❑Code of Practice for the DESIGN, INSTALLATION AND OPERATION OF UNDERGROUND PETROLEUM STORAGE SYSTEMS

CODE 2002

CONTENTS

1. INTRODUCTION

This Code of Practice has been prepared as a statement, both of policy and of specific measures to be taken, to ensure safe and efficient storage of petroleum products in underground petroleum storage systems **UPSS**, for the protection of people, property, and the environment.

This code is an update of the code first published in 1992 and incorporates the additional information published in 1995 as Supplement No.1 Management Of Existing Underground Petroleum Storage systems. It also reflects changes in technology and experience gained since the publishing of the original code

The Code is intended to be read in conjunction with, and to complement, the Hazardous Substances and New Organisms Act 1996 and the Resource Management Act. It does not replace or supersede the requirements of the Acts or Regulations but provides guidance on how they can be met, and at the same time the environment can be protected from the potential hazards of petroleum product leakage. It is not intended to be used as a technical specification. It must be supported by detailed technical documentation to obtain approval for any project work from a licensing authority.

The Code defines requirements for the storage of hydrocarbon products underground, and states specifically and in detail how these facilities and the individual items therein shall be designed, fabricated, installed, commissioned and operated.

The Code will be reviewed from time to time as the requirements of society change and available technology improves. Such reviews should be undertaken at least every five years by the representatives of all those who have contributed to its preparation.

2. SUMMARY

The handling of petroleum products has always involved risk. The hazardous nature of the products handled and the serious potential consequences of system failure have required the oil industry to become highly accomplished in the management of this risk to a level at which the probability of system failure is acceptably remote.

One of the first principles in handling hydrocarbon fuels is to keep the product within the system. The primary concern is to maintain and operate the system to ensure that at all times the product is contained. The consequences of system failure may then be regarded as the result of exceptional circumstances rather than a hazard associated with normal operation.

This Code of Practice has been prepared in response to concern over the integrity of Underground Petroleum Storage Systems (UPSS) and reflects collective experience and expertise in risk management.

The UPSS is to be engineered, maintained and operated so that the possibility of product release into the ground is minimised by:

- A high standard of engineering and installation reflecting currently available and proven technology.
- Provide UPSS that will store and dispense their contents in a safe, efficient, effective and workable manner.
- Physical leak detection.
- Identification of risks of product release associated with the use of older storage systems.
- Stipulate procedures and equipment for the proper management of existing UPSS.
- The application of regular detailed inventory control so that any product loss will be detected at the earliest stage.
- Ensure that the possibility of a product release of sufficient magnitude to be hazardous to life, health, property or the environment from any existing UPSS is minimised.
- Immediate and appropriate response to product release.

Specifically, the above is to be accomplished by:

- Careful selection of materials used.
- Corrosion protection of steel tanks and pipework.
- Overfill protection.
- Spill containment for the fill points of tanks.
- Strict supervision and control of installation standards and procedures.
- Use of appropriately experienced contractors.

- Inventory control records maintained on-site and available for inspection.
- Verification of system integrity:

    - At manufacture, by tank testing
    - During installation, by tank and line testing
    - During operation, by tank and line testing and by regular confirmation of satisfactory operation of any leak detectors or other special systems installed and by stock reconciliation.

3. PURPOSE

To ensure that the possibility of a product release from a UPSS of sufficient magnitude to be hazardous to life, health, property or the environment is minimised.

To stipulate procedures, equipment and construction details that must be followed in the design, installation and operation of Underground Petroleum Storage Systems by all owners, operators and installers of UPSS.

To ensure that high standards of engineering and installation practice are applied in all UPSS.

To provide UPSS that will store and dispense their contents in a safe, efficient, effective and workable manner.

4. SCOPE

This Code of Practice applies to all underground petroleum storage systems where hydrocarbon products (such as automotive, aviation and industrial fuels, and toxic solvents) are stored underground in tanks.

All new storage systems (installed since 1992) shall be engineered and installed in accordance with this Code.

All new and existing storage systems shall be operated in accordance with this Code, and any alterations and additions shall meet all applicable requirements of it.

5. DEFINITIONS

For the purpose of this Code, the definitions listed below shall apply.

5.1 Applicable Regulations

Regulations and/or By-laws that apply in the region, or municipality in which the storage system is to be installed, which apply to the work being carried out and to the equipment being installed in the course of the works.

5.2 Approved

Approved by the appropriate Authority.

5.3 Authority

The Authority having statutory control over, or obligation to control, a particular aspect of the UPSS.

5.4 Competent Person

Person who through both experience and training has sufficient knowledge and skill to undertake the work being carried out.

5.5 Corrosion Expert

A person or organisation having the specialised knowledge and experience needed to design, install and maintain cathodic protection systems.

5.6 Contractor

The person or company engaged by the Principal to carry out installation or maintenance work.

5.7 Dangerous Goods Regulations

The Dangerous Goods (Class 3 - Flammable Liquids) Regulations 1985 and amendments thereto.

5.8 Existing

An underground petroleum storage system becomes an existing installation as soon as it has been commissioned and remains an existing installation until it has been removed.

5.9 HAZNO

Hazardous Substances and New Organisms Act 1996 and Amendments 1999 and 2000

5.10 Inspector

The Inspector of Dangerous Goods responsible for the area in which the UPSS is situated.

5.11 Licensing Authority

The Authority responsible for the issue of Dangerous Goods licences in the area in which the UPSS is situated.

5.12 MFE Guidelines

Ministry for the Environment guidelines prepared to provide information on how processes should be carried out

5.13 Monitoring Wells

Wells installed at a distance from the UPSS to allow the spread of hydrocarbons through the ground to be monitored should a leak occur. (See Section 16)

5.14 Observation Wells

Wells installed within the UPSS tank pit to allow any hydrocarbons in the ground to be detected. (See Section 12.9.3)

5.15 Operator

The occupier of the site or any person responsible for the daily operation of the UPSS.

5.16 Owner

The owner of the storage system as distinct from the owner of the land upon which the storage system is installed.

5.17 Principal

The person or company who contracts to have the work carried out on their behalf.

5.18 Product

Any petroleum product stored or handled on the site.

5.19 Project Engineer

The person who is to administer the contract between the Contractor and the Principal on behalf of the Principal. In most cases, the Project Engineer will be an employee of the Principal; however, the Principal may engage a third party to administer the works.

5.20 Purchaser

The purchaser of an item of equipment as distinct from the eventual owner of that item.

5.21 Shall, Must, Should, May

The words "shall" and "must" are to be understood as mandatory and the word "should" as advisory. The word "may" means that discretion may be used.

5.22 Site

That portion of the property on which the storage system is located that may reasonably be considered to be associated with the storage system and the operation thereof.

