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COMBUSTIBLE LIQUID DELIVERY AND STORAGE TANK DESIGN REVIEW FOR COMPLIANCE TO AS 1940, BARANGAROO BUILDING C1

REPORT VERSION – 1.1

OUR REFERENCE: CN181175

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1. INTRODUCTION

CETEC were engaged to provide design input, based on the best practice as documented in Australian standards, for the installation of a 20 kL tank for the storage of used vegetable oil that's to be used to power one or more diesel generators within the Barangaroo building complex. The review includes the associated piping and venting, along with the system for filling the tank and monitoring the liquid level. It also includes consideration of the proposal to locate a tank of aqueous urea solution within the same area.

CETEC have been engaged by Lend Lease to conduct a design review of the diesel storage area, associated piping and diesel generator motors for the Barangaroo South project.

As part of this review CETEC are to:

- Review the design and report on identified non-conformances.
- Detail design requirements as per relevant sections of AS 1940.

This review encompasses the broad requirements for design and construction as per AS 1940. The assumption has been made that appropriate equipment, construction methods and materials have been specified and as such these are outside the scope of this report.

2. General Information – Design and Construction for Dangerous Goods

The liquid to be delivered and stored within the proposed tank is canola oil that's been used in commercial kitchens and undergone some degree of treatment and purification before delivery. The safety data sheet (SDS) for the oil as delivered states that it's non-hazardous, has a flash point of approximately 282°C and a boiling point of 340°C. Under the AS 1940 standard[1] this makes the canola oil a C2 combustible liquid. Under the Globally Harmonized System[2] (GHS), a C2 combustible liquid is not a flammable liquid (C1 combustible liquids are Category 4 flammable liquids under the GHS).

The NSW Work Health and Safety Regulation 2017, hereafter called the 'WHS Regulation', defines a combustible liquid as "a liquid, other than a flammable liquid, that has a flash point, and a fire point[3] less than its boiling point". As a general rule, the fire point of a liquid is roughly 10°C higher than its flash point, which would give the liquid in question a fire point of roughly 293°C, which is well below its boiling point.

CETEC reviewed the SDSs for a range of commercially available vegetable oils including palm oil, peanut oil, sunflower oil, linseed oil, olive oil and soyabean oil and all showed flash points well over 93°C. This review concluded that a range of other vegetable oils could be stored within the proposed tank without any requirement to alter the 'C2 combustible' status.

It's assumed therefore that the liquid in question is a C2 Combustible Liquid under AS 1940, is a non-flammable and non-hazardous liquid under the GHS, and is considered a 'combustible liquid' under the WHS Regulation. As the liquid is not a C1 combustible liquid, it doesn't come under the scope of Part 7.1 of the WHS Regulation, which covers hazardous chemicals. As a result, it's not a hazardous chemical under the legislation. As a further result, most of the advice given in this report is based on AS 1940 and not on any specific legislation.

There are no placarding or manifesting limits for C2 combustible liquids under the WHS Regulation and as a result the current manifest would not need to be altered when installing the proposed liquid.

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[1] AS 1940:2017, entitled "The storage and handling of flammable and combustible liquids", hereafter referred to as "the Standard".

[2] Globally Harmonized System of Classification and Labelling of Chemicals, 3rd Revised Edition, United Nations 2009 (the NSW legislation still references the 3rd Edition, even though the 7th Edition is now issued).

[3] Although the 'fire point' isn't widely defined in the literature, Wikipedia describes it as the "the lowest temperature at which the vapour of that fuel will continue to burn for at least 5 seconds after ignition by an open flame".

It's noted that the client intends to install a tank of aqueous urea solution, with a proposed capacity of 3,500 L but with a maximim capacity of 5,000 L, within the same containment area as the proposed tank. Urea as a powder is non-hazardous and is not classified as dangerous goods but could give off oxides of nitrogen in a fire. Urea as an aqueous solution is also non-hazardous. This has been confirmed by reviewing the SDS from one of the proposed suppliers (AUSBlue)[4]. In the event that a fire was to occur, releasing the urea solution into the area around the proposed C2 liquid tank, it's unlikely that oxides of nitrogen would form until significant evaporation of the water has occurred.

2.1. SCOPE OF THIS REPORT

This report covers the installation of a 20 kL tank at the specified location, which is to contain a C2 combustible liquid as defined in AS 1940. It also covers the delivery system for that liquid and the associated piping. CETEC points out that in the event that a liquid with a lower flash point (i.e. a C1 combustible liquid or a flammable liquid) was to be delivered to and stored in the proposed tank, the advice in this report would cease to be relevant.

The fuel pump room, where both the diesel and vegetable oils are to be pumped, is not considered a fuel storage area and as such is not covered within the scope of AS 1940. However, CETEC assessed the floor plans to the general construction requirements in an earlier report. It was the understanding in the earlier report that the fuel pump room is constructed to the following FRL specifications:

- Non-load bearing walls with FRL -/180/180.
- Fire doors of FRL -/240/30.

CETEC assumes that this is still the case.

Certain clauses of AS 1940 are considered to be outside the scope of this report. In particular, Clause 9 (Operational and Personnel Safety), Clause 10 (Emergency Management) and Clause 11 (Fire Protection). Some aspects of emergency management and fire management are discussed, but only to the extent that they're discussed in other sections of the Standard. CETEC considers that these are matters that need to be resolved by the client as part of overall safety management, emergency management and fire management strategies for the site.

[4] The SDS for 'Adblue' from AUSBlue, dated 15/11/2016, was reviewed. Adblue is a 30-40% solution of Urea in water.

2.2. Existing Infrastructure, and Assumptions Carried from Earlier CETEC Report

A cut-out drawing showing the location of the tank and the fill point is shown in Figure 1.

The Fuel Pump Room is shown in the top right area of Figure 1. Extending to the left of this in the figure are four rectangular areas indicated as "Fuel tanks". The figure shows the outline of three tanks which are understood to represent the existing diesel tanks and to the left of them, indicated by the yellow mark, is the chamber in which the tank of vegetable oil is to be located. In previous drawings this area was indicated as the Green Utility Workshop.

In the earlier CETEC report (CN150120[5]) it was accepted that the walls indicated to be enclosing the four rectangular areas to the left of the Fuel Pump Room in Figure 1 are loadbearing walls and columns having an FRL of 240/240/240. CETEC assumes that this is still the case, and that the doors, floors and ceilings are also as accepted in that report. It was accepted in that report that the tanks were to be located (as they now are) in 'tank chambers'.

The earlier CETEC report (CN150120) also stated "Although the tanks are not on the lowest level, the levels below (B3 and B4) are unoccupied areas as these areas form part of the building foundations and pump-out stations for the underground water". CETEC assumes that this is still the case.

The earlier CETEC report (CN150120) also discussed the penetrations connecting each tank storage room and accepted that the proposed design included the appropriate fire rating.

Additionally in the earlier report, the following was accepted in Section 2.3 of that report:

- "Dry sump/spill containment area provided within the diesel tank rooms to contain spill from tank. As indicated sump capacity is greater than the minimum requirement of 54,100 L plus 20 minutes of fire sprinklers".

CETEC comment: it's understood from email correspondence with the client that the area proposed for the new vegetable oil storage tank, described in earlier drawings as the "Green utility workshop" (Code C2B2G02 in those drawings) will be restored to its original design so that it then has the same containment capacity, and the same fire ratings for penetrations, doors, walls and ceiling, as the three current diesel storage areas (Fuel Tank Rooms No. 1, 2 and 3, Codes C2B2E02, C2B2E03 and C2B2E04 in Drawing BB1AD1062200, Revision S). If so, then the enclosure is already adequately bunded for a tank containing combustible liquid of 20,000 L capacity, even if it was to contain an additional tank, as

