30 YEARS OF TANK CONTAINERS AND SWAP TANKS

This presentation was originally presented by Jaap Huigen[1] of Sea Containers and was written in collaboration with Bob Fossey of C.P.V. Ltd. This document recounts some of the tank container industry's thirty-year history and hopefully comes up with a near enough answer to at least three questions:-

1) Who were pioneering design and manufacture of tank containers and was there perhaps any particular company or individual that could claim to have been there first?

2) Which were the main catalysts that brought inspiration to try and develop 20ft ISO tank designs to like minded people in the end-sixties early-seventies?

3) The significant plateau's in the design and use of tank containers.

I will touch on a few design aspects, and finally I will briefly speak about valves and fittings. I must tell you that it will be a bit of a helicopter view with the limited time available.

Some thirty years have gone by since the very first tank containers with frame dimensions in accordance with ISO 668 were designed and manufactured. Thirty years of experience that went into tank container design, valves, fittings and integral systems such as those for heating and cooling, has culminated into a product with a second to none track record in terms of safety, versatility, reliability and cost efficiency.

To trace the industry's roots, I would like to take you back to 1964 when a young and rather enterprising engineer, Bob Fossey, worked for Willimas Fairclough in London. In that year, young Fossey had recognised the potential for both intermodal and multi-modal container tanks. He started off designing swap tanks to be used for combined road-rail transport, the reason being that at that time in the UK, railway equipment did not yet conform to ISO standards.

Commercial production at Williams Fairclough for those swap tanks started two years later in 1966 and the design of the very first ISO tank, a beam type, followed in 1967. The first series of those tanks were purchased by yet another pioneer which was tank container operator Trafpak, then owned by Dutch conglomerate Pakhoed in 1968. Interestingly, these tanks would later become Sea Containers property when it bought Trafpak in 1986.

The standardisation of corner fittings around 1968 now known as the post-moscow corner casting appears to have removed the last technical obstacle which cleared the way for a number of companies to design and build prototypes for tank containers in preparation of commercial production. Blair transport technology in the UK was one of the first manufacturers that supplied the post-moscow corner fittings in accordance with ISO 1161.

1 Jaap Huigen has been working for Sea Containers and GE SeaCo since November 1994 as Regional Tank Manager FE

Hot on the heels of Williams Fairclough came:-

- Gloster Saro who produced GRP tanks and Butterfield in UK, specialising in tanks for liquefied gases, corrosives and toxic substances.

- Coder, France

- Joseph Graaf and Luther Werke, Germany

- Holvrieka, Netherlands and

- Morteo Soprefin and Acerbi, Italy

Design and commercial production of some proportion only began in 1970, when Bob Fossey joined Containers and Pressure Vessels (CPV) in Clones, Ireland and introduced it's first light-weight beam tank design, and the first dedicated production line for tank containers.

Sea Containers who already had established itself as a lessor of specialised marine containers would become one of CPV's first clients and a relationship began which lasts until this day.

In the early seventies, French manufacturers joined the fray. BSL is reported to have started in 1972. Orval followed two years later in 1974. Fauvet Girel later known as Arbel Fauvet and ANF are said to have started operations around 1976.

French manufacturers, especially BSL, I believe deserve the credit for pioneering large scale manufacturing of ISO tanks in excess of 1,000 tanks/annum into what during the eighties became a French national industry and stronghold. BSL pioneered all main facets of high volume line production manufacturing which included prefabrication of frame and parts and full automatic (SAF) welding processes. The number of hours to complete one ISO tank at that time dropped to ±300 inclusive of insulation. To cater for prototype testing, SNCF, the French national railway, as early as 1967, set up a test station in Tergnier located 250km north-east of Paris, conspicuously near to the BSL factories in Soissons.