5.23 Storage System

The system used for underground storage of hydrocarbon products comprising underground tanks, all associated pipework, fittings, vents, fill points and dispensing equipment.

5.24 Underground Tank

A tank capable of storing hydrocarbon products, which is installed below the surface of the ground and entirely covered with backfill and as defined in the Dangerous Goods Regulations 1985.

5.25 UPSS

The Underground Petroleum Storage System.

5.26 Zones "A" "B" and "C"

The environmental sensitivity zones described in the code.

6. INSTALLATION CONTRACTORS

The engagement of skilled professional UPSS installers is a vital factor in avoidance of system failures. The installation of storage systems for flammable and combustible liquids is a unique field. Whilst every effort is to be made to adequately design and document UPSS, the ability to recognise and react to unexpected, abnormal conditions encountered during an installation job requires experience as well as skill.

Experience has shown that a high proportion of system failures are attributable to poor workmanship. To ensure that high standards are achieved, the Principal shall only engage contractors whom he is satisfied are capable and knowledgeable in the type of work required to undertake the installation of UPSS.

The Principal shall ensure that the contractors used to carry out any work shall have in place quality control processes and practices that can be monitored to ensure that all work is carried out correctly. This will include the provision of documentation, plans, testing information, photos and any other information required.

7. DRAWINGS AND SPECIFICATIONS

Drawings and specifications are required to provide guidance for installers and a record of all components of the UPSS. Drawings must adequately describe the property and identify the size and location of the tanks, and products to be stored, as well as the location of the pumps and piping, protection system and cabling.
The plans and specifications must also detail the materials of construction and piping dimensions, as well as dimensions and locations of vents .the choice of suitable approved equipment and materials is necessary to help ensure long-term system operation and integrity.

The plans shall also show cathodic protection component locations, when used.

If hold down pads or other anchoring devices are included in the tank system, dimensions and construction details must be included in the drawings.

Installation drawings and any amendments thereto shall be approved by the appropriate Authorities prior to commencement of any installation work on site.

7.1 Site Specific Drawings

Site specific drawings shall detail the locations of:

- Site boundaries;
- Existing buildings, foundations, structures and all underground services, including any LPG and / or CNG installations;
- New tanks;
- Existing tanks which are to remain in use;
- All decommissioned tanks;
- Vents;
- Fill points
- Pumps and pipe-work(operating and decommissioned); and
- Monitoring wells and observation wells.

The site specific drawings shall clearly indicate the size of all tanks, existing and new, showing both tank capacity and physical dimensions.

The product to be stored in each tank shall be recorded.

Pipework size shall be shown unless pipe sizes are detailed on the standard drawings. If, for any reason, pipe sizes are different from sizes shown on standard drawings, then they shall be shown on the site specific drawings

7.2 Standard Drawings

Standard drawings shall show standard details of installation work and shall be in accordance with standards detailed in this Code of Practice.

Standard drawings shall include:

- details of pipework and fittings to be used;
- tank installation and anchoring details;
- fill point and spill containment details;
- details of tanks and tank fittings;
- details of any observation and monitoring wells;
- cathodic protection system details;

7.3 "As-Built" Drawings

On completion of the work, the Contractor shall prepare "as-built" drawings of the UPSS, supplemented by any photographs taken during construction showing all relevant details and dimensions. He shall provide one set of drawings and photographs each to the Principal and the Owner.

The "as-built" plans may consist of installation drawings marked up by the Contractor.

The information recorded shall include:

- The locations and sizes of all tanks, including decommissioned tanks.
- The location and sizes of all piping, valves, pumps and dispensers.
- Clear indication of which pumps are connected to each tank and of product stored in each tank.
- The locations of pipework connections to each tank.
- The locations of all electrical conduits and all underground services within or adjacent to the area occupied by the UPSS.
- The locations and details of any observation and/or monitoring wells installed.
- Details of any cathodic protection system provided, including locations of anodes.
- The date the installation was commissioned.
- The dates of all modifications.

These drawings shall be updated whenever any modification is made to the UPSS.

7.4 Site Lay-out Drawing

In addition to the above drawings, the Owner shall provide three drawings;

- UPSS As-Built drawing
- Stormwater and drainage Management drawing
- Hazardous Areas drawing.

These drawings will show the site lay-out with all buildings, tanks, fill points, vents, dispensing equipment, pumps, pipe runs, observation and/or monitoring wells, and all electrical conduits and other underground services clearly indicated. Each tank shall be identified with its size, the product it contains, and the fill point(s) and dispensing equipment to which it is connected.

The Owner shall supply one copy of these drawings to the Licensing Authority, and a second copy to the site operator, who shall update them whenever any change is made, and shall keep it available.

8. SAFETY OF WORKS

8.0 General

All work on a UPSS site shall be carried out with due regard to the safety of persons employed on the work, other persons employed on the site, and the general public.

The work shall be carried out in accordance with all statutory regulations pertaining to safe work practices.

In many cases, the Principal will have his own safety requirements. This section sets a minimum standard for safety precautions to be observed and shall be read in conjunction with the requirements of the Principal.

8.1 Permits, Regulations and Standards

Before work commences, the Project Engineer shall ensure that all necessary permits have been obtained from the relevant authorities. The Project Engineer may instruct the Contractor to apply for and obtain the permits; nevertheless it is the Project Engineer's responsibility to ensure that permits are obtained except where there is a statutory obligation upon the Contractor to obtain certain permits.

The work shall be carried out in accordance with all applicable statutory regulations, whether those regulations require a permit to be issued or not.

8.2 Safety of Contractor's Personnel

The works shall be carried out in accordance with all applicable occupational safety and health regulations, including those regarding work in excavations.

The Contractor and the Project Engineer shall both make themselves familiar with the Regulations, particularly as they impact upon the execution of the contract for site works.

8.3 Excavation Safety

In general, every effort should be made to minimise the need for persons to enter the tank excavation. Where this is unavoidable, regulations shall be complied with, and particular care taken to eliminate any risks such as asphyxiation, presence of hydrocarbon vapours, or cave-in. No one should ever enter an unshored or

unbattered excavation unless a competent person has approved the excavation.

8.4 Safety of Third Parties

The Contractor shall take all necessary precautions to ensure that the works are carried out in such a manner as to present no hazard to the site, customers, staff or the public in general.

The Project Engineer shall satisfy himself, on behalf of the Principal, that all reasonable measures have been taken. This duty upon the Project Engineer shall in no way relieve the Contractor from his responsibilities in this area.

All excavations and work areas shall be barricaded, and unauthorised persons kept clear of such areas. Where work areas are open to the public or staff working on the site at night, the Contractor shall provide and maintain adequate lighting to keep the area safe.

