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Proposed Flammable Liquids Tank Wagon Code of Practice

Submission to the Environmental Risk Management Authority (ERMA)
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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 approximately 10,000 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, 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 "Flammable Liquids Tank Wagon Code of Practice" (CoP) consultation paper. We note ERMA's desire that this CoP will provide users with a method of meeting the requirements of the Hazardous Substances (Tank Wagons and Transportable Containers) Regulations 6-29, 32-37 and 42 (Reg or Regs).

IPENZ recommends that ERMA's approved Test Certifiers be Chartered Professional Engineers assessed within the previous five years as being competent in this branch of mechanical engineering.

IPENZ recommends that the CoP clauses that allude to the steel structures standard NZS 3404 limit the applicability of that standard to the tank wagon parts for which that standard is valid.

Many of the points refer to the international typographical conventions used in technical writing. We believe that these are important in documents that specify quantities and units that are intended to be used in calculations. Academic engineers who teach students who have English as a second language have asked that standards and codes of practice be written in a clear, modern style familiar to advanced learners.

Other points refer to specified dimensions where the dimensions may have been specified ambiguously. Diagrams would help to remove ambiguity.

Submission

The following recommendations are numbered corresponding to the consultation paper.

1.1.1 The phrase *"...provide a standard for the design..."* risks confusion between this CoP and the publications of Standards New Zealand, which are known as Standards. The phrase used in CoP clause 1.3.2 is better: "...provide an acceptable solution for the design..."

1.2.1 We suggest that the last sentence is changed to "*These risks are compounded when hazardous substances are transported in bulk",* as the present wording suggests that the risks are transported in bulk..

1.5.1 Demountable Tank (Multi-modal tank)
New Zealand Standard NZS 5418 Part 1: 1983 is subtitled *"Specification for tanks for multi-modal transportation of hazardous liquids".* This predates ERMA's CoP, but as it deals with the matter of 1.5.1 it should either be explicitly acknowledged, or if it is no longer relevant, explicitly excluded as an approved document leading to an acceptable solution.

1.5.2 Design Test Certifier
IPENZ recommends that the persons ERMA approves to certify tank wagon designs are Chartered Professional Engineers assessed not more than five years previously as being competent in this branch of mechanical engineering. CPEng registrants are persons recognised by statute in the Chartered Professional Engineers of New Zealand Act 2002.

1.5.11 Ullage
Remove second full stop.

2.3.1.4 The sentence *"The height of the collision bumper measured from the ground to the lowest surface of the bumper shall be not less than 600mm and not more than 1000mm"* appears to be more restrictive than Reg 23(1) which puts the limits at 500 mm and 1000 mm. We also note the typographical convention whereby there is a space between the dimension and the unit – the Regs use the convention correctly.

2.3.1.5 1500 mm, not 1500mm.
We consider that the last sentence *"A limit state or allowable stress method of design can be used"* needs to be expanded. The steel structures standard NZS 3404:1997 also allows both methods but uses the phrase "*alternative method*" rather than "*allowable stress*". If the allowable stress method is to be used, factors of safety must be specified: 3404 does so in its appendix P Table P3.3.

2.3.2.1 We note that one measurement has been incorrectly provided in metres; it should be millimetres.

2.3.2.2 300 mm and 500 mm, not 300mm nor 500mm.

2.3.2.4 Is a load of 10 tonnes to be taken as a force of 98.1 kN or 100 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 (kg 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.
Also, 1500 mm, not 1500mm.

2.3.4 *"Where it is practical, one bumper may serve as both a collision bumper and an under-run bumper."* We approve of this clause, and suggest that it be expanded to specify the required dimensions. It will need to be compatible with 2.3.1.4 and 2.3.2.2 and also satisfy Reg 23(1).

2.4.6 The term *"heavily insulated"* should be defined.

2.4.8 The abbreviation AS/NZS 2430.3 3 needs to be punctuated in the style that the standard itself uses. We also recommend that the title of the standard be given on the first occasion it is cited. Also:

- 1.5 m above and 6 m laterally, not 1.5m nor 6m.
- During discharge…0.1 m…0.5 m, not 0.1m nor 0.5m.
- Outside Zone 1…0.5 m…8 m, not 0.5m nor 8m.

2.5.2 *"…ready for use within 10 seconds."* What event marks the start of the 10 second period?

2.7.2 Fire Resisting Shields
…radiant heat transfer that exceeds 2.56 kW/m^2, not 2.56 kw/m2.

2.7.3 Cab Rear Windows
…fixings at 300 mm centres, not 300mm.

2.7.5.2 less than 5 mm thick…less than 3 mm thick, not 5mm nor 3mm.

2.7.6.2(b) It needs to be clarified as to whether this requirement refers to the vehicle fuel tank or the cargo tank.