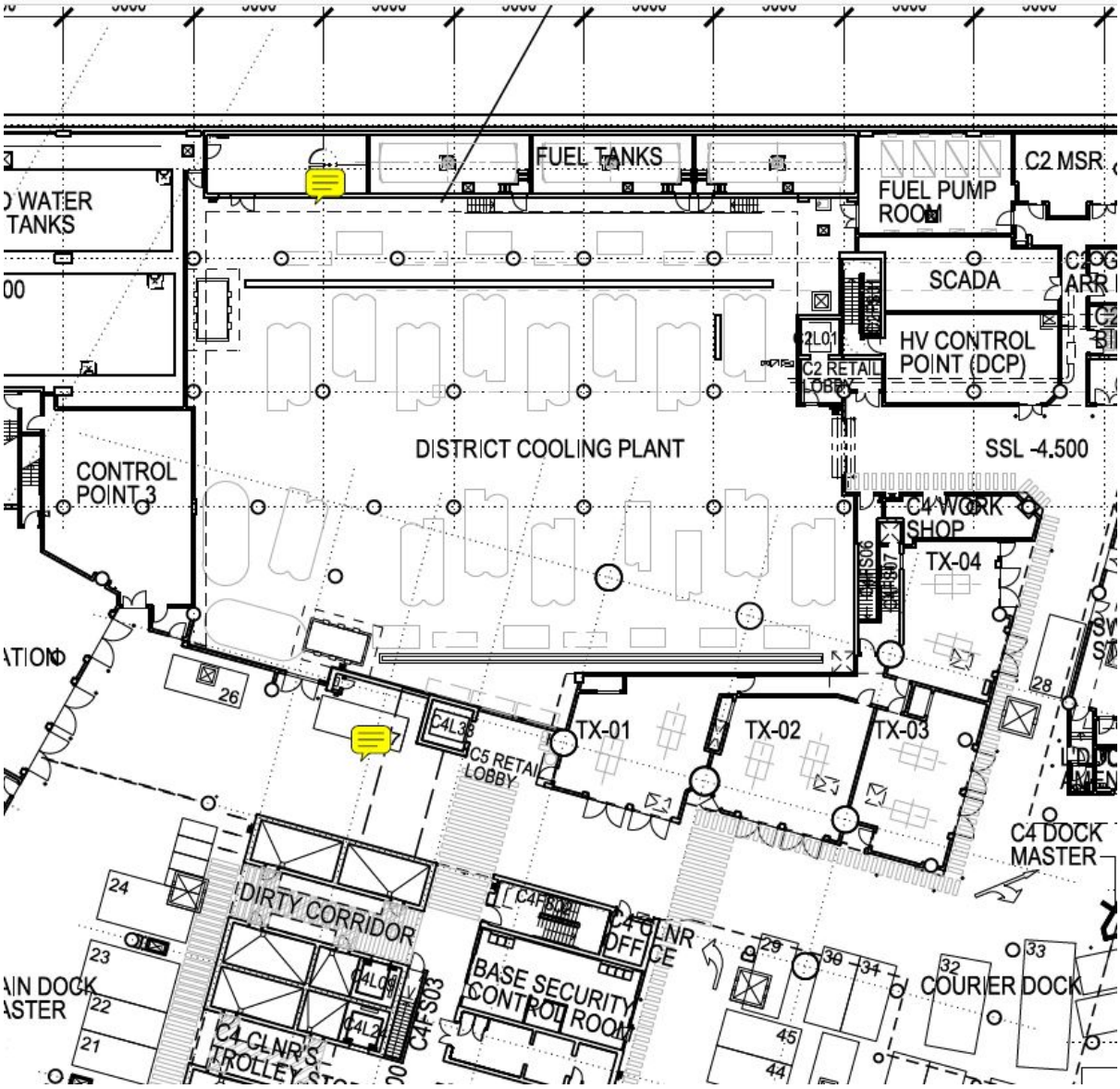
[5] CETEC Report CN150120, issued March 31st 2015, entitled "Diesel storage design review for compliance to AS 1940, Barangaroo South"

proposed, of a non-hazardous aqueous solution of urea of 3,500 L capacity, with the tank possibly displacing as much as 5,000 L. If the enclosure is indeed to be restored to being an adequately bunded area then this adequacy would need to include the volume of the bund being sufficient to preclude any possibility that the simultaneous loss of containment of the urea solution tank and the vegetable oil tank, along with 20 minutes of full discharge of fire sprinklers, could cause the bund to overflow.

Further CETEC comment: it's assumed that the current bunding of the diesel storage tanks conforms to design and construction requirements of Clause 5.8.3 of the Standard ("Design and Construction, as applied to "bunds and compounds", sub-clauses (a) to (h), excluding requirements for earthen walls. These requirements were described in Section 3.1.5.3 of the earlier CETEC report (CN150120) and it's assumed that these requirements were met in the subsequent construction of the bunds for the three existing diesel storage tanks, and possibly for the fourth storage area described as the Green Utility Workshop (see above), if restored to its original design. There were minor changes to Clause 5.8.3 in the 2017 revision to the Standard (issued since the earlier report), of which the relevant changes were as follows:

- Concrete (among other materials) is deemed to be a material that is "sufficiently impervious to retain spillage".
- Requirement for a bund to retain structural integrity during a fire applies to any bund wall joints and penetrations, and "such joints and penetrations shall include suitable fire resistant fillers in combination with metal waterstops".

Figure 1: Cut-out from LendLease Drawing AD0000008 showing location of proposed tank (upper yellow mark) and proposed filling point



3. DISCUSSION OF PROPOSAL IN RELATION TO PART 3[6] OF AS 1940:2017

Within this section of the report, each aspect of Part 3 of the AS 1940 standard that's relevant to the proposed installation is discussed. Parts that are not relevant to the proposed installation are not discussed or are left out. As the proposed tank represents greater than minor storage of a combustible liquid, Part 3 of the Standard applies.

CETEC assumes that the design and construction aspects listed below from the Standard have been included, however they have been included herein to ensure these items are addressed.

3.1. GENERAL DESIGN AND CONSTRUCTION REQUIREMENTS (CLAUSE 3.2 OF THE STANDARD)

3.1.1. DESIGN SAFETY AND SUITABILITY (CLAUSE 3.2.1 OF THE STANDARD)

Any installation intended for the storage and handling of flammable or combustible liquids shall be designed and constructed so that it is safe and suitable for the conditions of use.

Factors that need to be considered include the following:

(a) Working pressures and structural stresses.

(b) Heat, corrosion, or attack by the liquid being handled.

(c) Site conditions such as topography, usage of adjoining areas, or the risk of natural disasters, e.g. flood, earthquake, lightning strikes.

(d) Design of plant, equipment, and operating methods, so as to minimize fire and accident risks and the possibility of errors or misunderstanding by staff.

(e) Specific design for emergencies, particularly firefighting facilities.

(f) The identification of the function of every valve, switch or control actuator, including any remote switches or actuators.

(g) Safe access to and egress from all working locations.

(h) Avoidance of ignition sources.

(i) Ventilation for vapour dispersal, taking into account the possible effect of nearby structures, excavations, embankments, and the like.

[6] To avoid confusion, sections of standard documents are referenced in terms of 'parts', 'clauses' and 'sub-clauses'. 'Parts' refer to 'Sections' in the standard. The use of the word 'Section' is restricted to parts of this report.

(j) Separation of potential hazards, including areas where activities cannot be controlled.

(k) Points of vapour relief.

(l) Spill control measures to avoid contamination of soil and water.

3.1.2. EMERGENCY PROVISIONS (CLAUSE 3.2.2 OF THE STANDARD)

An installation shall be designed to facilitate the management of an emergency, taking into account:

(a) the nature and quantity of the liquids stored;

(b) the layout of the storage area;

(c) access through or around walls or other barriers;

(d) the type of construction of any buildings; and

(e) the type and means of operation of any fire protection system.

3.1.3. MINIMIZATION OF VAPOUR HAZARDS (CLAUSE 3.2.3 OF THE STANDARD)

Where a flammable liquid is being used or transferred in such a manner that vapour is released, the ventilation, extraction, or dispersal provisions shall be sufficient to maintain exposure levels below the exposure standards published by Safe Work Australia.

CETEC comment: in the case of vegetable oil, no exposure levels apply, so long as a mist of the oil isn't created at any location with the exception of within the generator itself.

3.1.4. IGNITION SOURCES (CLAUSE 3.2.4 OF THE STANDARD)

A hazardous area[7] shall not extend beyond a boundary if it could encompass a fixed source of ignition on the adjacent property.

CETEC comment: no hazardous area will be created from vegetable oil unless the oil is heated to close to its specified flash point, which is roughly 282°C.

3.1.1. SEPARATION DISTANCES (CLAUSE 3.2.5 OF THE STANDARD)

Separation distances to adjoining properties and protected places (including on-site protected places) are discussed in Section 4.7 of this report. The proposed tank location in relation to the type of liquid to be stored is well away from the property boundary and from any areas that would be defined as a

[7] Hazardous areas are defined in Standard AS/NZS 60079.10.1:2009, entitled "Explosive atmospheres Classification of areas - Explosive gas atmospheres" (IEC 60079-10-1, Ed.1.0(2008) MOD)

'protected place'.

CETEC assumes that there are to be no other dangerous goods being stored, or to be stored, within any distance that would trigger a requirement within the Standard, or within any other Australian Standards for the storage and handling of other types of dangerous goods, other than the diesel storage tanks within the same part of the building (the 'District Cooling Plant').

CETEC further assumes that there are no dangerous goods storages on adjacent occupancies that would trigger any concerns about separation distances.

3.2. Mechanical Equipment and Installations (Clause 3.3 of the Standard)

Clause 3.3 of the Standard only applies in the event that hazardous areas, as identified in AS/NZS 60079.10.1, are associated with the proposed installation. None are identified in this report relating to the installation of the new tank or its associated equipment.

3.3. Electrical Installations and Equipment (Clause 3.4 of the Standard)

Clause 3.4 of the Standard only applies in the event that hazardous areas, as identified in AS/NZS 60079.10.1, are associated with the proposed installation. None are identified in this report relating to the installation of the new tank or its associated equipment.

3.4. Internal Combustion Engines (Clause 3.5 of the Standard)

Clause 3.5 of the Standard only applies in the event that hazardous areas, as identified in AS/NZS 60079.10.1, are associated with the proposed installation. None are identified in this report relating to the installation of the new tank or its associated equipment.

3.5. Lighting (Clause 3.6 of the Standard)

Lighting shall be provided in accordance with the following requirements:

(a) During the hours of operation, lighting shall be sufficient to provide safe working conditions that include, but are not limited to, clear visibility of all markings on packages, signs, instruments and other necessary items.

NOTE: A minimum value of 50 lx is recommended.

(b) Sufficient lighting shall be available on any of the installation's internal roads when personnel at the premises might use them.

(c) Any lighting in a hazardous area shall be suitable to operate in that area.