Particular care must be taken on sites that continue in operation whilst work is being carried out. Equipment and materials to be used on-site shall be organised in such a manner as to cause no hazard to persons on the site.

Notwithstanding the above, the Contractor and Principal shall maintain appropriate insurance cover for any damage or injury to persons or property during the course of the works.

8.5 Statutory Permits

The formal approval of the Authority responsible for administration of regulations pertaining to UPSS must be obtained before starting any on-site work and its stipulations adhered to for every installation. Applications should be made as early as is practicable, and a reasonable time before it is intended to commence any work on site. For new sites, or sites where special approvals are required, a substantial period will be necessary.

8.6 Safe Handling of Petroleum Products

Brief notes of general safety precautions are covered in *Appendix D*.

8.7 Electrical Equipment

Any electrical equipment can be a possible source of ignition. Where petroleum products are stored the location of equipment must be considered and hazardous areas identified. The requirements regarding electrical installations may be determined by applying the principle of zoning into regions of differing degrees of hazard in accordance with a Code or Standard Specification as may be approved by the Chief

Inspector of Dangerous Goods *(AS / NZS 2430 Classification of Hazardous Areas is an acceptable standard).* Electrical equipment that is installed into any such zone must conform to the requirements of the Chief Electrical Inspector, Ministry of Commerce.

9. SITE ANALYSIS

Characteristics of the site that pertain to the UPSS are:

- The degree of environmental risk associated with the site.
- The corrosion environment to be addressed.
- The water table that will be encountered in the excavation.
- Properties of the soil with respect to the likely stability of the excavation.

9.1 Environmental Risk

The degree of environmental risk associated with an installation shall be evaluated with regard to the following parameters.

- The environmental sensitivity classification of the area in which the site is located.
- The permeability and porosity of the soil around and under the UPSS.
- The ability of the underground environment to transport hydrocarbons.

Three Environmental Sensitivity Zones are recognised:

Zone A - **Highly Sensitive Areas** those above a production sensitive aquifer (as defined by *MfE Guideline Section 5.2.3); and less than 300 meters up or across gradient to productive wells

A1- reticulated (multiple users) potable supply from a sensitive aquifer.
A2- Single unit domestic potable supply from a sensitive aquifer.

Zone B - <u>Moderately Sensitive Areas</u>

B1 – areas adjacent single unit residential areas where vapour migration is likely to be a threat to human health from indoor air inhalation or soil ingestion, eg. most likely only sandy silt to gravely soils over aquifers less than 8m below grade.

B2 – areas above a sensitive aquifer but where the water will most likely be used for stock or crop irrigation due to water quality, or that surrounding users are on a reticulated system supplied remotely

.

B2- areas within 100 meters of surface water bodies (including wetlands) with a high to moderately high amenity value (refer to the Resource Management Act 1991 for amenity definition), where any leakage from a UPSS will have a medium to long term adverse effect on that environment (most likely only sandy silt to gravely soils). Or a greater distance (400 meters) if there is a high likelihood of U/G services creating a preferential path to them, eg. in high density commercial/residential situations where it is known many utilities are in ducts, or where there are large stormwater systems creating such pathways.

B3 - areas adjacent other occupied buildings eg. Commercial, where vapour migration is likely to be a threat to human health from indoor air, eg. most likely only sandy silt to gravely soils over aquifers less than 8m below grade.

Zone C - <u>Other Areas of Lesser Sensitivity</u> where any leakage from a UPSS is unlikely to pose a significant threat to human life or the environment

Secondary Containment (see Section 10.10) shall be installed in all Zone A areas.

For Zone B sites, an Environmental Sensitivity Survey *(see section 9.1.1)* must be carried out unless the Principal, chooses to install a secondary containment system.
If secondary containment is not used in Zone B the Environmental Sensitivity Survey shall be carried out to show that no complete exposure pathway exists.

Table: Acceptability of containment methods

Site Classification	Double Containment	Single Containment
A	Yes	No
B	Yes	Complete ESS
C	Yes	Yes

9.1.1 Environmental Sensitivity Survey

9.1.1.1 Where an Environmental Sensitivity Survey is to be made, the Principal shall commission a competent person to carry it out.

9.1.1.2 The area of 100 metres radius (or such greater distance that the Authority shows is needed) around the proposed installation shall be surveyed for locations which may create danger to people, if hydrocarbon leakage should find its way to them.

Such locations would include, but not be limited to, basements, tunnels, manways, service pits, etc., where hydrocarbons could infiltrate and accumulate if they were floating on the groundwater.

9.1.1.3 The survey shall also take note of areas that would be damaged environmentally by the presence of petroleum products.

Such areas would include, but not be limited to, stormwater drains, natural waterways, and sensitive aquifers that are currently being used or that have been designated for future use.

9.1.1.4 If this survey indicates that there are locations within the area surveyed that require consideration, then the likelihood of hydrocarbons being transported towards these locations should be assessed by means of a hydrogeological survey.

9.1.2 Hydrogeological Survey

The hydrogeological survey shall be carried out by a competent person.

The hydrogeological survey shall determine the rate and direction at which a release of hydrocarbons will spread from the point of release. The hydrogeological survey will take into account soil permeability and porosity, the existence, depth, fluctuation in level, and gradient of the water table, and the existence of service trenches with permeable backfill that may act as conduits for hydrocarbon movement.

Should the hydrogeological survey indicate that a continuing release of hydrocarbons would be likely to reach a hazardous or environmentally sensitive location in less than 30 days, monitoring wells shall be placed outside the tank excavation in the probable direction of travel of released hydrocarbons to ascertain the need for interception and recovery measures in the event of suspected leakage. These

monitoring wells will be in addition to the observation wells within the tank excavation. (See Sections 12.9.3 and 16)

9.1.3 Survey Record

A copy of all survey information comprising the evaluation of the degree of environmental risk shall be retained by the owner of the installation.

9.2 Soil Test

The Principal shall arrange for a soil test to be carried out on change of ownership of the UPSS and also on the removal of any existing tank. Prior to or during the installation of a new UPSS, soil testing may be required in the approximate location of the tank excavations to ascertain:

- Corrosive properties of soil, including resistivity (except where fibreglass tanks and pipework are to be used) - see *Section 13*.
- Structural properties of the soil for allowable proximity of the excavation to nearby building foundations, and the likely need for shoring of the excavation where prior knowledge of the site is limited.
- Existence and depth of water table, where it is not more than 2 metres below the bottom of the tank excavation.

This information, together with experienced judgement, will indicate whether tank anchorage is necessary.

- Existing soil contamination. For a variety of reasons, there may be existing residual hydrocarbons in the site soil. Where significant contamination has occurred, representative soil samples must be taken and checked as set out in *Section 25.2.2*.

