Stronger than a pipeline, but still flexible – as close as you can get to a pipeline connection

EN1474-1:2009: The latest standard for LNG Transfer Arms and Swivel Joints on onshore terminals

Robin Boot, Kanon Loading Equipment BV, Zeewolde, The Netherlands

Introduction
The transfer of fluids from a storage facility to a tanker vessel always includes a flexible part. This flexible part is needed to follow the ship's movements in the horizontal plane, like drift and sway, and in the vertical plane as a result of the water level.

Marine loading arms with swivelling joints provide a fully rigid but flexible connection, offering almost as much reliability as a fixed pipeline connection.

In order to replicate the benefits of a rigid pipeline connection between ship and shore, the mechanical design of the Marine Loading Arm (MLA) (MLA) and the performance of the swivel joints are crucial. For liquefied gases, improving reliability and safety becomes more and more important.

In addition to existing standards like the OCIMF1999, the Technical Committee CEN/TC 28 ‘Installation and equipment for LNG’ has prepared the Euro norm EN1474-1:2009 for designing and testing marine transfer systems. According to the CEN/CENE: EC Internal Regulations, all EU countries are bound to implement this European Standard.

Swivel qualification against the EN1474-1:2009
What does the latest standard mean in terms of the design of swivel joints in transfer arms? Until recently, swivel joints in general were qualified against the OCIMF guidelines, including liquefied gases like LPG and LNG. The EN1474-1:2009 standard has governed LNG applications since January 2009.

There is a lot of similarity between the OCIMF 3rd edition 1999 and the EN1474-1:2009 when comparing the load test criteria for swivel joints. The OCIMF distinguishes ‘General Liquid’ and ‘Liquefied Gas,’ whereas the EN1474 is written specifically for LNG application.

We will view the load test requirement, since the strength and leak tightness are the first features to be tested.

Swivel joint loads can be combined in a so-called ‘combined swivel design load’ (OCIMF) or ‘test load combination’ (EN1474), which is a combination of axial force, radial force and bending moment. This is also known as the \( P_{CA} \) value.

Both standards include a four-stage load test, each with a factor (OCIMF: Test Load Factor or EN1474: R-factor) to multiply the \( P_{CA} \) value.

During and after the first two stages, with a factor of 1.5 and 2.0 plus the internal pressure, the binning of the ball races and leakage are measured. Stage three and four are meant to test the mechanical limits, regardless of eventual leakage and damage. No structural failure should have occurred after these stages.

Both standards do not determine the \( P_{CA} \) value for this test, but a reasonable value would be 600 kN for a 16-inch swivel joint, which is specified in the dynamic test part of the EN1474. Taking the 600 kN as \( P_{CA} \) value will result in test load combinations of 900 kN, 1200 kN, 2100 kN and 2400 kN respectively.

These values are extremely high and a swivel joint that can withstand these loads without leakage or damage will definitely prove to be strong and reliable. However, when it comes to swivel joints for cryogenic applications, the choice of materials is limited to stainless steel, and no ball race greasing is possible at all. This provides a real challenge for any swivel joint supplier determined to comply with the latest standards.

MLA Design
In the transfer of liquids between vessel and shore, an MLA offers a significant improvement over hose. It provides an easier and more ergonomic operation, gives longer service life and permits Emergency Release Action without any spillage of product or pollution. Because of the high weight of the steel piping, the piping must be balanced with a counterweight.
 Convenient operation and cost of ownership are important factors and they have everything to do with the MLA design. A clever, well-thought design will optimise the design in such a way that maintenance-requiring cables and wheels are eliminated, and only one rotating counterweight is needed for both moving pipes (see Figure 1.)

The basic structure can be either designed with self-supporting piping or piping attached to a support frame:

**Self-supporting product piping**

When swivel joints are strong enough to take the relevant forces, depending on the product and structure, the product piping can be made self-supporting. This eliminates the need for a separate support frame. Any reinforcements will be welded to the product piping to prevent bending and to achieve the required stiffness.

**Product piping attached to a support frame**

This is an original design from the early days of MLA's some 60 years ago, when swivel joints could not be made strong enough to support the weight and forces of the construction in combination with the product loads, due to pressure and temperature.