3.6. Restricted Usage (Clause 3.7 of the Standard)

Clause 3.7 of the Standard only applies in the event that other products are to be stored within the same area. It's assumed that this is not the case, with the exception of the bulk storage of diesel fuel, which doesn't trigger the requirements of this clause.

3.7. Firewalls (Clause 3.8 of the Standard)

Clause 3.8 of the Standard applies in the event that firewalls and vapour barriers are to be used to achieve necessary separation distances. This is not a requirement in the case of the proposed tank installation and is not discussed here. Some discussion of firewalls in relation to the use of tank chambers can be found in Section 4.9 of this report.

3.8. Security Signs and Notices (Clause 3.9 of the Standard)

All installations shall be appropriately secured against unauthorized access and tampering.

At the entrance to the storage area (in this case, the 'District Cooling Plant'), the following signs shall be displayed:

- A 'DANGER—NO SMOKING, NO NAKED FLAMES' sign.
- For combustible liquids, a COMBUSTIBLE LIQUID sign.

The following signs shall be placed at the entrance(s) to the premises:

A 'WARNING—RESTRICTED AREA, AUTHORIZED PERSONNEL ONLY' sign.

- A sign listing the emergency contact names, titles and phone numbers relevant to the installation.
- The name, address and phone number of the occupier.
- A layout diagram showing the location of fixed fire protection facilities (where installed), the drainage system and the 'Emergency Stop' switches.

Where two or more points of access are adjacent to each other so that a single set of signs and notices are clearly readable from each point of access, duplicate signs and notices are not required.

Signs shall comply with AS 1319. Class labels shall conform to AS 1216 and be a minimum of 250 mm square. Other signs shall have lettering at least 50 mm high.

NOTE: Composite signs or pictographs complying with the above requirements may be used.

3.9. TRANSIT STORAGE (CLAUSE 3.10 OF THE STANDARD)

CETEC assumes that there is to be no transit storage at the proposed site.

3.10. IGNITION SOURCES (CLAUSE 3.11 OF THE STANDARD)

Clause 3.11 of the Standard only applies in the event that hazardous areas have been identified, as shown in AS/NZS 60079.10.1. No hazardous zones have been identified in the installation of the tank and its associated equipment.

4. Discussion of Proposal in Relation to Part 5 of AS 1940:2017

Part 5 of the Standard deals with "Storage in Tanks".

Within this section of the report, each aspect of Part 5 of the AS 1940 standard that's relevant to the proposed installation is discussed. Parts that are not relevant to the current design are not discussed or are left out.

4.1. General Discussion in Relation to Part 5 of Standard

Under the Standard, the proposed tank would be a Category 4[8] tank. It would come within the requirements of Part 5 of the Standard as a Tank chamber located on the lowest floor level of the building.

The proposed tank will be located within the building at one level below street level. It will be located in a neighbouring enclosure next to the three existing enclosures storing a total of 54 kL of diesel fuel. These are horizontal above-ground tanks that were the subject of an earlier review by CETEC[9].

The proposed additional tank would need to be designed and constructed to comply with AS 1692 or an equivalent standard for the category of tank appropriate for the application.

It's assumed that the neither the filling pressure, the static head, nor the vapour pressure in the ullage space will exceed 35 kPa.

Standard AS 1692 requires certain essential information be provided by the purchaser of the tank to enable the correct tank to be supplied. This requirement will fall on the client and is outside the scope of this report.

4.2. General Requirements (Clause 5.2 of the Standard)

4.2.1. Markings (Clause 5.2.2 of the Standard)

Markings should be displayed on the outside walls of the tank. As the diameter is to be less than 6 m, the markings shall not be less than 150 mm in height.

[8] The Standard classifies tanks in accordance with AS 1692-2006 (Steel tanks for flammable and combustible liquids), which was re-endorsed as an Australian Standard in 2016.

[9] CETEC Report CN150120, issued March 31st 2015, entitled "Diesel storage design review for compliance to AS 1940, Barangaroo South".

The base of the markings shall be above the crest of the main bund.

If possible, the markings should be clearly visible from the main alternative access points likely to be used by the fire brigades. If there's to be a foam pumphouse or a manifold for the control of firefighting foam, one such marking shall be clearly visible from that point or from close proximity.

The markings should be of a colour contrasting with that of the tank.

The tank should be marked with the appropriate warning placard as required by the relevant regulation.

CETEC comment: In this particular case, no placarding is required.

4.2.2. CHANGE OF TANK CONTENTS (CLAUSE 5.2.3 OF THE STANDARD)

If there was to be any future change of tank contents, for example a change to a liquid with a lower flash point that makes it a flammable liquid (either under the GHS or under AS 1940) then the requirements under AS 1940 and under the WHS Regulation would apply to the new liquid.

4.2.3. PIPEWORK (CLAUSE 5.2.3 OF THE STANDARD)

Pipes and joints must be resistant to any possible attack by the liquid and must be compatible with it under all service conditions.

All pipes must be adequately protected from physical damage. This may require the use of physical barriers. In particular, piping may be subject to environmental stress cracking and ageing (and UV degradation if exposed to sunlight).

CETEC comment: under the proposed design the piping will not be exposed to sunlight.

Above-ground pipes should be colour-coded or labelled.

Pipework should be well supported and protected from potential traffic damage.

Flexible hoses shall not be used, except at transfer points. Where such hose is used, it shall be constructed of material that is resistant to attack by, and is compatible with, the oil being transferred. The length of the hose shall be kept to a minimum.

The use of bellows joints should be avoided.

4.3. STORAGE TANK FILL POINTS (CLAUSE 5.3 OF THE STANDARD)

It's proposed that the tank will be filled from a tank vehicle via a fill point and piping. It's assumed that

the liquid being pumped from the vehicle will not be a C2 combustible liquid at elevated temperatures, which may result in the liquid being recharacterized as a flammable liquid. This assumption is important in the context of this report as additional requirements would apply under the Standard in the event that a flammable liquid, or a C1 combustible liquid, was to be pumped and stored (see Section 4.2.2 of this report).

4.3.1. FILL CONNECTION (CLAUSE 5.3.1 OF THE STANDARD)

The fill connection to a storage tank that is filled from a tank vehicle (as is proposed in this case) shall incorporate a liquid-tight connection unless the filling method employs a hand-held trigger nozzle with a non-latching feature. A cap or cover shall be provided for the fill point.

4.3.2. LOCATION OF FILL POINT (CLAUSE 5.3.2 OF THE STANDARD)

The fill point should be readily accessible and protected from accidental damage.

The Standard requires that where practicable, the fill point for any tank containing a combustible liquid shall be outside. If located inside, it "shall be not more than 2 m from a building entrance useable by a tank vehicle, and shall not be in a boiler room, furnace room, or an elevated temperature area".

CETEC comments:

It's known that the client doesn't intend to locate the fill point in any areas matching those descriptions above, but a preference has been expressed to locate the fill point below street level, within the building, and immediately outside the District Cooling Plant.

The Standard goes further to say that "Fill points located inside a building should not be operated unless the building has sufficient alternative access and egress points to ensure the safe evacuation of personnel in an emergency".

An emergency in this instance would involve a fire that has the potential to heat up the contents of all or some of the pipework, the storage tanks or the combustible liquid that's standing within a transport vehicle, to within a few degrees Celsius of the liquid's flash point. If the combustible liquid was to be heated sufficiently for its vapour to catch fire, with the liquid being released from its containment, then the fire would have the potential to spread rapidly.

If the client intends to proceed with the intended location of the fill point, then CETEC would recommend engaging the services of a qualified fire engineer to advise on whether this requirement is met and if further fire mitigating strategies are required (i.e. whether the building has sufficient

alternative access and egress points to ensure the safe evacuation of personnel in an emergency). This would need to include egress of maintenance staff working within the District Cooling Plant where the tanks are located.

Further CETEC comment: it's understood that the client has taken this matter up with a suitably qualified person and that there are considered to be sufficient alternative access and egress points as required.

The following other requirements for the fill point apply:

- The fill point for a tank shall be located so that a tank vehicle is not required to enter the tank compound to make a delivery.
  CETEC is satisfied that this requirement is met with the proposed fill point.
- For any tank containing a flammable liquid, the location shall be such that the tanker can stand wholly off any public road.
  CETEC is satisfied that this requirement is met with the proposed fill point. There may also be circumstances in which the ADG Code allows the vehicle to stand on a public road if the proposed method of delivery is changed.
- Each fill point shall be clearly identified. For petroleum products, fill points shall comply with AS 4977.
  CETEC does not consider vegetable oil to be a petroleum product.
- The areas around the tank fill point and the vehicle hose connection point shall be impervious to the product.
  CETEC is aware that the area surrounding the proposed fill point (outside the doors marked "District Cooling Plant C2B2M01" has a concrete floor, and that the area behind the doors is raised by roughly 200 mm so spilt liquid would be prevented from entering that area.

CETEC assumes that liquids will only be unloaded into the proposed tank, and that no loading of road vehicles from the proposed tank will occur, or that any removal of liquid from the tank for the purposes of maintenance would occur rarely and only during maintenance schedules.

4.3.3. LIQUID LEVEL INDICATION (CLAUSE 5.3.3 OF THE STANDARD)

It's assumed that the tank won't be filled by gravity, as the intended fill point is at roughly the same elevation as the tank.