The amount and extent of contamination must be recorded and reported to the appropriate area authority, who may advise regarding the
necessity for further testing and clean-up. The background level of contamination at a site must also be taken into account in any subsequent investigation of suspected leakage.

Where a hydrogeological investigation is carried out, the soil test may be carried out in conjunction with that investigation.

The results of the soil tests shall be passed on to the Contractor for his information in assessing the need for shoring- up or dewatering any excavations.

10. TANKS

10.1 Tank Construction

Tanks may be of steel, fibreglass or composite construction.
Single wall steel tanks are not recommended for new installations.

Steel tanks for use in UPSS shall be constructed in accordance with the requirements of an approved standard, and shall have a corrosion-resistant coating as detailed in *Section 10.5* of this Code.

Steel tanks shall be cathodically protected unless soil analysis shows the corrosion environment to be sufficiently inert that cathodic protection is not required. Tanks wrapped in HDPE or similar protective membranes shall not require cathodic protection.

Fibreglass tanks may only be used provided they are constructed by an approved manufacturer and tested and installed all to an approved standard.

Except as permitted in *Section 24.3* of this Code, all tanks installed into underground storage systems shall be new.

Where multi compartment tanks are used, the compartments must be used for the same product, or for different grades of the same product such as Regular and Super grades of motor gasoline. If diesel and petrol are to be stored in adjacent compartments the tank shall be constructed with double bulkheads and interstitial space monitoring.

Tanks shall have all fittings, as specified by the purchaser and as shown on the purchaser's detail drawings, installed prior to testing by the manufacturer. Fittings shall include separate fill, suction and vent connections, and dip tube fitted with a calibrated dipstick to show tank contents at any level.

Approved standards are those currently approved by the Chief Inspector of Dangerous Goods, and are those listed in *Appendix D* for steel tanks, and *Appendix F* for fibreglass tanks.

10.2 Tank Size

When suction pumping systems are used with petrol or other similarly volatile products, the tank diameter should be restricted to 2.5m maximum.
When submersible pumps are used, suction lift and therefore tank diameter is not limited. There is then no theoretical limit to the size of such tanks. Practical limitations will apply.

10.3 Tank Identification

Each tank shall be identified according to the requirements of the purchaser. Notwithstanding the purchaser's requirements, the following minimum information shall be permanently and visibly marked on the tank.

- Manufacturer's identification.
- Construction Specification, e.g. NZS 7521.
- A reference number unique to the tank.
- The date of fabrication.
- The tank capacity.

10.4 Tank Testing

The tank shall be tested at the manufacturer's premises prior to application of the coating.

The test shall either be a hydrostatic test wherein leakage can be directly observed or detected by accurate volumetric measurement; or an air pressure test using soapy water on all joints and fittings to detect leakage. Air test pressure must be 35 kPa. Any higher pressure may rupture the tank and is highly dangerous. The recommended test method is set out in *Appendix E*.

Both compartments of a double compartment tank must be tested at the same time, without applying differential pressure to the internal wall.
The interstitial space between double bulkheads shall be tested independently
If any leak is found, it shall be repaired, and the test repeated. Test records certifying that each tank has been tested successfully shall be supplied to the purchaser, and a duplicate copy retained by the manufacturer.

10.5 Coating Steel Tanks

10.5.1 Surface Preparation. All external sharp corners and weld pinnacles on the tank shall be removed and the shell shall be abrasive blast-cleaned to S.A.2½.

10.5.2 Coating Material. The coating material shall be an approved coating.

A touch-up kit in sealed cans containing sufficient of each component to make 500 ml of mixed material shall be dispatched with each tank.

10.5.3 Application: The coating material shall be applied strictly in accordance with the manufacturer's instructions.

Successive coats shall vary in colour.

Sufficient material shall be applied to give a uniform coating with a minimum dry film thickness as recommended by the coating manufacturer.

10.5.4 Coating Test at Manufacture: The coating shall be carefully inspected for any obvious holidays, defects or damage. Coating thickness shall be checked using a paint thickness tester. Readings shall be taken at 1m intervals maximum along opposite sides of the tank.

The coating shall be subjected to a comprehensive holiday test using a high voltage spark holiday detector calibrated to NACE RP 74-09.

10.6 Records

Records of the leak test and the coating tests shall be retained by the purchaser, and copies attached to the "as-built" drawings.

10.7 Tank Handling and Site Testing

Tanks shall at all times be handled in such a manner as to avoid any damage to the tank, its fittings or its protective coating.
During application of coating, care shall be taken that sections of the coating are allowed to harden prior to any load being applied to that section of surface such as the tank being rolled or ladders or other equipment being placed against the side of the tank.

During lifting on to and from the transport, the tank shall only be lifted using the lifting lugs installed by the manufacturer. Lifting chains or straps shall be arranged so as to be at an angle of no more than 30 degrees to the vertical to avoid placing undue axial stress upon the tank shell.

Unless suitable holding-down fittings are provided, the tank shall be secured to transport using webbing straps only. The tank shall be secured to prevent movement against the truck tray during transportation that may damage the coating. If cradles are used they shall be so designed as to give even support to the tank and not damage the coating or dent or otherwise damage the tank shell.

Guide ropes shall be attached to each end of the tank and manned during all lifting and placement operations.

Whenever possible, the works should be scheduled so that tanks may be lifted from the transport and placed adjacent to the excavation ready for site testing. Following testing, the tank must be lifted directly into its final position in the excavation. Tanks must not be dragged into position.

The tank, and in particular its coating, shall be inspected by the Project Engineer or his nominee prior to placement into the excavation. Where cathodic protection is to be installed, this inspection shall be carried out by the Cathodic Protection Contractor *(refer Section 13)*. Any defect in the coating shall be repaired using a material that is compatible with the coating and that can be readily applied in the field.

Immediately prior to installation on site, the tank leak test described in *Appendix E* shall be repeated and shall be witnessed by the Project Engineer or his nominee. The contractor shall also notify the Inspector at least 24 hours in advance of the time at which the test will be carried out so that the Inspector can attend if he so wishes. The contractor shall supply a copy of the test certificate to the Licensing Authority.

During connection of piping and cathodic protection wiring to the tank shell, it will be necessary for installation and inspection personnel to walk on top of the tank. A layer of durable material shall be placed over the exposed portion of the tank shell to ensure that the coating is not damaged by this traffic.

10.8 Tank Location

Tank location will be determined considering the following parameters.

- Dangerous Goods Regulations
- Delivery vehicle access, parking and egress
- Safe dipping of tanks
- Location of pumps
- Site Boundaries
- Building Foundations

- Environmental Constraints.

