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PROPOSED TOXIC, CORROSIVE AND ECOTOXIC LIQUIDS TANK WAGON CODE OF PRACTICE

SUBMISSION TO THE ENVIRONMENTAL RISK MANAGEMENT AUTHORITY (ERMA)

13 NOVEMBER 2009

BACKGROUND TO IPENZ

The Institution of Professional Engineers New Zealand (IPENZ) is the lead national professional body representing the engineering profession in New Zealand. It has over 11,000 Members, including a cross-section of the engineering community from students to senior Fellows in management or governance positions in important design or construction organisations. IPENZ is non-aligned and seeks to contribute to the community in matters of national interest giving a learned view on important issues, independent of any commercial interest.

In making these comments IPENZ has drawn particularly on the knowledge of its Members who work in road transport engineering (Road Transport Certifying Engineers, RTCE), or are otherwise aware of the issues.

EXECUTIVE SUMMARY

IPENZ thanks the Environmental Risk Management Authority (ERMA) for the opportunity to comment on the proposed "Toxic, Corrosive and Ecotoxic Liquids Tank Wagon Code of Practice" (CoP) consultation paper. In particular, IPENZ values the face-to-face discussions that have occurred. IPENZ notes ERMA's desire that this CoP will provide users with an acceptable solution under the Hazardous Substances (Tank Wagons and Transportable Containers) Regulations 2004 (the Regs) for the design and construction of tank wagons for the conveyance of certain hazardous liquids by road. This submission follows similar ones IPENZ has made in recent years.

IPENZ notes with sympathy the regulatory morass faced by project managers tasked with supplying vehicles of this type.

- The chassis and brakes must be certified by an engineer holding a Deed from the New Zealand Transport Agency. These engineers are often, but not invariably, chartered professional engineers (CPEng).
- If the tank is a pressure vessel, it must be certified by a Design Verifier (DV) recognised under the Health and Safety in Employment Act. DVs are registered by IPENZ under a scheme identical to that used for CPEng.

- ERMA's approved engineering design Test Certifiers must certify compliance with this CoP. IPENZ recommends that the Test Certifiers be CPEng registrants assessed within the previous five years as being competent in this area of mechanical engineering.

IPENZ notes that the Regs defer in several places to the Pressure Equipment, Cranes and Passenger Ropeways Regulations (PECPR Regs), and recommends that the CoP emphasises this point in its Scope.

IPENZ recommends that the "competent persons" mentioned in 2.1.1 be assessed within the previous five years as being competent in this area of mechanical engineering anywhere on the spectrum of technician, technologist, or professional.

SUBMISSION

The following recommendations and comments are numbered in correspondence with the consultation draft.

1.3.1 Performance-based regulations

IPENZ agrees that regulations made under an Act should specify a desired outcome without prescribing how to achieve it, that is, be performance-based.

1.3.2 Prescriptive subsidiary documents

IPENZ agrees that approved codes of practice should provide users with a method of meeting the regulatory requirements, that is, prescribe solutions that are deemed to comply with the regulations. Approved codes of practice may cite other documents such as design guidelines and standards which may be either prescriptive or performance-based.

1.5.1 Definitions

- Under "tank", IPENZ understands that the acronym IBC means intermediate bulk container. IPENZ recommends that this, and all other acronyms and abbreviations, be defined at their first occurrence.
- ERMA recognises that some tanks are permanently fixed, others are not, and others are portable. IPENZ recommends that ERMA clarifies the text to show the significance in the CoP of the fixing.

2.1.2 We recommend that ERMA's Test Certifiers for these tank wagons be CPEng assessed within the previous five years as competent in this area of engineering.

2.2.1 One of our Members, well experienced in heavy truck engineering, asks if 40 mm per metre means what it appears to mean. He suggests it is too small, especially as the unladen ground clearance is not to be less than 350 mm.

2.3.3 We agree that the collision bumper not be attached directly to the tank. IPENZ's Engineering Practice Manager adopted a corresponding rule in respect of ice shields over microwave antennas. A Member suggests that the phrase "inner face" means "front face".

2.3.4 This clause may be redundant, as it appears to be covered by the second bullet point of 2.3.5.

2.3.5 IPENZ recommends that this clause be tidied to incorporate more clearly the intent of 2.3.4. A possible ambiguity could be removed by using the phrase "Full width of the collision bumper". An IPENZ Member has suggested that if the

rearmost tyres are sufficiently far to the rear they should be able to be counted as part of the collision bumper.