The standard states: It shall be possible to monitor or gauge the amount of liquid in any tank intended to receive a delivery. This gauge or monitor shall also show the normal fill level of the tank. The following shall apply:

- The normal fill level shall not exceed 95% of tank capacity (overfill level).
- The provision of only a dipstick without an alarm is acceptable for liquid level monitoring of tanks up to 25,000 L tank capacity for combustible liquids.

A contents gauge or monitoring device together with a high level alarm (LAH), remote from the tank, shall be provided at the fill point, or where the tank filling operation is monitored and controlled (e.g. a control room), as a result of the following circumstances:

- The tank is to be located within the building (and at the base of the building), and the dip point is likely to be more than 8 m from the entrance to the building or otherwise inaccessible.
  CETEC assumes that this is to be the case with the proposed design.
- The tank is to be located within an existing tank chamber and access to the dip point is prevented.
  CETEC assumes that this is to be the case with the proposed design.
- The tank is to be out of direct sight of the attendant monitoring filling flow controls.
  CETEC assumes that this is to be the case with the proposed design.

In addition to the LAH, the gauge or monitor shall incorporate a physically and electrically independent high-high level alarm (LAHH). It will warn of a failure of some element of a primary (process) control system. It shall be set at or below the tank rated capacity to allow adequate response time to terminate the transfer before loss of containment and any resulting damage occurs.

The response time of this gauge or monitor should be based on the maximum flow rate of the filling pump, should generally should not be more than 10 minutes, and should be determined by a risk assessment.

Further requirements are as follows:

- The alarm system should be appropriately maintained with a safety testing regime.
- When a high level is reached, consideration should be given to shutting down the filling pump via a suitable interlock.

4.3.4. FILLING OF ELEVATED TANKS (CLAUSE 5.3.4 OF THE STANDARD)

If the fill point is at or below the highest likely level of liquid in the tank or piping system, the fill connection shall be a dry-break type, incorporating a manual shut-off valve immediately upstream of the coupling. Alternatively, an end-of-line assembly comprising a non-return valve, manual shut-off valve and cap with witness hole may be used in lieu of a dry-break coupling.

CETEC comment: CETEC accepts that the proposed tank is not an elevated tank.

4.4. VENTING (CLAUSE 5.4 OF THE STANDARD)

CETEC comment: venting requirements were discussed in Section 3.1.3 of the earlier CETEC report (Report CN150120) in relation to the diesel tank installations within what's termed the District Cooling Plant. CETEC has reviewed the venting requirements of Clause 5.4 of the Standard (which is the 2017 version of the Standard) and is satisfied that the new revision of the Standard did not include any additional venting requirements that would apply in the context of the proposed tank. As a result, CETEC accepts that if the venting system for the proposed tank were to be connected to the existing venting system, then that would ensure compliance to the Standard with respect to Clause 5.4 of the Standard, provided that the requirements described in Section 4.4.2, sub-sections (f) and (g), including the note in sub-section (f), are met. This does of course assume that no tank containing a flammable liquid is to be connected to the venting system, which would incur additional requirements. The requirements of Clause 5.4 are discussed below in case there are any plans to alter the existing system. CETEC notes that Drawing SKM 6005[10] indicates that a separate vent is to be used from the proposed tank.

The design and size of the vent provided by the tank manufacturer will require consultation concerning the conditions of installation, filling, and operation.

As the proposed tank is a Category 4 type under the Standard, the tank owner will be required to hold documentation confirming compliance with the relevant Standard, or the owner will need to be able to demonstrate that the tank is fit for service.

Each tank shall be fitted with a vent or vents in accordance with the following provisions:

- A free vent or a pressure-vacuum (PV) vent designed for use in a tank containing a

[10] This refers to Drawing SKM 6005, dated 6/10/2018, 'Barangaroo Stage 1A - C1, Vegetable Oil Fuel System, Preliminary Schematic', as supplied to CETEC by the client.

combustible liquid

CETEC comment: specifically the liquid is vegetable oil.

- No emergency vent will be required unless the tank is to be located in the same compound as a tank containing a flammable liquid.

  CETEC comment: it's assumed that the above requirement would not necessitate emergency venting.

- Vapours shall be safely discharged outdoors

  CETEC comment: CETEC assumes that there are no plans to recover vapour.

- The vents shall be separate from the filling pipe.

  CETEC comment: CETEC assumes that the vents will be separate from the filling pipe.

The basis for the above venting requirements is API Standard 2000[11].

4.4.1. VENT CAPACITY (CLAUSE 5.4.2 OF THE STANDARD)

The standard requires that the size of any free vent or pressure-vacuum vent shall be such that pressure or vacuum resulting from filling, emptying, or atmospheric temperature change will not cause the maximum allowable stress for the tank to be exceeded, nor the tank to collapse. For the Category 4 tank to be installed, these requirements shall be met by compliance to API Std 2000. The minimum vent size for the tank will depend on the maximum liquid flow rate to be used for both filling and emptying. In the case of above-ground tanks of combustible liquid, a minimum vent diameter of 32 mm applies for all filling rates up to 3000 L min. (enough to fill a 20 kL tank in about 7 minutes), while for liquid withdrawal rates from 250 to 3000 L/minute, the minimum vent size ranges from 32 mm to 71 mm (the higher vent size applies in each case, and the requirement assumes a maximum tank pressure of 17.5 kPa and vacuum of 0.5 kPa below ambient pressure).

CETEC comment: CETEC understands that at the time of preparing this report fill or discharge rates were yet to be determined, but that the client intends to meet the above requirements. It's understood from Drawing SKM 6005 that the proposed vent will have a 50 mm diameter. The proposed withdrawing rate appears to be 400 L/hour (6.7 L/min) which, according to Table 5.1 of the

[11] API 2000: 2014 "Venting Atmospheric and Low-Pressure Storage Tanks", published by American Petroleum Institute; hereafter referred to as API Std 2000.

standard would require a minimum vent diameter of 32 mm. As the proposed vent diameter is to be 50 mm, this would allow for all filling rates up to 3000 L/min.

4.4.2. VENT PIPING (CLAUSE 5.4.3 OF THE STANDARD)

Any vent piping between the tank vent connection and the discharge point shall comply with the following requirements:

(a) The vent pipe shall fall consistently back to the tank at a slope of at least 1 in 100.
CETEC comment: Drawing SKM 6005 shows a 50 mm diameter vent pipe from the tank with an opening above ground level; the client's reminded that this needs to slope at a minimum gradient of 1 in 100.

(b) A vent pipe shall not pass through building foundations but may be embedded in concrete that is part of other building construction. Joints in vents shall be—

(i) of such quality as to prevent vapour leaking;

(ii) located so that any leaking that might occur, is prevented from accumulating inside or transferring into cavity walls, ceilings or enclosed spaces.

(c) An underground vent pipe shall be either embedded in a concrete slab or laid in the earth.
If the vent pipe is laid in the earth, it shall be—

(i) located at least 300 mm below ground level;

(ii) surrounded by clean washed sand;

(iii) suitably protected if the area is subject to vehicular traffic;

(iv) designed and installed to provide flexibility to accommodate settlement; and

(v) protected from corrosion.

(d) Where vent piping penetrates a fire-rated wall, it shall be installed so as to ensure that the fire resistance of the wall is maintained.

(e) The vent pipe and terminal shall be located or protected so that they are not liable to damage resulting from normal activities.

(f) Joints in vent piping shall be sealed to prevent liquid or vapour release and tested to a minimum hydrostatic pressure of 35 kPa or the operating pressure of the vent unit, whichever is the greater.

CETEC comment: CETEC understands that the client intends to meet the requirements in sub-headings (a) to (f) above.

NOTE: Vent pipes may be connected together to form a common vent line, provided that the area of any common vent line is not less than the sum of the cross-sectional areas required for the individual vents connected to it, and that cross-contamination will not affect adversely the use of the contents of either tank.

CETEC comment: Drawing SKM 6005 indicates that it's proposed to use a separate vent for the proposed tank.

(g) Where several tanks are interconnected by a common venting system and the vapours in the vapour are within the explosive range, measures shall be taken to prevent the possibility of flashback or flame propagation through the system from one tank to another, e.g. by the use of flashback arresters, barometric dampers, nitrogen inerting or ensuring that the vapour concentration is always above the explosive range.

NOTE: Additional requirements may be necessary where vapour recovery is adopted.

CETEC comment: CETEC understands that the use of vapour recovery is unlikely due to the storage of only diesel and processed cooking oil. Vapour concentrations within the venting system of the vegetable oil tank are likely to be well below the explosive range, and the same would apply if this tank was to be interconnected with the other tanks within the District Cooling Plant, as they also comprise C1 or C2 combustible liquids with low vapour pressures. If the client considers that there's a possibility that used vegetable oil could become contaminated with an organic compound that has a relatively high vapour pressure, and if tanks are to be interconnected, then the use of flashback arrestors (or devices with an equivalent function) to prevent flame propagation from tank to tank may be advisable.

4.4.3. VENT OUTLET LOCATION (CLAUSE 5.4.4 OF THE STANDARD)

The discharge point of a vent shall comply with the following requirements:

(a) For tanks of combustible liquids, the vent discharge point shall be located laterally at least 2 m from any opening into a building, e.g. window, door, ventilator, air conditioner or a mechanical vent intake to reduce the possibility of the entry of nuisance vapour. The vent shall be located such that the opening into a building shall be outside the hazardous area (as described by AS/NZS 60079.10.1).