Generally, it will be proximity to pumps that will be the overriding criterion. As petrol tends to vaporise, the suction pipe length needs to be minimised. Delivery vehicle access can be improved by running fill lines to a location where the vehicle can safely unload.

Unless shared or sheet piles tank excavation shall be far enough away from structural foundations and existing tanks so that no load can be transmitted to the excavation wall. In general, a slope of 45 degrees drawn from the nearest part of the foundation should not intersect with any part of the tank excavation. In practice, the soil test *(see Section 9.2)* will indicate the allowable proximity to foundations.

The location of tanks to be installed shall be shown on the site drawings, and tanks shall be installed strictly in accordance with those drawings.

10.9 Tank Installation

Tanks shall be buried in such a manner as to ensure that they are:

- adequately supported by the surrounding backfill.
- insulated from direct corrosion attack by being surrounded by inert material.
- protected from imposed loads from above by pavement and/or adequate cover of compacted backfill.

Steel tanks shall be surrounded with sand, but for fibreglass or wrapped steel tanks, pea-gravel or similar approved materials shall be used. Whichever material is used, it must be properly tamped into place to provide good support to the tank shell and ends.

At sites where the nature of the ground is such that the sand or pea gravel may be washed away into the surrounding material and allow the tank to settle, the sand or pea gravel shall be surrounded with a suitable filter membrane to prevent migration.

Minimum cover over tanks will usually be determined by the need to have all pipework draining back to the tank, but shall not be less than:

(i) Where the tank is under an open yard where it will not be subject to frequent or heavy traffic loadings and is not less than 3m from any building:

- Not less than 400mm of earth, or

- Not less than 300mm of cover of which not less than 100mm is reinforced concrete.

(ii) Where the tank is under a building or in an open yard within 3m of a building and will not be subject to traffic loading:

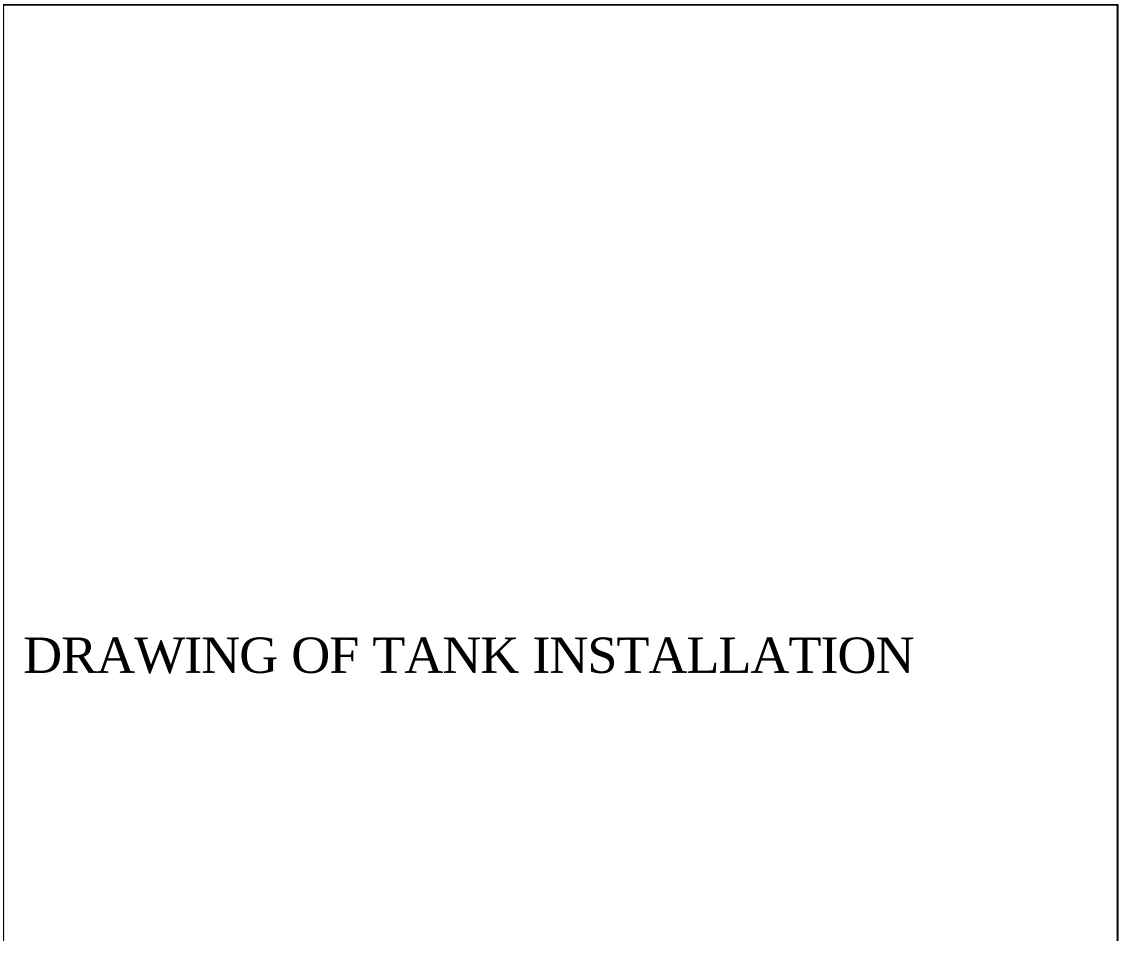
- Not less than 600mm of earth, or
- Not less than 400mm of cover of which not less than 100mm is reinforced concrete.

(iii) Where the tank is subject to frequent or heavy traffic loadings:

- Not less than 900mm of earth, or
- Not less than 650mm of cover of which not less than 150mm is reinforced concrete. Where the concrete is supported by the walls of a concrete chamber, the total cover may be reduced to 500mm.

(iv) Alternative combinations of reinforced concrete and earth cover that provide appropriate equivalent bearing capacity may be used provided the minimum cover over the top of the tank is not less than 300mm in any case.

Fig 12.9 Tank Installation (Typical)



10.9.1 Materials

10.9.1.1 Sand

The sand backfill surrounding steel tanks and pipework shall be clean, non-plastic, chemically inert, free from salt, shells, organic matter, balls of clay, lumps of earth and corrosive materials. The backfill shall be approved by the corrosion practitioner referred to in Clause 15.7. The latter may require sample resistivities from stock pile or truckload in which case such samples shall be taken by the soil box method in accordance with the corrosion practitioner's instructions. The sand shall be free-flowing and of an approved grade complying with the following:

Sieve Aperture mm	*Percent Passing*
9.5	100
4.75	70 - 100
2.36	50 - 100
0.425	15 - 70
0.075	0

10.9.1.2 Pea Gravel: Pea gravel used to surround fibreglass and wrapped steel tanks and pipework must comply with the specification recommended by the tank manufacturer and approved by the Chief Inspector of Dangerous Goods. Wherever fines are present it shall be laid within an approved filter membrane designed to prevent the ingress of fine soil or sand particles, in strict accordance with the tank manufacturer's recommendations.

