and control, and also include a modem inside for remote monitoring and control. However additional software (NGV View - for around $2500), which can be operated from a normal PC, is required to do remote work.

The top compartment of a Sulzer dispenser is “x-purged.” Before the unit can be powered up the fan purges the volume of the cabinet 10 times and then maintains a positive air pressure in the cabinet. This avoids the need for explosion proof components. Sulzer dispensers also provide for installation of a CRIND card reader in the upper dispenser. Micro Motion flow meters are used in light duty car and truck dispensers and Enderess Hauser meters in bus dispensers.

ASME storage vessels are pretty much the only storage vessels used now. This is apparently because only visual inspection is required, whereas DOT cylinders require hydro testing every five years. He believes there is an ASME requirement for PRDs to be removed every five years for inspection (see footnote on p. 5).

Tony discussed the new DM compressor model which is totally oil free with a magnetic drive (rather than shaft or belt drive) to cut maintenance and leakage. It has a capacity of 20-70 scfm, an inlet pressure down to inches of water and a low noise level. The cost will be around $80,000 and there is a 2000 hour guarantee for the head.

There is also a new dispenser coming. It meets ADA requirements, has a monochrome screen readout for the customer, uses Parker O-ring face seal fittings, and features simplified plumbing with a multi-function valve to increase reliability.

Heat Exchangers – Henderson International Technologies (See Attachment 11)

Attachment 11 contains two sections on heat exchangers: a comprehensive PowerPoint presentation and a Word section explaining the PowerPoint slides. The presentation includes the basic physics of compressor operation, an explanation of why and how much heat is introduced during compression, the "balancing act" of a heat exchanger in removing heat, controlling pressure drop, device size and cost, the types and advantages and disadvantages of air and water cooled heat exchangers, Henderson's standard air cooled heat exchanger design, heat exchanger problems, methods of field repair, and noise control.

Neil Milburn, Operations Manager, explained that Henderson is now wholly owned by Sulzer, which bought 51% four years ago and other 49% last year. They operate out of Sulzer's Richardson, TX facility.

Henderson was formed by the Henderson family in the '50s. They started in the oil field business and in the '70s bought old missile silos to get the cryogenic vessels. From there they went into the air separation business. They found available compressors to be unreliable so they built their own, primarily for specialty industrial gases. They now have 80-90% of the North American market for Helium compression. On the Space Shuttle helium is used to purge hydrogen tanks.

With the CNG business increasing, Henderson has changed their method of constructing skids to a modified assembly line. Construction should now take 10 days from start to finish compared with 21 days using the older "cell type" construction.

Henderson builds approximately 20 times more air cooled heat exchangers than water cooled. They have made no water cooled heat exchangers for NGV use, although they could. They use mono-slab air heat exchangers for most NGV compressors (mono-slab describes the header which is made of one piece of metal). For the new Sulzer DM compressor they use finned tubes, but that cfm size is about the limit of the finned tubes' capacity.

A four stage CNG heat exchanger sells for about $8K. An equivalent water cooled heat exchanger would cost around $20K.

Heat exchanger tube leakage is generally an age-related issue – a unit would have to be 5-10 years old and then it's a combination of vibration, corrosion, etc. which causes the leakage. He can't remember failures on NGV coolers.

They're seeing NGV machines now going into the retail environment (rather than industrial) where they need lower noise levels, like the DM which records 65-70 dBA at one meter. Ninety percent of system noise comes from the cooler fan. Low noise level is a selling point of Henderson heat exchangers as well as Sulzer compressors. He suggests the future benchmark will be 70-75 dBA at one meter.

The group discussed the merits of repairing heat exchanger leaks as shown in the Attachment. Neil made the point that their heat exchangers are over-designed so they do the job when

tubes are dirty or it is necessary to plug one or more tubes to control leakage. Henderson recommends either a mechanical or hydraulic method of rerolling/expanding tubes in the header to cure leaks. Tubes can also be plugged off if leaks cannot be easily repaired otherwise. Tubes in Henderson heat exchangers can also be replaced in units of four with their rerolling (expanding) tool used to mechanically seat the ends in the header. That mechanical bond holds up to 7000 psi.