2.8.1 We suggest the following wording would make the requirement clearer:
"A tank trailer of more than 2000 litres capacity shall have 2 or more axles, which shall not be in line transversely. A tank trailer of 2000 litres capacity or less may have 1 axle and a means of stabilising it when detached from the towing vehicle."

2.8.3 The terms "*mass*", "*weight*", and "*load*" in the same sentence need to be clarified.

2.8.4 We suggest that the wording *"…hold the trailer on its becoming disconnected"* is changed to "…hold the trailer should it become disconnected".

2.8.5 We note that "s*hould"* indicates guidance, but suggest that if this intended as a requirement it is changed to "shall*".*

2.9.1 Is the 100 mm clearance between the back of the cab and the front of the articulated cargo tank, or is it between the back of a fitting behind the cab and the front of the articulated cargo tank?

2.9.4.1 Should read "*M = mass of tank*…", if M is to be given in kilograms.

2.9.4.2 "The mass of the cargo shall be calculated from its density and volume…" is better. As written, a weight is to be taken as a density. The cargo volume is the tank volume minus the ullage. We assume the CoP means 1000 kg/m^3, not 1000 kg/m2.

2.9.4.3 "*limited state"* needs to be changed to "*limit state"*. See also 2.3.1.5 above.

2.9.5 "*Due consideration for fatigue…"* We suggest that this statement be considerably expanded. If ERMA requires only qualitative considerations, then we recommend that the CoP provides diagrams showing acceptable details. If ERMA requires quantitative considerations, then we recommend that the CoP specifies the form of these, as does NZS 3404 in its Section 10.

2.10.1.1 …at least 0.45 g, not 0.45g, according to Reg 21.

2.10.1.2 …ratio of 0.6, not ration of 0.6.

2.11.1.1 Overseas Designs
As in 1.5.2 above, IPENZ continues to recommend that ERMA's Design Test Certifiers be Chartered Professional Engineers.

3.1.5 *"…should be welded from both sides…"* If this is mandatory, then the word "shall" is the usual way of specifying the requirement. If it is a suggested good practice guideline, then this must be stated. The terms "normative" and "informative" are sometimes used to distinguish requirements from guidance. (The author of this submission made a finite element analysis of a 35,000 litre road tank wagon in 1987, using design actions [see 3.3.1 below] similar to those now required. The most severe stresses all occurred along the welds between the bulkheads and outer shell. No highly stressed areas occurred in the middle of thin shells, so there was no evidence of the buckling problem that had been feared.)

Additionally, the CoP as written suggests that bending strength in an accident should be minimised, but we do not believe that to be the intention. Would "…as well as increase bending strength…" convey the required meaning?

If sealing rings are "*not preferred*", are there circumstances in which ERMA would allow them?

3.2.1 Aluminium Alloys
Strengths must be given in the form 248 MPa, not Mpa.

3.3.1 Design Loads
To eliminate ambiguities in the meaning of design loads, the practice of referring to "design actions" is being used in structural engineering. For example, AS/NZS 1170 is entitled *"Structural Design Actions"* and specifies the procedures for structural design of buildings under the actions of permanent (dead load), imposed (live load), wind, snow, earthquake, liquid pressure, ground water, rainwater ponding, and earth pressure. The phrases *"design loads"* and *"load effects"* still occur, but the text makes the requirement clear. For example, Part 1 section 4.2 states that the *"action resulting from static liquid pressure (F_{lp}) shall be calculated from the depth of the liquid and the unit weight of the liquid."*

The proposed CoP specifies the use of NZS 3404 for steel parts. Clause 1.1.4 of this states that it does not apply to elements less than 3 mm thick, but Table 3.1 of the CoP recognises many situations where the plate may be less than 3 mm thick. IPENZ recommends that the parts that are to be designed from the provisions of 3404 should be so specified, and that the parts that are to be designed by reference to Table 3.1 should be excluded from the provisions of 3404.

3.3.1(a) The words *"loading"* and *"mass"* appear in the same context. In some calculations the design action will relate to the gravitational attraction on the mass, in which case it is called a weight; and in others it will relate to a longitudinal, lateral, or vertical acceleration of the mass, in which case the action would conventionally be known as a force.

3.3.1(d) *"...load ranges at constant amplitude..."* This needs to be specified more clearly. If the load fluctuates from zero to some maximum value, or if it oscillates from -½ to +½ of that value, then the range of the load (peak to trough) is the same. However the resulting stress ratio $\sigma_{min}/\sigma_{max}$, often known as the R value in the literature on fatigue, is different, and the fatigue life may be different. The writer interpreted the 1987 rules to require vertical accelerations of ± 0.3 g, These were combined with twice the all-up weight to give a vertical down force of 2.3 times the all-up weight, treated as a static load case. We have also received the suggestion that the magnitude of the fatigue component of the vertical load should be specified as 0.6 g M, the longitudinal 0.4 g M, and the lateral 0.4 g M. Does ERMA require a static vertical load case of 2.3 g M, and an oscillating vertical load case of ±0.3 g M for 5×10^6 cycles?