10.9.1.3 Test Certificate: The Contractor shall furnish the Project Engineer with a test report for the sand or pea gravel certifying that it complies with the relevant specification.

10.9.1.4 Concrete: Concrete shall be structurally engineered to provide the required strength for the applied loading.

10.9.2 Excavation: The excavation for the tank(s) shall be sufficiently large to allow the placement of the full depth of

sand/pea gravel bed below the tank and with adequate clearance at ends and sides to allow backfilling around the tank to be properly placed. The floor, sides and ends of the excavation shall be smoothly shaped and free from loose stones or projections that may reduce the minimum thickness of bedding material to less than 150mm at any point.

The excavation shall also accommodate the anodes of the cathodic protection system where installed.

If circumstances require people to enter the excavation, then statutory regulations shall be complied with. *See Sections 8.2 and 8.3 also.*

Fig 10.9 (a) Single Skin tank and Monitoring Well

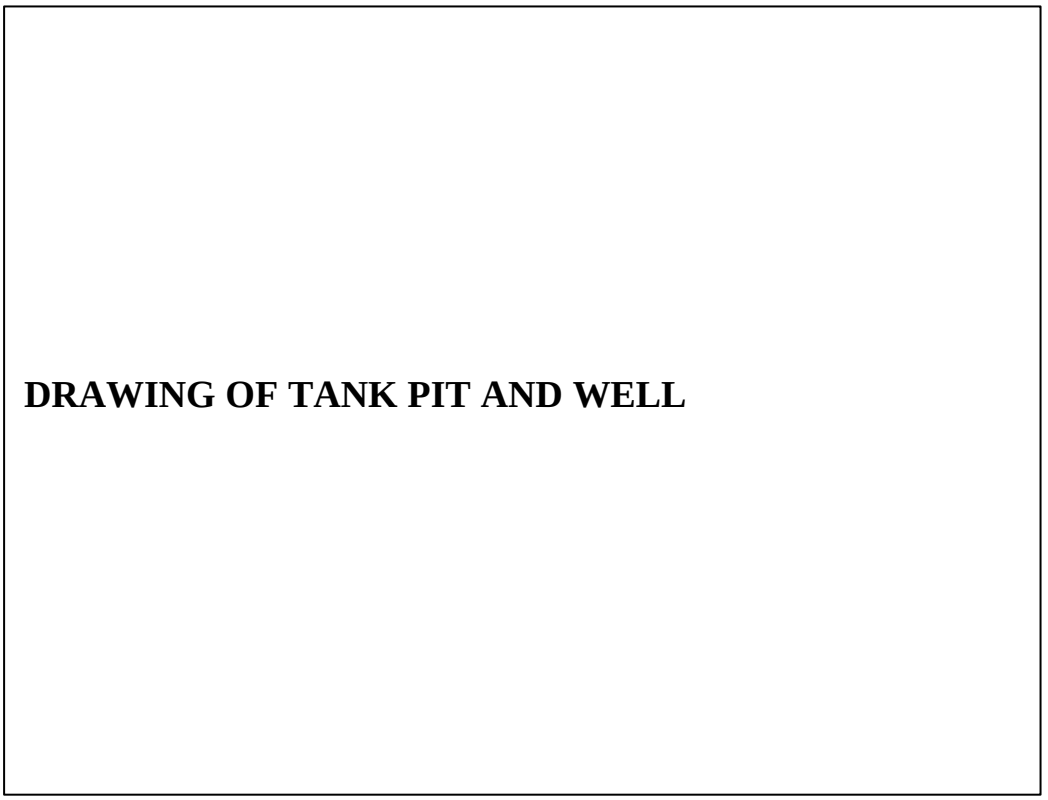


Fig 10.9 (b) Single Skin Tank with Plastic Liner and Observation Well

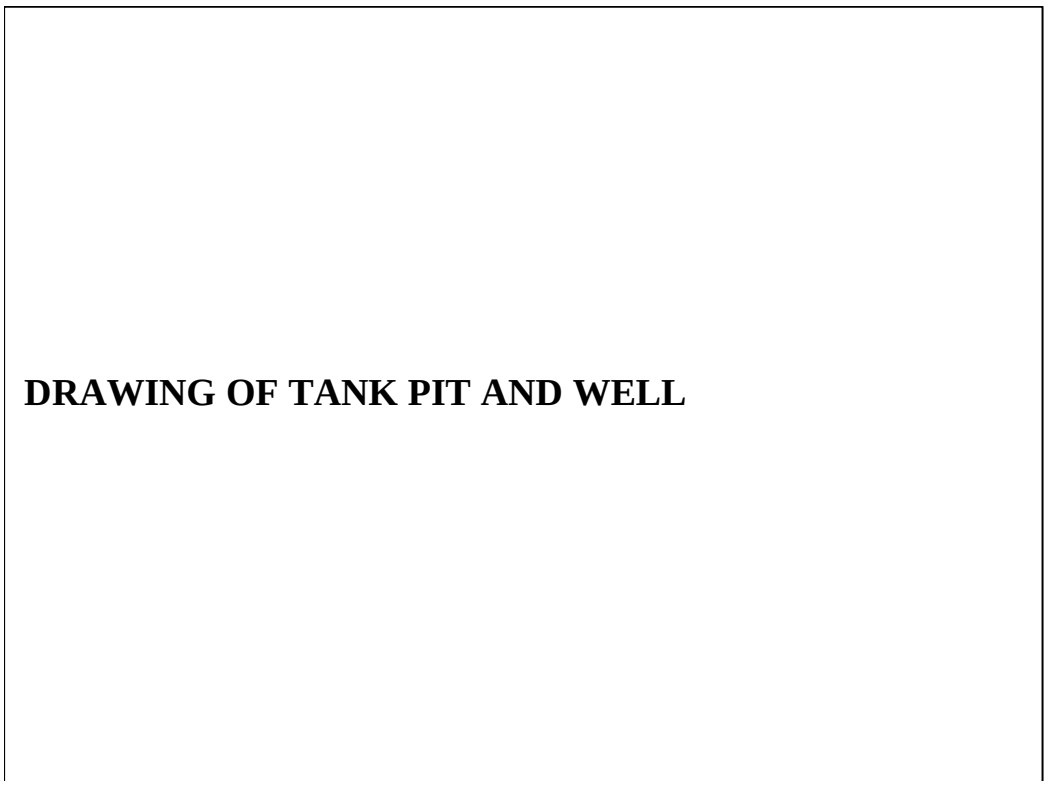


Fig 10.9 (c) Observation Well (Typical)

DRAWING OF TYPICAL OBSERVATION WELL

10.9.3 **Observation Wells:** Observation wells shall be installed within the excavation alongside all new tanks or groups of tanks. See also *Section 16 – Leak Monitoring, and Figures 12.9b and 12.9c*.The toby lid over the well shall be identified by an equilateral triangle.