Besides in Ireland and France, tank containers were also designed and manufactured in many other parts of Europe. In Austria, for example there was Schaffer and Budenberg. In Germany, Luther Werke and WEW started off to produce tanks involving designs of identifiable similarity. Luther Werke discontinued their production in the early eighties. Other manufacturers in Germany in operation in 1970 were Stahlwerke Bruningshaus and Ench Wolff GmbH as of 1972. In the UK, M-1 Engineering added further tank manufacture capacity when it started commercial production in 1973.

Other UK companies that were getting ready to manufacture ISO tanks in the end-sixties early-seventies in the UK were Crane-Fruehauf and Universal Bulk Handling Ltd, as well as RTGF – Road Tanker and General Fabrication.

In 1973 in Sweden, a company by the name of Dynatrans entered the market with 20ft 14,000Ltr ultra light weight half height tanks with a tare weight of about 1,000 Kgs primarily designed for carriage of milk which they dubbed CONNY system.

Of those companies mentioned earlier several have since disappeared, indeed some became casualties of design failure, others such as Golden Vale Engineering in Charleville in S. Ireland did in 1980, gave up even before series production began. Again others fell victim to a drastic and sudden market downturn such as was the case with Hugonnet in France. In the case of Hugonnet, their suspended design generally referred to as the “pedigree” later re-emerged as a Henred Fruehauf product, marketed by Kerby in UK.

Let’s see where we stand with regard to answering the two questions mentioned in the beginning. We did come up with an answer to Question 1 by identifying Bob Fossey of CPV as the engineer who might very well have designed what was one of the very first ISO tanks built by Williams Fairclough in London.

Question 2 is two fold. You will remember that we have found that the introduction of the post-moscow corner casting removed the last technical obstacle which allowed companies to venture into the manufacture of ISO tanks. The second argument to develop ISO tanks was more of an economical nature.

The main thrust came from the global drive towards containerisation of cargo at the expense of conventional shipments. At that time, intermediate parcels of bulk liquids were predominately transported in steel 200-litre drums and either shipped conventionally or in 20ft box containers. A common realisation that there should be a more cost efficient method of transporting bulk liquids triggered what soon became a collective effort in Europe to design the ISO tank container. The main consideration was that inside a 20ft box container, one could accommodate plus or minus 76 drums that each containing 200 litres would add up to 15,600 litres.

With this in mind, one obvious goal at the drawing board was to design a tank container with a capacity much beyond that. The projected tank container design had to conform to ISO standards so that it would enjoy the benefits of the existence of a modern and ever improving global infrastructure increasingly available in ports around the world to handle ISO containers. The tank container, as a substitute for the use of drums would not only eliminate the cost of drums, but also the chores of filling them, stuffing in dry freight containers, emptying, while it would eliminate the risk of product loss in terms of residues. If, it was reasoned, shipping lines were to quote a rate for the 20ft tank comparable with that of the 20ft box, the economic advantages associated with the use of ISO tanks would be formidable.

At this time the maximum capacity of tank container was approximately 18,500Ltrs. The restriction on tank diameter, due to the bottom entry footvalve was lifted when Bob Fossey of CPV designed and built the first 45º footvalve and realised the first 20,000Ltr and 21,000Ltr tank containers.

At a container exhibition the Fledgeling Fort Vale Company was asked by Bob Fossey if they could produce their existing 1½” pressure vacuum relief valve as a 2½” varlant and following this introduction Fort Vale was asked to produce the 45º Footvalve. Most people know Fort Vale today as a major influence in the supply of ancillary fittings for tank containers.

One of the main constraints for manufacturers to design tanks of larger capacity was the ISO maximum gross weight of 20,320 Kgs which depending on the tank tare weight left only 16 to 17 metric ton payload. However, soon the international Union of Railways (UIC) became the trendsetter for higher maximum gross weights in the earlier seventies and elevated its maximum gross weight standard for freight containers to 24,000 Kgs. During those years, tank containers often had three different maximum gross weights. ISO at 20,320 Kgs, UIC 24,000 Kgs and the maximum gross weight to which the manufacturer's prototype had been tested often at a rating superior to UIC. It was only during the eighties that ISO finally elevated its standard for the maximum gross weight to 24,000 Kgs. ISO never elevated maximum gross weight to 30,480 Kgs but accepted that tanks were designed and tested to a maximum gross of 30,480 Kgs and that this is a minimum for design and a maximum for operation.