2.3.6 The sentence "The height of the collision bumper measured from the ground to the lowest surface of the bumper shall be not less than 600 mm and not more than 1,000 mm" appears to be more restrictive than Reg 23(1) which puts the limits at 500 mm and 1,000 mm.

2.3.7 IPENZ is in the process of examining examples of limit state and alternative (ie working stress) methods of design according to NZS 3404:1997 *Steel Structures Standard.* We note that many heavy vehicle engineers prefer to use AS 3990-1993 *Mechanical Equipment – Steelwork* and we recommend that this Standard be given a status equal to that of the alternative method of NZS 3404.

We understand that the New Zealand Transport Agency (NZTA) will not accept limit state design at all; nor do they accept NZS 3404 Appendix P Alternative Design Method. NZTA accept design to AS 3990 (static and fatigue) and BS 7608:1993 *Code of Practice for fatigue design and assessment of steel structures.*

As ERMA will accept both limit state and the alternative method (working stress), care is required in interpreting the design forces specified in CoP 2.7. IPENZ acknowledges very useful discussions with ERMA on this point, and is pleased to have been allowed extra time for investigation.

Is a load of 40 tonne to be taken as a force of 392 kN or 400 kN? We note that the Regs specify some loads in tonnes, but the time is overdue for technical writers to specify forces in force units (eg kN), masses in mass units (kilograms or tonnes), and to make it clear that the term "load" could be either a mass or a force depending on the context. The phrase "design action" may be useful.

2.4.1 IPENZ notes that the section on electrical wiring is much shorter and less prescriptive than that proposed for other tank wagons.

2.5 IPENZ notes that requirements for the prime mover are no longer specified.

2.6.4 IPENZ notes the requirement to make brake equipment compliant with all NZTA requirements. IPENZ is aware that means of compliance with the Brake Rule are continually being developed, and we recommend that ERMA engages with NZTA's developers.

2.7.1 IPENZ is not sure of the meaning of the sentence "Any fittings carried in this space will not compromise the integrity of the load tank". Does ERMA mean that the fittings in this space must not interfere with the tank as it articulates on its fifth wheel? Does it mean that an exhaust pipe must not overheat the tank?

2.7.2 IPENZ notes that ERMA's specification for design forces is the same as for other types of tank wagon and for body attachment in the Heavy Vehicles Rule 31002. One of our Members has commented that "the loads they have chosen are so large that the tanks will continue to stay attached to their chassis long after the whole vehicle has rolled off the road and down the bank". Another Member agrees with this comment, adding that "the connection between the two masses only has to exceed the lighter mass capacity for the two to stay together". A third Member states that the loads [ERMA] has chosen are sensible and reasonable, but clarity would be improved by replacing the phrase "resist the following forces" with "resist the following static forces with integrity maintained".

2.7.2.2 IPENZ and RTCE have been engaging in discussions on the limit state and working stress methods of design. While both can lead to the same solutions, there are situations where this does not necessarily occur – bolts are a case in point. ERMA's Test Certifiers will need to be aware of these issues.

2.7.3 IPENZ recommends that ERMA specifies the required fatigue spectrum much more closely. NZS 3404 Section 10 gives no guidance on the spectrum appropriate for road tank wagons. NZS 5446:2007 *Heavy vehicle towing connections* does, and so does Wong in *Ladder frame chassis design & modification.* Regrettably, these authorities differ in their recommendations.

IPENZ also recommends that ERMA specifies the fatigue loads. RTCE and IPENZ discussed this point at RTCE's annual conference, possibly taking guidance from Wong.

Does ERMA expect that the provisions of 5.2.3.4 to apply? If so, IPENZ recommends that 2.7.3 makes reference to 5.2.3.4.

IPENZ is aware that methods for designing welds subject to fatigue are evolving and that there is some divergence between American and European practice. There is also some divergence of opinion between those who favour finite element methods and those who prefer "code equations".

2.7.6 ERMA's specification of proof loads on twist locks is interesting. If the proof loads are to be twice those specified 2.7.2, it appears that, for example, the total downward load on the chassis would be 4 g M. This is noticeably more than Wong's recommendation of 3 g M. Does ERMA in fact require 4 g M?

From 2.7.4, it may be that ERMA requires proof loading only in the vertically upward direction, in which case the load would be 2 g x M.