CETEC comment: this requires verification; CETEC accepts that the possibility of a hazardous area occurring due to the presence of vapours from processed vegetable oil is extremely low.

(b) The vent discharge point shall be located at least 4 m above ground.

CETEC comment: this is assumed to be the case. Drawing SKM 6005 indicates the discharge point emerging above ground level.

NOTE: The vent for any above-ground tank may discharge at a point at least 150 mm above the top of the tank, provided that other requirements for tank and vent locations are met.

(c) Where the tank is to be filled by gravity flow from a tank vehicle, the vent discharge point for the tank shall be at least 4 m above ground level at the fill point and in all circumstances shall be higher than the tank vehicle.

CETEC comment: it's understood that it's not the intention to fill by gravity in the case of the vegetable oil tank, but the client should be aware of this in case the mode of delivery is to be changed.

(d) Where a Category 4 tank is to be filled by pumping from a tank vehicle—

(i) the vent pipe or overfill point shall terminate in view of the filling operator; or

(ii) the tank shall be fitted with a high level alarm audible to the filling operator.

CETEC comment: CETEC understands that if the filling operation is to take place indoors, then the second of the above clauses would apply, and that a high-level alarm will be required.

Notwithstanding other requirements in the above clauses in Section 4.4.3, a vent provision may be connected to a vapour recovery or collection system.

NOTE: When filling rates are high, the velocity of the discharging vapour may be high enough to carry it a considerable distance. In such cases, particular attention should be paid to direction of discharge, to vapour diffusion and to potential ignition sources, especially for flammable liquids.

4.4.4. VENT TERMINALS (CLAUSE 5.4.5 OF THE STANDARD)

The discharge end of the vent shall be protected from the ingress of foreign material by means of a protective cage or fitting. As the tank is not to contain flammable liquid there is not likely to be any issue with explosive vapour and as a result a flame arrester or similar device will not be required. The protective cage or fitting shall not reduce the required effective vent area or create undue back-

pressure within the tank.

4.4.5. Application of Pressure-Vacuum Vents (Clause 5.4.6 of the Standard)

For a Category 4 above-ground tank, no restrictions apply to the use of a pressure-vacuum vent.

4.4.6. Setting of Pressure-Vacuum Vents (Clause 5.4.6 of the Standard)

The settings of any pressure-vacuum vent shall be such that the pressure and vacuum limits, as given in the Standard to which the tank has been designed and tested, are not exceeded.

For the proposed Category 4 tank, and assuming that it's designed and tested in accordance with AS 1692, the pressure setting shall be such that the test pressure of the tank is not exceeded under maximum normal venting conditions. The vacuum setting shall be such that the internal pressure does not fall below a pressure of -0.5 kPa gauge.

If an emergency vent is to be used (and CETEC does not see the need for one in this context), the setting of the pressure-vacuum vent shall be more than 7 kPa below that of the emergency vent.

4.5. Emergency Venting (Clause 5.5 of the Standard)

As the tank is not to contain flammable liquid, and nor will the other tanks within the same tank chamber, and the proposed tank won't be of the type having a fixed roof, CETEC does not see the need to provide emergency venting in this context.

4.6. Location and Capacity of Indoor Tanks (Clause 5.6 of the Standard)

As the liquid within the proposed tank cannot be said to be an integral part of blending, mixing or processing equipment, the requirements of Clause 5.6 of the Standard will apply.

As the liquid in question is a C2 combustible liquid, only sub-clause 5.6.4 of Clause 5.6 of the Standard will apply.

4.6.1. Location and Capacity of Indoor Tanks (Clause 5.6.4 of the Standard)

As it's proposed to store a Class C2 combustible liquid in a tank within the building and on the lowest floor level, the following requirement will apply:

The capacity of each tank that is located on the lowest floor level shall not exceed 60,000 L.

CETEC comment: CETEC accepts that this is the case.

4.7. SEPARATION OF ABOVE-GROUND TANKS (CLAUSE 5.7 OF THE STANDARD)

Separation between the proposed tank and various other features of the building are discussed in this section.

Other tanks within the District Cooling Plant may contain diesel in the form of C1 combustible liquid but these are adequately separated from the proposed tank (as will be discussed).

As the proposed liquid is a C2 combustible liquid, there are no restrictions on how close it, or the fill point, can be located to security fences and on-site protected places (as defined within the Standard).

The separation distance to protected places beyond the site boundary would be a minimum of 3 m for a 20 kL storage of C2 liquid, so this requirement would be easily satisfied.

If at some stage the vegetable oil was to be classified as a C1 combustible liquid, then these requirements would change and the changes would need to be considered in the context of the Standard.

4.7.1. HORIZONTAL TANKS (CLAUSE 5.7.6 OF THE STANDARD)

CETEC understands that the proposed tank is to be a Durotank ST020 Smart Tank, which is a tank of double-walled construction that is self-bunded (i.e. has integral secondary containment). The discussion below is based on the use of this type of tank and indicates in places where the tank supplier needs to verify requirements of the Standard.

The proposed tank is specified at 4.50 m long by 2.45 m wide with a height of 2.70 m.

The following requirements apply to the storage of liquids in horizontal tanks:

(a) Horizontal tanks shall comply with AS 1692 as well as the requirements of AS 1940.
CETEC comment: CETEC accepts that the proposed tank is likely to comply, but suggests seeking verification from the tank supplier. In section 4.9.2, it's pointed out that it's a requirement of the Standard that double-walled tanks are "wholly constructed of steel and shall be designed in accordance with AS 1692 or an equivalent standard".

(b) The distance between horizontal tanks shall be at least 600 mm. Where horizontal tanks are adjacent to vertical tanks, the distance requirements for vertical tanks shall apply.
CETEC comment: it's understood that no vertical tanks of flammable or combustible liquids are to be used within the District Cooling Plant. The dimensions shown in Drawing AD106220 (Rev. S) for the area described as the "Green utility workshop" indicate that the workshop is

roughly 3.9 m wide by 10.6 m long. This would easily accommodate the proposed tank with a margin of about 3.0 m from the walls of the proposed tank compound where it borders the adjoining compound indicated as "Fuel Tank Room No. 1" if centred within the compound. If 600 mm from this wall the distance to the neighbouring tank would be sufficient, regardless of the fire rating of the wall. However, this assumes that the location of the proposed tank forms a bund under the definition within the standard (discussed in Sections 2.1 and 4.8 of this report). If this proves not to be the case, then the secondary containment properties of the proposed tank would be important, and the above separation distance would still apply.

(c) Tanks shall not be arranged end-to-end unless the potential for end failure and the resulting exposure hazard has been taken into account when determining the tank's location.
CETEC comment: the possibility of end failure and any resulting exposure hazard is outside the scope of this report and CETEC recommends engaging a specialist or the tank manufacturer to address this issue. However, as the tanks are within separate enclosures separated by concrete walls, arguably they are not arranged end to end (and the FRL of these walls is understood to be 240/240/240).

4.7.2. MIXED PRODUCTS (CLAUSE 5.7.6 OF THE STANDARD)

Within the same storage area (the District Cooling Plant) there are also horizontal tanks of diesel fuel. This particular diesel fuel is classified as a C1 combustible liquid. As the C1 liquids have the lower flash point, any separation distances between tanks will be dictated by the requirements for a C1 liquid rather than a C2 liquid. This will also apply to tanks separated by bunds. However, in this instance the tanks are installed within their own fire separated enclosures, aiding in maintaining separation between tanks.

4.8. BUNDS AND COMPOUNDS (CLAUSE 5.8 OF THE STANDARD)

The Standard requires that provision be made to contain any leakage or spillage from the tank storage facility and to prevent it from contaminating the surrounding soil or from entering any watercourse or water drainage system.

It's proposed that the tank will be installed within a walled chamber, as for the existing C1 diesel tanks within the District Cooling Plant. In the earlier CETEC report it was accepted that the enclosure for each diesel tank constituted an adequate bund for the volume of liquid to be stored within each

(maximum 54,200 L). If the proposed storage area in what's termed the Green Utility Workshop is of the same construction (or if it is to be restored to its original state of construction, or its original design), then it too would represent and acceptable bund for the proposed storage volume (20,000 L of vegetable oil and additionally 3,500 L of an aqueous solution of urea).

It's understood that the proposed tank will have integral secondary containment and as a result Clause 5.8 of the Standard, dealing with "bunds and compounds", does not necessarily apply. However, if it's the intention to restore the area that forms the location of the proposed tank to become a compound that comprises a bunded area for a single tank, then the requirements for bunding in Clause 5.8.3 of the Standard will apply. The applicable requirements of that section are discussed in Section 2.2 of this report, based on the assumption that an earthen wall will not form part of the bund. The discussion in Section 2.2 refers to the earlier CETEC report (CN150120) in which the design of the current diesel storage tanks within the District Cooling Plant was found to comply with the Standard.

If a tank with integral secondary containment is to be used, then it's the responsibility of the client to seek assurances from the supplier of the proposed tank that it meets appropriate requirements of the Standard, as discussed in various sections of this report.

The term "compound" is applied within this report within the definition from the Standard, which is:

> *An area bounded by ground contours or by a bund, and intended to retain spillage or leakage. This includes the floor of the compound.*

In the context of the group of storage tanks within the area referred to in the site drawings as the "District cooling plant", each tank storage area forms its own compound and the meaning within the standard is retained.