It was not until around 1975 with the introduction of the 8ft 6in high containers that a few manufacturers and for others, not until the beginning to mid eighties, that cylindrical tanks were designed of a capacity larger than 20,000Ltrs. Most of the ISO tank frames until then were of 8ft height. Besides inching closer to the extreme ISO parameters and modification of tank stiffening rings, the extra space needed for larger capacity tanks was found by increasing the frame height to 8' 6" as well as through the introduction of more refined and compact valves and fittings such as the low profile manlids and the introduction of the spring loaded internal discharge valve. The first large capacity 23,000Ltr tanks were in the beginning commonly referred to as Jumbo's. These tanks gave the tank container concept another shot in the arm by providing greater tank volume to the enduser.

Whereas since the early seventies, the global ISO tank container fleet has grown to some 80,000 TEU's today with a healthy annual growth of up to 15% still not all the early day prophesies have come true. Shipping lines, for example, are often criticised for charging a premium for the tank container over and above the 20ft box freight rate.

When we consider the difficulties those early day tank container manufacturers had to overcome, we have to bear in mind that it was only over the last decade that manufacturers were able to enjoy the luxury of having computer aided design software. The same applies to finite element analyses, a software that allows manufacturers to simulate the rigorous forces of multi-modal operation and pin-point the concentration of stresses. To ensure adequate strength of their designs, most manufacturers in the end-sixties-early-seventies, over designed their tanks which resulted in high tare weights up to 5,000 Kgs for a standard IMO 1. A notable exception to this was CPV who using knowledge gained from early designs and in-depth calculations were able to produce light-weight containers.

Before being allowed to manufacture series of tank containers, a design developed on basis of a recognised design code such as ASME, has to be appraised by a classification society such as Lloyds or Bureau Veritas.

The regulations that govern the transportation of dangerous goods such as IMO, ADR, US DOT and other require that prior to fabricating series of tank containers, a manufacturer must fabricate a prototype and, in order to prove its integrity, subject it to a barrage of tests.

The prototype testing in test centers approved by Classification Societies and recognised by the competent authorities of individual nations and in the case of C.P.V. its own test rig continues to be the “proof of the pudding”. During the prototype testing, forces equivalent to its R rating which is the maximum gross weight and depending on the test, multiples thereof will be exerted to the prototype in multiple directions. Perhaps, the most spectacular test is the dynamic or impact test to a force not less then 5R, in the case of Sea Containers tanks means 5 times 34,000 Kgs. These I assure you are what you may call “big bang” experiences.

Over the past 30 years, tank container manufacturers were forced to place three main and ever increasing demands on tank container design.

- to increase the tank capacity
- to reduce tare weight in favour or increased payload, and
- to increase the R-rating (maximum gross weight used during prototype testing).

The manufacture of tank and frame are two entirely different processes and in terms of design complexity; the integration of the two, most will agree is the most delicate task of all.

Today, we are able to differentiate between two main designs available in both fully framed and beam type tanks:

- Still the most common of all is the welded tank-to-frame design which is built in both beam as well as fully framed type tanks and
- the suspended tank-to-frame design, this design is available in fully framed configuration and more recently it is also available as a beam tank, designed and manufactured by Henred Fruehauf in S. Africa.

One of the most common beam designs are those where end frames are integrated with the tank via either 4 mild steel or Corten liaison plates, pre-formed cones, or hollow sections at each end which are in turn welded to the tank shell i.e. the pioneering C.P.V. design series.

The continued process of product innovation within the tank container industry will no doubt remain a significant contributing factor to sustain its growth.

http://www.cpv.ie