Assuming that proof loading vertically upwards and downwards is required, one of our Members comments that 1.25 times proof in service is appropriate as this has to include load transfer from the centre of mass being above the attachment height.

Another Member comments that the method of applying the test loads and their locations need to be defined to make the clause meaningful – for example, is it just the pin that is being tested or the attachment of the twist lock to the structure?

IPENZ assumes that the twist locks are to be proof loaded sequentially, not simultaneously.

2.7.7 ERMA's phrase "the design number of twist locks must be in use" requires some thought to interpret. IPENZ takes the meaning to be "If the drawings show (eg) four twist locks, then four must be fitted and all four must be in use during service".

2.7.9 One of our Members, experienced in heavy vehicle design, comments that the purpose of this clause is not clear.

2.8.2 IPENZ agrees that AS/NZS 1554 is a current Standard. Its scope includes applications other than structural, but does not include pressure vessels and pressure piping.

2.8.3 IPENZ agrees that NZS 4711 is a current Standard, but notes that it is in the process of review. IPENZ also notes that 2.8.3 is redundant. This is because

AS/NZS 1554.1 clause 1.7(a) requires that a weld shall be made in accordance with a qualified welding procedure, and clause 1.7(b) requires the weld to be carried out by a welder suitably qualified to carry out such a procedure.

2.8.4 IPENZ assumes that the "Health and Safety in Employment Regulations for pressure purposes" means the Health and Safety in Employment (Pressure Equipment, Cranes, and Passenger Ropeways) Regulations 1999 (PECPR Regs). The PECPR Regs do not regulate welding procedures.

The Health and Safety in Employment Act 1992 section 20 empowers the Minister [of Labour] to direct the Secretary [of Labour] to prepare statements of various types of preferred arrangements relating to health and safety. Amongst these is the Approved Code of Practice (ACoP) for Pressure Equipment which does cite several Standards specifically related to welding.

2.9.1 This clause is taken directly from Reg 21 which defines the static roll threshold, the dynamic load transfer ratio, and high speed transient off-tracking. It may be better to reproduce Reg 21.

2.9.2 IPENZ recommends that allowance be made for movement of the centre of mass of liquids (especially with large ullage) when determining SRT values.

2.9.3 See 2.9.2.

2.10.1 IPENZ notes that in order to satisfy the Land Transport Act, an engineer holding a Deed from NZTA must certify the chassis and brakes. In order to satisfy the Health and Safety in Employment Act, pressurised parts must be certified by an engineer assessed as competent by IPENZ as a Design Verifier, a process identical to that for a CPEng.

IPENZ recommends that ERMA's Test Certifiers be professionally capable of reviewing the work of professional engineers.

3.1.2 ERMA's description of a "competent person" needed to design a tank for toxic or corrosive liquids as an engineer experienced in the design of heavy vehicles seems odd.

- Designers and Design Verifiers for pressure vessels of the sorts governed by the PECPR Regs and the ACoP for Pressure Equipment may know little about heavy vehicles but could be extremely competent in the area of tanks.
- In Appendix A clause 1, ERMA requires a "qualified person" to design and supervise the construction of a tank wagon. This person is to be a chartered engineer familiar with the design and construction of road transport vehicles. IPENZ recognises that the phrase "chartered engineer" will please immigrants from the United Kingdom, IPENZ notes that New Zealand law recognises "chartered professional engineers", who are re-assessed for competence at least once every five years. IPENZ recommends that ERMA use the phrase "chartered professional engineer".

IPENZ recommends that the tank designers be assessed as competent in the relevant areas of engineering anywhere on the spectrum of technician, technologist, or professional.

3.4.2 IPENZ has difficulty with the wording of the suggestion that any lining material for the tank shall not be less elastic than the metal of the tank itself. Suppose that a steel tank is to be lined with a layer of glass fused to the steel. The modulus of elasticity of glass, E_{glass} = 70 GPa, is much less than the modulus of elasticity of the steel, E_{steel} = 200 GPa. When the tank deforms under load, the

strain ε at the interface must be the same in the glass and the steel to prevent delamination. For a uniaxial deformation (eg hoop stress only) the stresses σ would be given by

$$\sigma_{steel} = E_{steel} \times \varepsilon$$

$$\sigma_{glass} = E_{glass} \times \varepsilon$$

showing that the stress in the glass is much less than the stress in the steel, a desirable state of affairs.

IPENZ suspects that ERMA wants the lining to be able to deform with the steel without cracking.