We note that the CoP has specified the number of cycles as 5×10^6 whereas Regs 11(2) and 11(3) omit the exponent. Reg 11(2) specifies pressure cycles from -7 kPa to the recommended operating pressure, indicating that the design action is to go below as well as above atmospheric pressure.

3.3.2 Stiffening of Heads, Bulkheads and Baffles
The CoP specifies that these parts be *"dished"*, which suggests a spherical cap. Some bulkheads and ends used in the past have been parts of vertical cylinders. Does ERMA intend to accept only spherical shapes, or will it accept other curved shapes such as cylinders?

3.3.3.1 There should be a comma, not a full stop, between *"...2.5 metres"* and *"the distance..."*

3.3.4.1 The phrase *"section modulus of at least 180 x 103 mm3"* has no meaning. Trial calculations suggest that it means 180 x 10^3 mm^3 about a horizontal axis.

3.3.4.2 Where are the stress limits specified? If stress limits are specified, then the CoP must be alluding to working stress design (alternative design in NZS 3404). This appears to preclude the use of limit state design which clause 2.3.1.5 allows.

3.3.4.10 iv Welding of pads
We agree that welding should mimimise the possibility of corrosion. Why not weld the pad all around, and have a lug welded to the pad to which the component may be bolted?

3.3.6 Welding
IPENZ notes that NZS 3404 section 9.7 describes the design of welds and cites AS/NZS 1554.1 and where higher quality welds are required, 1554.5. If 1554.1 is used, then the welds must be designed as either general purpose (GP) or special purpose (SP) and so specified on the drawings or in the specification. GP and SP welds have different inspection procedures and different types and sizes of allowable imperfections. IPENZ recommends that the CoP refers to these tables and adds them to the list in 3.3.6.4.

3.3.6.6 i. IPENZ recommends that the CoP specifies the place where the inspection documents are to be stored.

3.4.4.4 *"…wire gauze of 500 micro-metres nominal aperture."* We note that at 2.7.4 the CoP specifies a *"500 micron gauze"*. These appear to mean the same thing, so consistent units should be used. IPENZ understands that micrometres are the preferred SI unit.

3.4.5.1 280 mm^2 and 17 kPa, not 280 mm2 nor 17kPa.

3.4.6.2 Table 3.3, not Table 3.5.
The units in the column headers should be m^2, m^3 free air/h, m^2, and m^3 free air/h.

3.7.1.2 *"A vapour-recovery system…35 kPa…"* not 35kPa.

5.1.2.8 The second clause *"any limitations…"* should be made into a separated sub clause.

5.1.3 "…characters at least 5 mm high", not 5mm.

5.1.4.1 "…numerals 75 mm high", not 75mm.

5.1.4.2 What is a *"hazardous substance tumbler"?*

CoP Appendix A – Means of compliance with this code

1. IPENZ recommends that a *"qualified person with relevant experience in the road transport industry"* be a Chartered Professional Engineer assessed as competent in this field within the previous five years. IPENZ also recommends that ERMA's Test Certifiers be similarly qualified.

CoP Appendix B – Smaller tank wagons (including tank trailers)

4. "…internal pressure of 35 kPa…", not 35kpa nor 35 kpa.

5. *"Corrosion should be taken into account"* suggests a guideline to good practice. "Corrosion shall be taken into account" specifies a mandatory requirement.

9. 600 mm, 1500 mm, 500 mm, and 600 mm, not 600mm etc. We note that the second bullet point clarifies the meaning of Reg 23(1).

15. Remove the superfluous closing bracket.

CoP Appendix E – Vacuum tankers

2.1.2 "…no less than 4 mm", not 4mm. Similarly, 6 mm and 950 mm. *"The tank must be circular in design"* would be better expressed as "The tank shall have a circular cross-section".

2.1.3 "…inlet size to be 80 mm NB", not 80mm.

2.4.4 "…must terminate 80 mm above…", not 80mm. Should there be a tolerance on this value?

2.4.5 "…must terminate at least 80 mm above…", not 80 mm.

3.9 "…characters at least 5 mm high…", not 5mm.

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 branch of mechanical engineering.

IPENZ recommends that the CoP clauses that allude to the steel structures standard NZS 3404 limit the applicability of that standard to the tank wagon parts for which that standard is valid.

IPENZ recommends that the internationally-recognised typographical conventions for quantities and units be used in this CoP.

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.

The recent development of two new 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 can, from 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 can, from 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 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.