10.9.4 **Tank Bedding:** A bedding of sand or pea gravel bed of 150mm minimum thickness for steel tanks and 300mm for fibreglass tanks is to be placed on the floor of the excavation.

10.9.5 **Placement:**
During tank placement and subsequent backfilling operations, care shall be taken to ensure that no foreign material, including soil, enters the excavation and becomes trapped in the sand/
Pea gravel surrounding the tank. The Project Engineer or nominee shall closely supervise placement and backfilling operations and ensure that any such material is immediately removed form the excavation, even if it means having to remove the tank to do so.

Immediately after placement, observation wells, when required, shall be placed into position.

10.9.6 **Ballasting:** When the Project Engineer considers it necessary, tanks may be ballasted with water. With the approval of the licensing authority, only aviation fuel tanks may be ballasted with product.

10.9.7 **Backfilling:** After placement and levelling of the tank, sand/pea gravel shall be placed around the sides of the tank. Sand/pea gravel shall be as specified and shall be placed dry to ensure free flow and compaction. The contractor shall ensure that the tank will be adequately supported and shall use vibration, tamping or whatever means is necessary to ensure that the sand flows in under the side of the tank. Water may be used to assist with the proper compaction of sand where allowance is made for the removal of excess water.

10.10 Secondary Containment

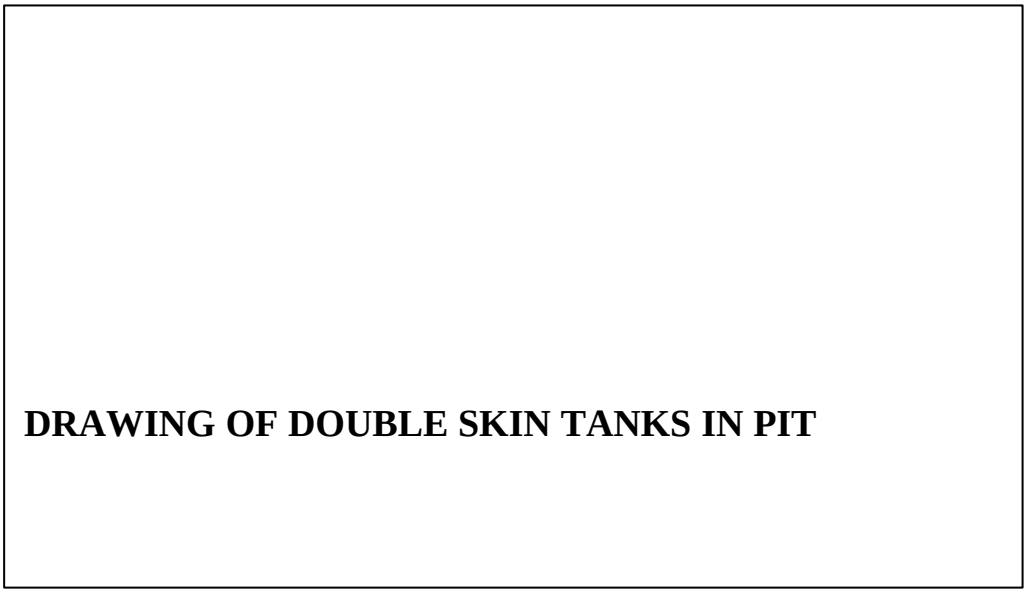
The purpose of secondary containment is to retain liquids that may be released from the primary storage tank.

All secondary containment systems must be able to be monitored for the presence of hydrocarbons and the secondary containment barrier must provide protection against further migration of the primary vessel's contents.

Where secondary containment is installed, it may be achieved by using composite tank construction double-walled tanks and pipework.

Where double-walled tanks are used, the interstitial space of each tank must be monitored using an approved method. The monitoring shall be conducted at the time observation wells are inspected.

Fig 10.10 Double Skin Tank with Interstitial Monitor and Level Gauge



10.10.2 Double-walled Tanks and Pipework: Double-walled tanks and pipework must be tested, installed, backfilled and protected as set out in this Code for other tanks and pipework *(see also Appendix E)*. In addition, the manufacturer's recommended handling, installation and testing procedures must be followed, and provision made for prompt detection of any leakage that may occur.

11. PIPING SYSTEMS

All pipework should be laid with a fall of not less than 1:100 towards the tank so that it can drain completely.
All pressurised or suction delivery pipework shall terminate at the dispenser or pump at a leak proof under pump sump. All penetrations of the sump shall be sealed appropriately

11.1 Piping System Design - Suction Systems

Suction lines should be not less than 50mm nominal bore.

To minimise the likelihood of suction problems, it is recommended that suction line length be kept as short as possible commensurate with good installation practices and the other requirements of this Code.

11.2 Safe Suction

Suction lines shall be fitted with a tank valve at the tank and a non-return (poppet) valve below the pump, and shall be arranged to drain

back to the tank at a gradient of at least 1:100. The non-return valve shall be so placed that it is protected from damage should the pump be damaged or knocked over.

Syphon connections may be installed between tanks/compartments containing the same grade of product by connecting between suction stubs. It is recommended that a suction line draws off this connection so that the syphon may be primed initially.

Tanks may only be syphon connected where the tank top levels do not differ by more than 50mm.

Safe suction systems do not require secondary containment.

11.3 Piping System Design - Pressure Systems

UPSS owner/operator may choose to use a system of delivery lines pressurised by pumps in the underground tanks. Any pressurised product line must be equipped with a leak detection device that is activated when leakage is detected in piping downstream of the pump.

When product delivery lines are pressurised, there shall be a rigidly anchored double shear valve installed in the supply line at the base of each individual dispenser. The valve shall contain a device designed to close automatically in the event of either severe impact or exposure to fire. The automatic closing feature shall be checked at the time of installation and annually thereafter by manually tripping the hold-open linkage.

11.4 Venting System

A separate tank venting system shall be provided for each tank. The vent fitting shall meet or exceed the requirements of the Dangerous Goods Regulations and be approved by the Project Engineer. *(Note - in relation to size Section 11.5 applies).*

11.5 Vent Location

Vent pipes shall terminate in the open air in such a position that flammable vapours will not accumulate or travel to an unsafe position, but in no case less than 4m above ground, nor less than 3m above the fill connection, and in accordance with the Dangerous Goods Regulations.