4.9. Requirements for Above-Ground Tanks with Integral Secondary Containment (Clause 5.9 of the Standard)

CETEC understands that the proposed tank falls at least partially within the description from Clause 5.9.1 of the Standard of "A double-walled tank", as well as being "a tank having secondary containment". The secondary containment would need to include "an external, fire-rated covering" in order for it to fully come under that description.

CETEC comment: CETEC suggests seeking verification from the tank supplier that the proposed tank does indeed include an external, fire-rated covering. The brochure for the tank describes it as being

"self-bunded" and as such CETEC accepts that this is equivalent to "integral secondary containment", subject to the conditions of the Standard.

4.9.1. Requirements for All Tanks Having Integral Secondary Containment (Clause 5.9.2 of the Standard)

The following specific requirements apply to the specified tank (that being a tank with integral secondary containment):

(a) The tank shall not be used for the storage of PG I flammable liquids.
CETEC comment: CETEC accepts that no PG I flammable liquids are to be stored.

(b) The capacity of the tank shall not exceed 110,000 L (as a tank containing a combustible liquid).
CETEC comment: CETEC accepts that this is the case (the tank does not exceed 100,000 L).

(c) The primary (inner) tank shall be constructed to AS 1692 or equivalent Standard.
CETEC comment: CETEC accepts that this is likely to be the case but suggests seeking verification from the tank supplier.

(d) The secondary containment shall be adequately designed and constructed, to contain the entire contents of the primary tank.
CETEC comment: suggests seeking verification from the tank supplier.

(e) Means shall be provided to establish and monitor the integrity of the primary tank.
CETEC comment: The brochure for the proposed tank includes a manway for access to the inner tank, which is presumed to be the primary tank as referred to above. It would be the client's responsibility to verify that this allows sufficient access for monitoring integrity.

(f) The tank shall be installed in accordance with Clause 5.11 of the Standard (which covers the proposed type of tank).
CETEC comment: see discussion in Section 4.10.

(g) Where flammable liquid or vapour could escape from the interstitial space of a tank, the tank shall be separated by at least 3 m from any ignition source, including vehicles being refuelled.
CETEC comment: CETEC understands that the proposed tank will not contain flammable liquid and that as the tank is to contain a C2 flammable liquid, the likelihood of a flammable vapour escaping from the interstitial space is extremely low and can be discounted as a possibility. As a result, this sub-clause need not apply.

(h) Spacing between adjacent tanks shall be at least 600 mm.

CETEC comment: CETEC accepts that this is the case.

(i) The tank shall be protected from damage caused by an impact.

CETEC comment: it's understood that vehicles occasionally enter the area described as the "District cooling plant", but that the tank will be within its own walled enclosure, and that this enclosure is sufficient to protect the tank from any impacts.

(j) Means shall be provided to prevent release of liquid by siphon flow from the tank.

CETEC comment: CETEC understands that the proposed tank incorporates an "anti-siphon valve". It would be the client's responsibility to verify its proper function..

(k) The tank shall be fitted with a means of determining the level of its contents. Such means shall be available to the delivery operator.

CETEC comment: this requirement is discussed in Section 4.3.3 of this report. CETEC understands that the design of the proposed tank includes a calibrated dipstick with a safe fill level. However, the proposed filling system would require the delivery operator to fill from a location well away from the tank and this extra design requirement would need to be taken into account.

(l) All piping connections to the tank shall be above the normal maximum fill level.

CETEC comment: this requirement, imposed on all tanks having secondary containment, requires that the tank is filled from piping connection that's above the highest maximum fill level.

(m) Tanks shall not be manifolded unless provisions are made to prevent their being overfilled.

CETEC comment: CETEC understands that this tank is not to be manifolded with any other tanks.

(n) Overfill protection shall be provided by a suitable alarm, with the flow of liquid being stopped, before the tank overflows.

If the tank is designed to contain overflow, such an alarm is the minimum provision necessary to achieve this objective. If the overflow is to be discharged outside the secondary containment, an automatic shut-off shall be provided. These provisions shall not restrict or interfere with the proper functioning of the normal vent or the emergency vent.

CETEC comment: CETEC already recommends a contents monitoring gauge along with a LAH

owing to non-accessibility to the dip point from the attendant who is likely to monitor the filling operation, and owing to the use of a tank chamber (preventing access to the dip point). CETEC also recommends installation of a suitable interlock that will shut down the pump when the contents monitoring gauge indicates that the tank is full.

(o) The fill point for the proposed tank shall be provided with spill containment having a minimum capacity of 15 L. The device shall be fitted to the tank in order to catch and contain any minor spill during product delivery to the tank.
CETEC comment: Drawing SKM 6005 shows a drip tray located beneath the fill point, located just outside the District Cooling Plant. It's assumed that this represents a minimum containment capacity of 15 L.

(p) Where a tank having multiple compartments is installed, the separation distance to protected places shall be based on the aggregate volume of the compartments and the lowest flash point of the liquid in any tank compartment.
CETEC comment: the tank is assumed not to be a multi-compartment tank.

(q) Venting shall comply with Clause 5.4 of the Standard.
CETEC comment: the venting requirements have already been discussed in Section 4.4 of this report (which addresses Clause 5.4 of the Standard).

(r) Where the interstitial space is enclosed, it shall be provided with venting in accordance with the Standard or with a method approved by Underwriters Laboratories (UL).
CETEC comment: CETEC recommends that the client discusses this requirement with the supplier of the proposed tank, which is "self-bunded and double-walled".

(s) Means shall be provided to physically test the correct functioning of any internal valve without the need to remove the valve.
CETEC comment: this requirement is brought to the client's attention.

4.9.2. ADDITIONAL REQUIREMENTS FOR DOUBLE-WALLED TANKS (CLAUSE 5.9.3 OF THE STANDARD)

CETEC comment: it's understood that the proposed tank fits the description of a "double-walled tank".

The following additional requirements apply for double-walled tanks:

(a) Primary and secondary containment shall be wholly constructed of steel and shall be designed in accordance with AS 1692 or an equivalent standard.
CETEC comment: it would be the client's responsibility to obtain an assurance from the

supplier of the proposed tank that this is the case.

(b) Separation distances as given in discussed in Clause 5.7 of the Standard (see Section 4.7 of this report) shall apply.

4.9.3. ADDITIONAL REQUIREMENTS FOR TANKS WITH EXTERNAL FIRE-RATED COVERING (CLAUSE 5.9.4 OF THE STANDARD)

CETEC comment (a): it's understood that the proposed tank is "self-bunded (double wall)", and that it's claimed to be suitable for the storage of C1 combustible liquids (which would make it suitable for the storage of C2 liquids). If the tank is specified to have an "external, fire-rated covering" then this section would apply. The external fire-rated covering would not necessarily be a requirement if the proposed storage area already represents an adequate bund for the tank.

CETEC comment (b): it's assumed that if the proposed storage area for the vegetable oil tank is to be restored to its original design to the extent that it has the same containment capacity, and that this is to be considered to be a containment or bund as defined in the Standard, that it will have the same fire ratings for penetrations, doors, walls and ceiling, as the three current diesel storage areas

NOTE: Fire-rated tanks include 'vaulted' tanks which comply with UL 2085 or are approved by Underwriters Laboratories (UL) or Factory Mutual (FM) to the equivalent US fire rating.

CETEC assumes that the tank to be installed is not of the type that could be described as a "vaulted tank".

The following requirements apply to tanks having an external, fire-rated covering on both the tank and any supports:

(a) The secondary containment shall have an FRL of 240/240/240.
CETEC comment: CETEC suggests seeking verification from the tank supplier.

(b) Emergency venting for the interstitial space in this tank system may be provided by a weak seam incorporated into the tank's external cover. In such a system, this seam shall fail preferentially if the pressure within the interstitial space builds up excessively, without compromising the integrity of the secondary containment.
CETEC comment: CETEC suggests seeking verification from the tank supplier.

(c) Tanks having an FRL of 240/240/240 shall be regarded as complying with the requirements for tanks in chambers (see Section 4.11.1 of this document for discussion of this requirement).

(d) Where the tank's secondary containment has an FRL of at least 240/240/240 or complies with

UL 2085, the following separation distances shall apply:

(i) To on-site and off-site protected places, the distances given in Clause 5.7 may be halved.

CETEC comment: In the case of a 20 kL tank of C2 combustible liquid, this requirement is irrelevant, as the nearest protected place is several tens of metres away.

(ii) To boundaries and public places: 2 m.

(iii) To any security fence: 1 m.

(iv) To a dispenser: nil.

CETEC comment: these requirements are irrelevant in this context, unless there are plans to mount a dispenser on the tank.

NOTE: A dispenser may be mounted on a tank, provided it is suitable for use in the hazardous area around the tank. (CETEC accepts that in this instance there would be no hazardous area).

4.9.4. Additional Requirements for Tanks with Integrated Spillage Compounds (Clause 5.9.5 of the Standard)

The requirements of Clause 5.9.5 of the Standard do not apply as the proposed tank is assumed not to be of the type described as having an integrated spillage compound.