This is certainly not the most efficient type of MLA in terms of steel for the support construction and natural resources needed for production of redundant steel, bearings, greasing and so on. Nowadays, there are only two cases where a support frame cannot be avoided: Cryogenic applications like LNG, and highly corrosive liquids.

**Symmetrical design**

The symmetrical design equally divides the mechanical forces on the swivel joints and within the MLA structure itself. In addition, the symmetry reduces the bending moment on the jetty due to dead load to almost zero. Kanon launched MLA's with a fully rigid and symmetrical design approximately 10 years ago, and they have proved their reliability over and over again. This makes them especially suited for extraordinary applications like cryogenic purposes, oversized dimensions and mounting on moveable carts and floating jetty.

Symmetric MLA for LNG and Swivels complying with EN1474

Combining the rigid pantograph connection with a symmetric support device, a configuration can be achieved where the best features of both are combined. Figure 2 shows the principle design. The support frame is located in the middle of the two inboard arms and supports the outboard arm on two sides.

This arm in combination with swivels, which have been successfully tested against the preEN1474:2005 norms, will increase reliability of the mechanical parts and minimum swivel maintenance. Swivel joints of older types might be field-proven, but they would need regular maintenance and may not be able to withstand today's strength testing requirements.

Kanon design

Kanon completed the load tests Stage 1 and Stage 2 with no leakage or visible damage (brinelling) of the ball races. Although leakage and brinelling did not need to be measured, the load tests at Stage 3 and 4 were completed with the same results of the Stage 1 and 2. All tests were witnessed and certified by a third party (Lloyd's).

The strength of the Kanon LNG swivel joints results from the double ball race design, the choice of materials and a special shape of the ball races. The joints are machined in one piece with ultra-high precision and no after-treatment whatsoever. No grease, graphite or any other lubrication is even permitted, and no replaceable parts except for balls, seals and o-rings are needed.

Kanon Loading Equipment BV has developed a unique and ultra-modern swivel joint that can easily meet the most stringent norms, thus providing an unrivalled reliable and secure way of handling LNG through marine loading arms.

This particular swivel joint design in combination with the well-known and highly reliable symmetrical marine loading arms will definitely set a new standard in reliable LNG transfer arms.

ABOUT THE AUTHOR AND COMPANY

Robin Boot is Sales & Marketing Manager at Kanon Loading Equipment BV who joined in 1999.

Kanon is a first-class supplier of marine loading arms and the only manufacturer of marine loading arms with innovative symmetric design.

ENQUIRIES

Kanon Loading Equipment BV
Edsonweg 27, 3899 AZ Zeewolde
The Netherlands

Tel: +31 (0)36 521 9777
Fax: +31 (0)36 521 9770
Email: rboot@kanon.nl
Web: www.kanon.nl

134 Port Technology International
KANON TO SET A NEW STANDARD FOR LNG MARINE LOADING ARMS

Being the only marine loading arm manufacturer in the world to fully comply with the latest and most stringent load tests combined with leakage tests according to European Standard EN1474, which became effective in 2009, Kanon reports a successful testing of its LNG swivel joint, even beyond the requirements.

Swivel joints are the most critical components of every loading arm. Especially for LNG transfer, the requirements with regard to strength and leak tightness of swivel joints have become more stringent throughout the years, ending up in last year's EN1474-1:2009. This standard is additional to the already existing Oil Companies International Marine Forum (OCIMF) guidelines for marine loading arms. Kanon has completed all four stages of load tests with no leakage and no visible damage (brinelling) to the ball races. The load tests were witnessed and certified by third party Lloyd's

KANON Loading Equipment BV has, no doubt, developed a unique and ultra-modern swivel joint, which can easily meet the most stringent norms, thus providing an unrivalled reliable and secure way of LNG handling by marine loading arms. This particular swivel joint design in combination with the well-known and highly reliable symmetric marine loading arms will definitely set a new standard in reliable LNG transfer arms.

www.kanon.nl

Symmetric Design for Excellent Performance