Filtration Technology – Parker Hannifin/Finite Filter Division (See Attachment 12)

Attachment 12 covers Parker Hannifin's corporate products, filtration facts and definitions, specific concerns for CNG filtration and information on filter types and installation. It also includes information on Finite's manufacturing processes, filter efficiency theory, operating considerations, applications and maintenance. Scott Spicer, Market Sales Manager for Finite's Filtration and Separation Division explained that Parker had bought out Balston so Parker is now the world leader in CNG filtration technology and sales. His division is called the "Filter and Separation Division." At the present time they will continue to sell both brand names of filters.

Scott explained that "aerosol" is often confused with "vapor." An aerosol is under 10 µm (micrometer = micron) in size and can be any liquid or solid particle suspended in the gas (e.g., mists, clouds, dust). The depth media of a coalescing filter is required to remove an aerosol. Coalescing filters also remove free water and oil. However, coalescing filters don't easily tolerate more than 50 ppm of liquid.

Water vapor has to be removed by suppressing the dew point. A particulate filter protects the compressor from solid particles.

Coalescing filters need to be drained daily. When they are drained (blown down) one should be careful not to "spike" a high pressure drop - so open the drain valve slowly. A gauge can be used to monitor differential pressure across the filter to determine when it is necessary to drain it. A session participant stated that draining the filter can be a problem. When it is opened the oil doesn't flow out. Using a pressure differential to spit out the liquid can destroy the filter element. Scott says that, yes, it can be hard to do and is an ongoing issue.

Filter element life is not generally affected by the amount of liquid collected (which should be drained), but by particles which can clog the filter, therefore requiring periodic filter replacement. Scott said that Finite's "UNI-CAST" design holds more particles and lasts longer than competitors.

Open Discussion

TCM (Twentieth Century Machine Works) Non-Lubed Compressors - Tom Alexander discussed short ring life, high cylinder temperatures, short packing life and high maintenance cost problems seen with TCM non-lubed compressors. TCM has been bought by Gardner Denver. A system of injecting lubricating oil into the cylinder inlet piping in each stage, after the intercooler, has been developed. Tom and Dale Sevy believe modifying the compressors in this

way is a solution to the problems described above. A modified TCM compressor has operated successfully so far for 611 hours. They are using Royco oil and Parker filters and dryer cartridges. The exact amount of oil added and how it affects oil carryover is unknown but they are watching filters for excess oil carryover and will add additional filtration if needed.

The unit is being sold as "Mini Lube for TCM Compressors" by TGT. See the last three pages of Attachment 7 for more information.

APTA Alt-Fuel Committee Questionnaire – Hank Seiff asked the group what questions might be useful in a questionnaire Jeff Clarke (of NGVC) is drafting for APTA's Alt-Fuel Committee. A large number of responses were received and subsequently turned over to Jeff.

Frequency of Visits to Unmanned Stations - Alan Wood asked whether visiting stations twice a week is too often? Tom Alexander replied that once or twice a week is appropriate, depending on station type and amount of load. Gary Lengle says he checks every two weeks. eFuels has public stations and they also use remote monitoring which they check each day. Cytek software is used for all their stations. The group discussed the costs, advantages and problems of remote monitoring and its applicability to various types and ages of stations. Gary said that eFuels goes to remote monitoring when they upgrade stations, as a step toward meeting their goal of cutting maintenance costs. With manned stations he can ask a person at the site for details when he monitors a problem. This often allows for quick repairs and restarts. eFuels promises 24 hour service as a marketing tool for their stations.

Attachments:

1 – Natural Gas Fueling Station Construction – Avoiding Major Pitfalls
Natural Gas Fueling Station Maintenance – Avoiding Major Pitfalls
2 – Bid Specifications
3 – Fueling Station Best Practices
4 – Anderson Greenwood Crosby – Pressure Relief Valves
5 – Mercer Valve Co. – Pressure Relief Valves
6 – Detector Electronics Corp. – Gas Detection Systems
7 – Tulsa Gas Technology - Station Operation
8 – Aztec Industrial Bearing and Supply - Vibration Monitoring
9 – Recent Incidents/Codes and Standards Update
10 – GTI Sponsored Fueling Station Projects
11 – Henderson International Technologies
12 – Parker Finite Filters