4.10. Installation Methods for Above-Ground Tanks (Clause 5.11 of the Standard)

As CETEC previously advised the client concerning compliance of the original tank installation to AS 1940, any aspects of that original report (CETEC report CN150120) applying to infrastructure that's already build would also apply to this report, notwithstanding any changes that were introduced to AS 1940 in the 2017 update of the Standard. Aspects of the Standard addressing tank installation methods are discussed in this section, with reference to the previous report where that report dealt with infrastructure that applies to the current installation.

4.10.1. Foundations (Clause 5.11.1 of the Standard)

Note: all aspects of this section are likely to have been addressed in the previous CETEC report (CN150120).

An above-ground storage tank shall rest on a foundation which is adequate to support, without unacceptable or uneven settling, the following loads and forces:

(a) The direct load imposed by the tank when full of either water or product, whichever is the more dense.

CETEC comment: water is denser than vegetable oil, so the imposed weight would be 20 tonnes.

(b) Any possible overturning forces, and in particular those due to wind when the tank is empty.

(c) Any uplift or other distorting forces such as may occur in a tank under pressure. Any attachment between the tank and its supporting structure or foundation shall be adequate to withstand any such forces.

NOTE: Because of the wide variety of surface, subsurface, and climatic conditions, it is obviously not possible to establish design data to cover all such situations. The allowable soil loading requires a decision for each individual case, having regard to the permissible settlement (refer to AS 1726[12]).

4.10.2. SUPPORTING STRUCTURES (CLAUSE 5.11.2 OF THE STANDARD)

Any supporting structure between the foundation and the tank shall comply with the following requirements:

(a) Any supporting structure, or ancillary structure used to provide rigidity, shall be made wholly of non-combustible material.

(b) Any metallic support that is more than 1 m high and supports a tank having a capacity greater than 10,000 L of combustible liquid, shall be protected by material having an FRL of at least 120/120/120.

(c) The structure shall be designed according to the requirements of the Australian Standard applicable to the particular construction (refer to AS 4100 for steel and AS 3600 for concrete).

(d) The design shall take account of the total mass of the tank when full of either water or product, whichever is the greater (in this instance water has the greater density so the mass due to water alone will be 20 kL), any wind loading, any possible uplift loading on restraining connections, and any likely seismic loading (refer to AS 1170.4). Any such anchorage shall be designed to overcome the maximum anticipated buoyancy force.

[12] AS 1726:2017 Geotechnical site investigations

4.10.3. TANK BEARING AREA (CLAUSE 5.11.3 OF THE STANDARD)

The method of support of a tank shall avoid excessive concentration of loads on the supporting portion of the tank shell. Legs, cradles or similar methods of support shall be attached in a manner that will prevent possible trapping of moisture and corrosion of the tank shell.

4.10.4. TANKS IN AREAS SUBJECT TO FLOODING (CLAUSE 5.11.4 OF THE STANDARD)

A tank located in a flood-prone area shall be anchored to prevent floating.

CETEC comment: it's assumed that there's an extremely low risk of flooding within the District Cooling Plant.

4.11. INSTALLATION METHODS FOR TANKS IN TANK CHAMBERS (CLAUSE 5.13 OF THE STANDARD)

4.11.1. ABOVE-GROUND TANK CHAMBERS (CLAUSE 5.13.1 OF THE STANDARD)

CETEC comment: in Section 2.2 of this report, it's noted that if the design and construction of the enclosure for the proposed new tank, currently called the Green Utility Workshop, is the same as for the current enclosures for the existing three diesel tanks then it would represent a tank chamber with containment capacity of at least 54,200 L and with sufficient fire protection. If this is the case then the requirements of Clause 5.13.1 of the Standard for above-ground tank chambers (as laid out below) would be considered to be met, based on the conclusions of the previous CETEC report (CN150120).

Any tank chamber that is on or partly below the lowest floor level shall be constructed in accordance with the following requirements:

(a) The walls shall have an FRL of 240/240/240.

(b) The roof shall be of reinforced concrete at least 150 mm thick.

NOTE: The roof may have a removable section or sections for access or maintenance.

(c) Where a tank chamber is subject to superimposed loads, the thickness of the roof or walls, or both, shall be increased appropriately.

(d) The floor shall be of masonry or reinforced concrete, or of material of equivalent strength, excluding earth and asphalt.

(e) There shall be a clear space of at least 450 mm between any tank and any wall or roof of the chamber, or any other tank in the chamber.

CETEC comment: in the earlier CETEC report, it was established that the diesel tanks were

separated from the four walls by roughly 863 mm, 765 mm, 641 mm and 543 mm from the four walls, and that the top of each diesel tank was at greater than 450 mm below the slab above. CETEC accepts that the proposed new tank is of different dimensions, although with a smaller capacity. The client would need to verify that the above requirement is still met with the new tank.

(f) Any doorway or other access opening in any wall shall be protected by a fire door or cover having an FRL of at least –/120/30. Such a door or cover shall be designed to normally be closed.

(g) The sill of any doorway shall be raised to provide a liquid-tight compound capable of sustaining the hydrostatic load and having a net capacity at least that of the largest tank.

(h) The tank chamber shall not have an automatic pump-out system.

NOTE: If spills could accumulate in the tank chamber, a manually operated low-point sump or pump-away facility should be installed.

4.12. SERVICE TANKS (CLAUSE 5.14 OF THE STANDARD)

CETEC understands that no service tank is to be used in the delivery of fuel from this tank to the generator and as a result of the requirements of Clause 5.14 of the Standard do not apply.

5. Discussion of Proposal in Relation to Part 6 of AS 1940:2017

CETEC comment: Part 6 of the Standard deals with "Systems for Piping, Valves, Pumps and Tank Heating". Possibly relevant aspects of the standard are reproduced below as a guide to design.

5.1. General Design and Construction (Clause 6.1 of the Standard)

5.1.1. Design Suitability (Clause 6.1.1 of the Standard)

The design, fabrication, assembly, testing and inspection of piping that is to contain flammable or combustible liquids shall be suitable for the expected working pressures, temperatures, and structural stresses. AS 4041[13] shall also be consulted.

5.1.2. Material suitability (Clause 6.1.2 of the Standard)

Any material used in the construction or installation of piping shall be suitable for the conditions of use (see also Clause 5.2.4). The following requirements apply:

(a) The material shall be compatible with the particular liquid or any other component with which it may be in contact.

(b) The material shall be resistant to any heat to which it may normally be exposed.

(c) Where exposed to corrosion, from within or without, the material shall be sufficiently resistant to ensure a life span at least equal to other parts of the installation or to achieve its design life.

NOTE: Copper is not a preferred material for product lines and its use is to be discouraged for the following reasons:

(a) It is mechanically weaker, has a lower melting point than other materials (e.g. steel).

(b) The jointing methods used for copper pipe are less robust than other systems (e.g. flanges, welds).

(c) Given the wide range of flammable and combustible liquids, chemical reaction between the liquid and the copper pipe may be more likely.

(d) Vibration could cause copper to harden over time.

[13] AS 4041-2006 (R2016), entitled "Pressure piping"

(e) Copper could catalyse the decomposition of some fuels.

5.2. PIPING (CLAUSE 6.2 OF THE STANDARD)

5.2.1. DESIGN AND CONSTRUCTION (CLAUSE 6.2.1 OF THE STANDARD)

The following general design considerations shall be taken into account when designing or installing any piping:

(a) Access for operating, testing, maintenance, replacement or drainage.

(b) Support and fixing.

(c) Exposure to mechanical damage.

(d) Protection against corrosion wherever necessary, particularly for piping that is outdoors, or underground, or underwater, or which passes through or is embedded in any material likely to induce corrosion.

(e) Suitability for the liquids to be piped, and possible change of such liquids.

(f) Integration with any cathodic protection system.

(g) Any need to relieve excess pressure between valved-off sections of pipe in liquid service.

(h) Expansion or contraction of the piping.

(i) Drainage for any trench in which pipes are laid.

(j) Protection for any buried piping from superimposed loads or ground settlement.

(k) Electrical bonding and earthing (refer to AS/NZS 1020 and IEC 60079-32-2).

(l) Where piping is encased in concrete, the need to guard against corrosion and to provide for expansion.

(m) Painting or marking of piping, to permit ready identification of its contents (refer to AS 1345).

(n) Access to, and operation of, valves and other control devices, including ergonomic considerations.

(o) Fire resistance, where piping could be exposed to fire.

5.2.2. JOINTS (CLAUSE 6.2.2 OF THE STANDARD)

Joints in piping shall be suitable for the operating pressures, temperatures, materials, and other conditions of use. Particular attention shall be paid to the joint's vulnerability to failure in the event

of fire and susceptibility to corrosion, particularly if it is buried or submerged.

Joint types that are suitable are—

(a) threaded joints conforming with AS 1722; and

(b) flanged joints conforming with AS 2129 or ASME/ANSI B16.5, Class 150.

NOTES:

1 Mechanical grooved couplings tested to API Std 607 should only be used to accommodate misalignment or movement.

2 AS 4041 provides requirements for joints in pressure piping.

3 For small diameter piping, joints should be of a metal-to-metal compression type.

Any joint in copper pipework shall be made only with a flare compression fitting, or with a capillary fitting using a brazing metal with a melting point of at least 540°C, or by a spigotted joint formed from the pipe itself, and brazed as above. Flare fittings having mismatching cone angles shall not be used.

