FLARE, KNOCKOUT DRUM
and
FLARE GAS RECOVERY SYSTEMS

The Last Line of Defense
in Emergency Relief and Depressurisation

Manchester-UK- 23 – 27 July 2007
Introduction

Refinery and offshore flare systems represent the last line of defence in the safe emergency disposal of unwanted products released from emergency relief or depressurisation systems. It is vitally important that the flare system is well designed and maintained to achieve safe operation under all circumstances with acceptably small environmental impact. A survey of the typical arrangement of various flare systems, identifying the purpose and importance of each component, is followed by an examination of gas combustion, air requirements, excess air and the how combustion affects emissions. The differences between ground and elevated flares and their typical construction is explained including the various types of elevated flare tip. Methods of combining ground and elevated flares into an integrated system are reviewed together with staging systems to ensure steady operation as flare load changes. A group exercise looks at optimizing the operation of an integrated system.

Techniques for achieving good smokeless operation on elevated flare tips, such as air-blown, steam injected and sonic flares are reviewed and contrasted. Performance in terms of radiation, noise, emissions and utility requirements are identified together with their effects upon personnel and adjacent facilities. Trade-offs between elevated flare stack height and sterile area size are considered via a group risk assessment exercise.

Liquid knockout facilities are examined and appropriate system requirements identified to prevent liquid carryover to the flare. Liquid disposal methods and the appropriate target levels for maximum carryover drop size are presented. The effects of liquid carryover on various flare types are considered.

Seal pot systems, often used in flare staging, are considered and alternative methods of providing and disposing of the seal water are compared. The uses and advantages of seal pots are reviewed.

Systems for flare gas recovery are examined and types of compressor are compared. The need for elevated flare stack purging is considered and alternative approaches using fuel and inert gases are compared. The economics and recommended sizing of the flare gas recovery system are studied via an extended group exercise.

At each stage of the course, recommendations regarding essential maintenance and repair of the components of the flare system will be developed.

Throughout the course the relevant contents of established specifications for flare systems, such as API 520 and API 521, will be developed and related to the balance of the course content.

Course Objectives and Key Benefits

Understand the typical arrangement of a refinery and an offshore flare system
Know how the air requirements for combustion are calculated and provided
Understand the staging arrangements of flare systems and how this staging is achieved
Recognise the various types of elevated flare tip and understand how they operate to achieve the necessary performance
Be aware of the effects of radiation, noise and emissions on personnel and adjacent equipment
Understand the need for and the methods of achieving adequate liquid knockout in flare systems
Know how seal pots work and understand the options for seal water systems
Be aware of the use of compressors in flare gas recovery systems and understand the potential economic savings which such a system can offer
Understand the maintenance and repair needs of an efficient flare system
Be aware of the recommendations of standard flare system specifications such as API 520/521
Who Should Attend

Operations personnel who are involved in the use of the flare and/or who rely upon the flare system to safely dispose of unwanted releases
Design engineers who are involved in the design, modification or repair of the flare system
Maintenance personnel who are involved in or responsible for the routine maintenance of the flare system
Safety engineers who are involved in the continuing assessment of the flare system as a safe means of disposal
Environmental engineers concerned with emissions and the effect of noise and radiation on personnel.

Approach

The course will include a number of workshops and case studies drawn from the oil, gas, chemical and petrochemical industries with maximum candidate participation throughout. Candidates will be assessed on a regular basis through exercises and question and answer sessions and the results will be used to fine-tune the program as it progresses.

Course Outline

Day One:
Function of a Flare System
   Equipment and vessel relief valves and the need for a disposal system
   What do we want from our disposal system?
Components of a Flare System
   Collection main, liquid knockout, back pressure control and disposal
   Group exercise: Develop a performance specification for the total flare system
   Requirements of each item for satisfactory performance
Introduction to Combustion of Gas Mixtures
   Typical components, heat of combustion, air demand and combustion products
   Total flare load, total heat and flue gas emission

Day Two:
What do we get out of the flare?
   Possible emissions from the flare system: Radiated heat, smoke, particulates, downwind pollutants, un-burnt hydrocarbons, noise
   Possible steps to minimise environmental impact
   Dangers to personnel and limits on emissions
Types of Flare
   Ground and Elevated flares – Construction and Operation
   Combination to form an integrated disposal system
   Staging to achieve back pressure control
   Group exercise: Develop a staging policy for an integrated flare system
Day Three:

Elevated Flare Types
- Burn pits, pipe flares, steam injected and air-blown, sonic flares – performance and typical application
- Radiation, noise, emissions and utility requirements
- Constraints on flare height and types of tower

**Group Risk Assessment** – Minimum flare height for safe operation
- Ignition and flame monitoring systems
- Smoke and emissions monitoring
- Radiated heat and sterile area requirements

Day Four:

Liquid Knockout
- Knockout pots – types and typical construction
- Vertical vs. horizontal – advantages and disadvantages
- Target sizes for maximum droplet size
- Disposal of Liquids

Seal Pot Systems
- Back Pressure control as a prelude to flare gas recovery
- Seal Water systems to maintain the seal
- Minimum purge rates on elevated flare stacks not in use to prevent oxygen ingress

Flare System Maintenance
- Crucial role of the flare system for safe operation
- What can we do between shutdowns?
  - **Group exercise** – How can we make our flare system more easily maintainable while the refinery is on stream?