3.4.3 Stainless Steel, not Sainless.

3.5 Clauses 3.5.1 and 3.5.2 appear to be inconsistent, especially as 5.2.4 will usually require the bulkheads to be dished.

4.3.3 IPENZ has difficulty with the clause "be designed to withstand a load applied in any direction equal to twice the mass of the fully laden tanker."

- In the first place we disapprove of wording equating masses to loads. ERMA got it right in 2.7.2, and we suggest a similar format for 4.3.3.
- Designers will ask whether the load is to be applied as a point or along a line, or in some other manner. ERMA should specify this.
- Many designers would want to reduce the force transmitted from the shroud to the tank by allowing the shroud to deform plastically and so absorb energy. We recommend that ERMA explicitly allows plastic deformation.

5.2.1 IPENZ recommends that a Code of Practice intended for use in New Zealand refers to New Zealand Standards where these are appropriate. Hence, we believe it inappropriate to refer to AS 4100 when the New Zealand equivalent, NZS 3404, is in widespread use, and is cited elsewhere in the CoP, eg at 2.3.7 and at 2.7.3.

Despite this, IPENZ is aware that many heavy vehicle designers in New Zealand prefer to use the working stress method of design and are guided by AS 3990.

5.2.3.4 IPENZ notes ERMA's interpretation that subclauses 5.2.3.1 and 5.2.3.4 combined have the effect of providing an oscillating vertical load case of ±0.3 g M about an all up vertical load case of 2.3 g M. IPENZ acknowledges very useful discussions with ERMA on this point, and is pleased to have been allowed extra time for investigation.

5.2.4 Will ERMA accept bulkheads which are curved in only one direction, i.e. are parts of cylinders rather than parts of spheres?

5.3 Table 5.1 ERMA has given the limits on shell radius in an unconventional manner. IPENZ suspects that >2.3 =3.2 is to be taken to mean 2.3 < radius ≤ 3.2.

5.3.1.2 The phrase "keep stresses within specified limits" is appropriate in a chapter on tank design as tanks are designed in accordance with working stress methods. IPENZ recommends that ERMA cites the Standard(s) that specify the limits of stress. AS/NZS 1554 may not appear here, as its clause 1.2 excludes pressure vessels and pressure piping from its scope. IPENZ suggests AS 1210 – 1997 *Pressure vessels* as this is cited in DoL's ACoP for Pressure

Equipment. AS 1210 specifies reinforcing rings for vessels subjected to internal pressure at its clause 3.10.6.5.4.2. IPENZ presumes that AS 1554 means AS/NZS 1554. This applies to welding of steelwork in structures that comply with AS 3990 and NZS 3404.1 and to applications other than structural. Hence, it is suitable for road vehicles.

AS/NZS 1554 does not apply to the welding of pressure vessels and pressure piping – see its clause 1.2. IPENZ recommends that ERMA cites AS 1210 – 1997 *Pressure vessels,* as this is cited in DoL's ACoP for Pressure Equipment. AS 1210 specifies the requirements for welding in its clause 4.2.

5.4.5 IPENZ notes that ERMA's requirement for a minimum of 5% x-ray inspection of production welds is more stringent than required by AS/NZS 1554.1 Table 7.4, which suggests no radiographic or ultrasonic inspection of GP welds. However, that table suggests 0 to 10% for SP welds. Hence, IPENZ suspects that ERMA meant to specify SP in 5.4.2.

One of our Members suggests that ERMA's requirement for x-ray should be replaced with a requirement for non-destructive examination, as methods other than x-ray are better for some weld configurations.

5.4.6 IPENZ Members do not recognise "weld quality class B". What is this?

6.1.3 IPENZ suspects that ERMA meant "shall be provided", not "shall be prevented".

6.6.5 IPENZ objects to the expression "force of at least 3600 kg" and recommends "force of at least 36 kN".

7.1.1.2 30 kPa, not 30kPa.

Appendix A

1.1 IPENZ is only partly pleased to see that the "qualified persons" who design of tank wagons are to be chartered engineers or similarly qualified persons familiar with the design and construction of road transport vehicles. IPENZ notes that chartered professional engineers in New Zealand are assessed for competence at least once every five years, but that this is not true of chartered engineers from some other jurisdictions.

1.2.9 As for 1.1 in respect of supervising the construction.

1.4 Test Certifier, not test certifier, for consistency. However, IPENZ notes that the Regulations use lower case, i.e. test certifier and test certificate.