5.2.3. FLEXIBLE TUBING (CLAUSE 6.2.3 OF THE STANDARD)

This Clause applies to the connection of the fuel dispenser to the supply piping, but does not apply to the internal piping of the fuel dispenser.

Flexible tubing, piping or hose may be used, provided that the principles of Clauses 6.1 and 6.2.1 are met. Such tubing shall meet any necessary requirements with regard to compression, elongation, and angles of horizontal and vertical displacement.

A hose assembly shall be designed or shall have been tested to withstand at least 1.5 times the maximum allowable operating pressure, regardless of whether it is under pump pressure or at zero flow, and including dead-heading and system back-pressure.

5.2.4. TRANSFER HOSE (CLAUSE 6.2.4 OF THE STANDARD)

A hose and hose assembly for distribution of petroleum products (except LP Gas) shall comply with AS 2683.

NOTE: Products other than petroleum may require specific hose materials or couplings, because of compatibility of materials, additional hazards or the like.

5.2.5. VAPOUR RECOVERY PIPING (CLAUSE 6.2.5 OF THE STANDARD)

Any vapour recovery piping system for tank vehicle filling installations shall be designed so that when all pump-supplied tank vehicle filling provisions served by that vapour recovery system are in use simultaneously, the back-pressure on each tank vehicle does not exceed its normal operating pressure.

5.3. VALVES (CLAUSE 6.3 OF THE STANDARD)

5.3.1. SYSTEM REQUIREMENTS FOR VALVES (CLAUSE 6.3.1 OF THE STANDARD)

Sufficient valves shall be provided to permit proper operation of the system and to protect the installation. The following requirements apply:

(a) A manually-operated tank or liquid outlet valve shall be located as close as possible to the shell of an above-ground tank.

(b) A non-return valve shall be located in each tank-filling pipe close to the filling connection unless the levels of the filling connection, the downstream filling pipe, and the tank are such that backflow cannot occur when the filling hose has been disconnected. Where an anti-siphon opening is made in the filling pipe above the maximum liquid level in the tank, a non-return valve is not required.

5.3.2. EMERGENCY SHUT-OFF PROVISIONS (CLAUSE 6.3.2 OF THE STANDARD)

Provision shall be made to shut off the flow of liquid quickly in an emergency—

(a) from the storage tank and service tank to a consuming device; and

(b) to a tank vehicle fill point.

CETEC comment: the first point above would apply to the flow of liquid to a generator, while the second point would not apply as there are no plans to fill tank vehicles.

Any manually operated valve or the actuating device for a remotely operated valve shall be located in a convenient and safe location and conspicuously marked with the words 'EMERGENCY LIQUID SHUT-OFF' or 'EMERGENCY STOP'.

5.3.3. VALVE SELECTION (CLAUSE 6.3.3 OF THE STANDARD)

Any valve used for a flammable or combustible liquid shall comply with the following requirements:

(a) For any valve that can be operated or closed by manual action, the distinction between the open and shut positions shall be obvious.

(b) Any hand-operated valve having a handwheel, cross, tee or similar symmetrical handle, shall close by clockwise rotation, when viewed from the end of the spindle of the actuating device. A hand-lever operated valve shall be installed so that the lever is at right angles to the pipe when closed, and so that gravitational forces on the handle will not act in the direction of opening except where the valve is designed to fail-safe. The direction of closing shall be clearly marked.

(c) The use of detachable handles for valves shall be avoided unless essential for security, for procedures, or for sequences. Any such handle shall not be removable unless the valve is at a safe setting and so indicated.

(d) It is preferable that the valve type permits gland repacking to be achieved without having to remove the valve from its installed position.

(e) Any valve whose failure in the event of fire could create a hazard shall be of either steel or a suitable grade of spheroidal graphite iron. The valve handle shall be of metal not inferior to the valve body in fire resistance.

(f) Cast steel fire-safe valves shall be provided—

(i) where any tank valve is below the liquid level of a tank of Categories 4, 5 or 6 containing flammable or combustible liquid; or

NOTE: If a cast steel valve incorporates no soft seals or other parts that could be affected by a fire, it may be considered to be 'fire-safe' and does not usually require a fire type test, (e.g. gate valves to API Std 600).

5.4. PUMPS (CLAUSE 6.4 OF THE STANDARD)

5.4.1. PRESSURE AND TEMPERATURE CONTROL (CLAUSE 6.4.1 OF THE STANDARD)

Where the discharge pipe of a pump can be shut off, provision shall be made to prevent the build-up of pressure or temperature in excess of the design capability of the pump and piping. The design of the system shall take into account the following:

(a) A hydraulic relief valve shall not normally be provided with an isolating valve.
Any such isolation valves, if installed, shall be arranged to be secured in the open position.

NOTES:

1 Pump bypasses may be installed to prevent local overheating. Isolation valves to serve hydraulic relief valves or pump bypasses are not recommended.

2 Discharge from a hydraulic relief valve should be returned to the supplying storage tank or returned to the pump inlet provided that the heat generated by such recirculation is within design limits.

(b) The range of adjustment of any hydraulic relief valve shall be restricted to prevent excess pressure, or an excess-pressure relief valve shall be fitted.

5.4.2. EMERGENCY SHUT-OFF (CLAUSE 6.4.2 OF THE STANDARD)

An emergency shut-off device shall be provided on each pump. The shut-off device shall be readily accessible and its purpose clearly identified.

5.4.3. PUMP DRIVE (CLAUSE 6.4.3 OF THE STANDARD)

This clause of the Standard applies to motors and engines for driving pumps, and requires consideration of hazardous areas. The assumption is applied that no hazardous areas exist within the area in question and as a result this clause does not apply in this context.

5.5. HEATING OF LIQUIDS (CLAUSE 6.5 OF THE STANDARD)

CETEC comment: Clause 6.5 of the Standard applies only if the liquid is to be preheated before it's pumped to the generator. It's understood that fuel will be heated at the engine and in the loop by water/fuel heat exchangers to a temperature of 25-30°C (in the loop) and 45-70°C when passing into the engine. CETEC does not consider that a temperature of 30°C would be excessive but notes that the heating operation would require some heat input nevertheless. At the maximum temperature of 70°C, CETEC would not expect any problems associated with decomposition, cracking or boiling of the liquid. The temperature of 70°C is at least 100°C below the flash point of the liquid, and 23°C below the flash point of any C2 combustible liquid. However, some aspects of the requirements reproduced below may still apply.

5.5.1. ACCESS FOR SERVICE (CLAUSE 6.5.1 OF THE STANDARD)

Critical components of the control system shall be removable without the need to drain any tank. The design, fixing and sealing of any insulation or lagging on pipes and tanks shall be such as to avoid the retention of moisture and to allow the removal of the insulation for inspection and maintenance purposes.

5.5.2. CONDENSATE (CLAUSE 6.5.2 OF THE STANDARD)

Condensate from a steam heater that might be contaminated with flammable or combustible liquid shall not be returned to a boiler feed without treatment to ensure that it is suitable as feed water.

CETEC comment: it's assumed that this requirement does not apply.

5.5.3. HEATING OF PIPES (CLAUSE 6.5.3 OF THE STANDARD)

Where heating is provided by means of heat-tracing, the supply shall be thermostatically controlled and shall comply with AS/NZS 3000.

CETEC comment: it's noted from Drawing SKM 6005 that heat-tracing will be used, so the above clause will apply.

5.5.4. HEATER CONTROLS (CLAUSE 6.5.4 OF THE STANDARD)

Where heating elements could become exposed above the liquid level because of normal operating level fluctuations, and the temperature of the heating medium is within 6°C below the flash point of the liquid (see Clause 6.5.5), sufficient valves or control systems shall be provided to isolate such exposed heating elements.

CETEC comment: it's assumed that the heating medium will not be within 6°C of the flash point of the liquid to be stored and pumped, which has a specified flash point of approximately 282°C. If a liquid having a much lower flash point was to be stored (the flash point can be as low as 93°C and still be a C2 combustible liquid) then this apply. However, it would only apply if the heating elements were exposed above the liquid level.

6. CONCLUSION

CETEC has reviewed the design of the proposed vegetable oil storage area within the Barangaroo South project, as well as the proposed diesel fill point.

Overall the design of the system was found to be compliant to the requirements of AS 1940 subject to verification of various design requirements, addition to expert opinion from a fire engineer in relation to fire requirements and the availability of sufficient alternative access and egress points to ensure the safe evacuation of personnel in an emergency, so as to allow the fill point for the tank to be located within the lower floor of the building rather than at an entrance to the building.

6.1. OTHER CONSIDERATIONS FOR DIESEL STORAGE AND HANDLING

CETEC highly recommends that an 'emergency response' or 'consequence and action response' document be prepared which will detail the required actions should with any fuel leakage due to a pipe rupture either within the tank rooms, generator rooms, fill point or along the pathway between each location occurs. If this document has already been prepared for the existing diesel storage areas, then it should be updated to include any additional requirements resulting for the installation of the additional tank. Such action plans should entail both Operational and Engineering Response actions which outline automated and facility management actions to minimise the risk of uncontrolled fuel spillage. These response actions may need to be tested during the commissioning phase for appropriate consequence and action outcomes, depending on the extent of additional requirements resulting from the installation of the extra tank.

The design team should also consider installing appropriate spill kits for diesel fuel within each generator room, pumps rooms, fill point and bulk storage locations to mitigate the risk of a minor spill.

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