Day Five:

Flare Gas Recovery
- System Requirements – equipment arrangement
- Types of compressor
- Methods of capacity control to ensure safe operation

**Group Exercise** – Review of the economics of alternative capacities of flare gas recovery system to identify the optimum solution

Certification

On course completion, attendees will be issued with a certificate testifying to their understanding and assimilation of the training. However, MidWest Oil & Gas Engineering reserves the rights not to issue certificates to candidates with poor attendance rate and those judged to have not understood the training. This is done through regular questionnaires and group exercises.
Dr Malcolm J Leach BSc PhD CDipAF CEng FIChemE

Dr Leach is a chartered engineer and a fellow member of the Institution of Chemical Engineers who has been involved in the international oil, gas and petrochemical industries for over 35 years.

During the past 5 years, Dr Leach has been a senior consultant with MidWest Oil & Gas Engineering specialising in Process Engineering, Combustion Systems, Safety Systems and the design and commissioning of process plants, including combustion, distillation, heat transfer, boilers, heat exchangers and other process related equipments.

Recently, Dr Leach was assigned to commission and re-start an oil upgrading facility in Venezuela that was badly damaged by fire. He was also involved in the commissioning of onshore facilities on a gas reception facility in Ireland taking natural gas from an offshore platform. Other projects Dr Leach has been recently involved with include the troubleshooting of a crude oil heater in Wafra, Kuwait, Area classification and relief system design to new ATEX requirements for Clariant UK and the explosion investigation of a sludge dryer at Afon WwTW, UK.

During his long and distinguished career, Dr Leach has worked for companies such as BIRWELCO, a global supplier of refinery fired heaters and flare systems where he held the roles of technical manager and operations director responsible for a team of about 60 engineers specialising on thermal equipment such as fired heaters, high intensity crude distillation units, ethylene crackers, steam reformers, heat exchangers and many more other equipments. He was also engaged on proposal generation and project management of contracts in excess of $80 millions. He expanded activities to territories that included Kuwait, Saudi Arabia, Egypt, UAE, Japan, South Korea, Malaysia, Philippines and Greece.

Dr Leach was behind the task force that designed and commissioned a large energy from waste facility (1200 tonnes/day) generating 30MW of electricity in the UK.

Dr Leach has also worked for EXXONMOBIL Chemicals as Process lead technical manager on all ethylene craker units with responsibility for P&ID, hydraulic checks, instrument and equipment specification. He was the principle point of contact for all interaction with clients technical groups in Baylow Texas. Other companies he worked for include:

**Foster Wheeler**: Senior development engineer

**BP Chemicals**: Specialist design engineer responsible for design, commissioning and troubleshooting of all distillation and heat transfer equipment.

While with MidWest Oil & Gas Engineering, he has been assisting a number of British clients with the implementation of the new UK regulations for Dangerous Substances and Explosive Atmospheres (DSEAR 2003) which becomes a statutory requirement in mid 2006.

During the past few years Dr Leach has been using his knowledge transfer skills and experiences as a visiting lecturer at a leading UK University to develop new training techniques and materials for the industrial world.

He has delivered training on specialised subjects to many international companies in the UK and abroad.

Dr Leach is an accomplished speaker who is frequently asked to speak at international meetings and conferences. This is reflected by the number of peer reviewed publications he has written.
REGISTRATION FORM
Please use a separate form for each attendee

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Cancellations
For written cancellations received at least 2 weeks before class start a credit for future courses will be offered, less GBP 240 processing fee. Substitutions are welcomed. Full fee is charged for cancellations less than two weeks before the starting date.

Accommodation is not included in the course fee, but MWO&G Engineering negotiate a discounted rate with a number of hotels. If you require this service, please check the box.

Schedule
Course registration will be at 08:30 on first day. Course start at 09:00 prompt. Refreshment breaks will be at appropriate times.

Course fees will cover for faculties, tuition, complete course materials, practice exercises & workshops, evening consultations and daily refreshments.

MWO&G reserve the rights the change faculty or/and venue.

Dedicated Registration
FAX LINE
00 44 (0)7075707602

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