2.1 Test Certifier, not test certifier, for consistency. See also 1.4.

2.5 Test Certifier, not test certifier, for consistency. See also 1.4.

Appendix D

2 IPENZ suspects that ERMA meant to insert a horizontal dividing line in the definition of α.

RECOMMENDATIONS

IPENZ recommends that ERMA's approved Design Test Certifiers be chartered professional engineers assessed within the previous five years as being competent in this area of engineering.

IPENZ recommends that the designers mentioned in 2.1.1 and in A1.1 be assessed within the previous five years as being competent in this area of engineering anywhere on the spectrum of technician, technologist, or professional.

IPENZ recommends that the loads required for fatigue design be further investigated, and will be pleased to take part in such an investigation.

IPENZ SUBMISSION APPENDIX 1

Engineering registers and their relationship to road transport engineering.

Any comments on the appropriateness of engineering registers below are indicative of our views at present, but these may change when the other matters outlined in our submission are resolved.

A professional engineer's scope of work is regulated, by statute, through the Chartered Professional Engineers of New Zealand Act 2002 (the CPEng Act). Section 8(c) requires CPEng registrants to agree to be bound by the rules as amended from time to time, and s46(b) of the rules requires that a CPEng registrant must undertake engineering activities only within his or her competence. Should an allegation arise that a CPEng registrant has failed to work within his or her competence, that is, properly limit his or her scope of work, the duty to investigate the allegation and if necessary discipline the engineer falls on the Registration Authority. Section 4 of the CPEng Act interprets the Registration Authority to mean IPENZ.

Further, the competence standard for CPEng requires that engineers demonstrate the ability to follow good practice in New Zealand – this means working within any legislative or regulatory requirements that impact on their work.

Professional engineers presently doing tank wagon design, but not registered under the CPEng Act, may be IPENZ Members, and if so may use the postnominal MIPENZ. These people are bound by the IPENZ Code of Ethics, section 4(b) of which states that a Member must undertake engineering activities only within his or her competence. Should ERMA accept IPENZ's recommendation that Design Test Certifiers be CPEng registrants, IPENZ would encourage non-CPEng designers to offer their qualifications and work experience for assessment, including those chartered in jurisdictions overseas.

The development of two other engineering registers is also relevant to ERMA's need for In Service Test Certifiers and Pre-commissioning Test Certifiers:

- Engineering Technology Practitioner
- Certified Engineering Technician

The Engineering Technology Practitioner register is aligned to the international benchmark standard for engineering technologists, including those in the mechanical discipline. Typically these practitioners hold a three-year degree in engineering (for example, Christchurch Polytechnic Institute of Technology has produced BEngTech graduates for almost 10 years). After relevant experience these practitioners have been able since 1 July 2007, apply to IPENZ for assessment against the competence standard, which includes the same provisions as CPEng about demonstrating capability to work within the local jurisdiction. The register rules are almost an exact replica of the CPEng rules, including a code of ethics and the requirements to demonstrate current competence five-yearly.

Competent engineering technologists doing mechanical design, but not registered on that new register, may apply to IPENZ for Technical Membership, and may use the postnominal TIPENZ. These people are also bound by the IPENZ Code of Ethics, section

4(b) of which states that a Member must undertake engineering activities only within his or her competence.

The other new register is Certified Engineering Technician. The register is aligned to the international benchmark standard for engineering technicians, including those in the mechanical discipline. Typically these practitioners hold a two-year diploma in engineering (a number of polytechnics have produced such diplomates for many years, and before that a number of New Zealand Certificates in Engineering were awarded in mechanical engineering). After relevant experience these practitioners have been able since 1 July 2007 to apply to IPENZ for assessment against the competence standard, which includes the same provisions as CPEng about demonstrating capability to work within the local jurisdiction. The register rules are almost an exact replica of the CPEng rules, including a code of ethics and the requirements to demonstrate current competence five-yearly.

Competent engineering technicians doing road transport vehicle design, but not registered on that new register, may apply to IPENZ to become Associate Members, and may use the postnominal AIPENZ. These people are also bound by the IPENZ Code of Ethics, section 4(b) of which states that a Member must undertake engineering activities only within his or her competence.

Admission to the registers just described is not limited to qualification holders. There are assessment pathways for those who have experiential learning to undertake what is known as a “knowledge assessment”. Applicants who prove equivalent knowledge to a qualification can have their competence assessed in the same way as a qualification holder.