Vents from tanks used to store Class 3(a) or 3(b) products shall be not less than:

- 1.5m above the eaves line of any building that is less than 3m form the vent;
- 2m laterally from any opening to a building;

- 4m laterally from any chimney or flue outlet;
- 4m laterally from any exposed electrical equipment;
- 1.5 m laterally from a location where vehicles may park.

Vent risers shall be located so that they are protected form mechanical damage.

Vent lines shall not run through or under any part of a building (including soffits) or its foundations.

Except in the case of low volatility products and aviation fuels, the vent shall discharge upwards and shall be protected form ingress of foreign material. The vent shall be fitted with a flame arrestor, brass gauze shield of 500 microns mesh being sufficient for this purpose.

11.6 Vent Pipe Diameter

No vent pipe may be smaller than may be smaller than half the diameter of the fill line connected to the same tank, nor less then 50mm nominal bore for a run of up to 60m. Where possible to fill the same tank via two fill points simultaneously, the vent line diameter must be at least 70% of the larger fill connection diameter.

11.7 Fill lines System Design

There shall be a separate fill line for each tank.

Each fill point shall be identified as required by the dangerous goods regulations and shall also show:

- the tank to which it is connected;
- the product stored in the tank.

Fill points shall be located such that:

- they are readily accessible ;
- the fill point fitting shall be installed so that it will be protected from accidental damage and shall be able to be locked. Fittings shall be liquid and vapour tight.

Fill lines should be 100mm diameter.
Each fill point shall be installed in such a way that all spillage at the fill point shall be contained and kept for recovery. These can be redirected

to the storage tank with the exception of Aviation fuels. A suitable device is shown in *Figure 11.6a*.

The fill fitting shall be a system approved by the Project Engineer as complying with this Section, and may include an overfill protection device. *(See Figure 11.6b)*

Fig 11.6 (a) Spill Container Typical

DRAWING OF TYPICAL SPILL CONTAINER

Fig 11.6 (b) Over Fill Device- Optional (Typical)

DRAWING OF OVERFILL DEVICE

12. PIPEWORK INSTALLATION

Product and vent piping shall be installed so that it is completely surrounded by and supported by clean inert backfill. Backfill material shall be clean salt-free sand or pea gravel as specified in *Section 12.9.1*.

12.1 Piping Material

Piping shall be constructed of a material that is compatible with the contents of the UPSS and sufficiently corrosion-resistant to ensure a life comparable with that of the tank to which it is connected.

Piping shall be constructed of either steel, fibreglass, composite or other material approved by the Chief Inspector of Dangerous Goods.

Steel pipe shall be black or galvanised medium grade manufactured to BS 1387.

Steel pipe shall be protected from corrosion by a suitable anti-corrosion system.

FRP pipe constructed to a specification approved by the Chief Inspector of Dangerous Goods may be used.

Flexible or composite piping constructed to a specification approved by the Chief Inspector of Dangerous Goods may be used.

Pipe fittings shall be malleable iron, steel or bronze. Caps on fill and dip points, etc., may be aluminium.

12.2 Pipe Laying Trenches

Trenches shall be made sufficiently large that all buried pipes can be separated from the bottom and sides of the trench by a minimum of 150mm of pea gravel (or sand for steel pipework), and have a minimum cover of 300mm. Trenches shall be sufficiently wide to allow pipes to lie side-by-side with a minimum clear spacing of 50mm. Pipes following the same route shall not be laid over or under each other.

Backfill shall be placed in layers not exceeding 150mm loose depth and shall be thoroughly compacted to provide support at least equal to adjacent material.

The 150mm sand bed (or pea gravel) should be laid and compacted under pipe runs before piping is installed. Where necessary, temporary timber supports should be used to prevent movement during backfilling. Bricks shall not be used for this purpose.

12.3 Pipe Jointing

All pipes shall be examined before installation to ensure that the bore is clean. Any pipe showing internal dirt or other foreign matter shall be thoroughly cleaned by drawing a cleaning brush through with wire; on no account may rag or similar material be used.
Care shall be taken during installation to prevent the inclusion of foreign matter in the bore. All open ends of pipe shall be blanked off with a screwed cap or plug whilst work is not actually being carried out on that section of the installation.

12.3.1 Steel Pipe Jointing: Steel pipes shall be joined using a minimum of joints and long lengths of pipe used wherever possible. All joints shall be carefully made with good quality BSP taper threads, tightly assembled in a clean and true manner.

All joints shall be made using oil thread petroleum resistant jointing compound spread evenly on the male threads only, care being taken that none is allowed to enter the pipe during fabrication.

All traces of lubricant or cutting oil shall be removed from threads of pipe and fittings by washing with solvent and allowing to dry. All internal burrs shall be removed from threads before making joints.

Dies shall be adjusted so that all screwed joints shall be made with not less than eight threads engaged, and shall tighten hard on the taper of the thread leaving three threads free of engagement.

Where screwed valves are used in a pipe, the connecting thread on the male pipe should be cut to a length where a tight joint is obtained before the end of the pipe bottoms on the valve body.

Joints made with brass-seated unions shall be examined closely to ensure that good even contact is made over each face and that faces are in good condition. All flanges shall have machined finish contact faces.

Swing joints or flexible connections shall be installed at the tank valve, the riser to the pump, the vent riser and on indirect fill lines, and at other major changes in direction where subsequent surface settlement may distort the pipework.

All joints shall be left exposed until AFTER pressure testing has been completed and approved.

12.3.2 **Fibreglass Pipe Jointing:** Standards of manufacture and installation of fibreglass reinforced plastic pipe shall be as stipulated by the purchaser and approved by the Chief Inspector of Dangerous Goods, and in accordance with the pipe manufacturer's instructions.

Swing joints or flexible connections shall be installed at the tank valve, the riser to the pump, the vent riser and on indirect fill lines, and at other major changes of direction where subsequent surface settlement may distort the pipework.

12.3.3 **Other jointing materials:** Where other piping materials are used they must be used in accordance with the manufacturers specifications using approved jointing systems and equipment.

12.4 Testing Pipework

All pipework shall be tested prior to backfilling to allow visual inspection of all joints and connections, and again following backfilling to ensure that pipework has not been damaged during backfilling.

The contractor shall certify that appropriate testing has been successfully carried out The contractor shall also notify the Inspector at least 24 hours in advance of the time at which the test will be carried out so that the Inspector can attend if he so wishes.

12.4.1 **Delivery Lines:** New product delivery lines must be pressure tested before being placed in service. The line shall hold pressure for 10 minutes to be accepted as sound. Suction lines shall be tested to 250 kPa, pressurised lines shall be tested to 400 kPa.

Lines that have previously been in service may be tested with product.

Care shall be taken to ensure that the tank is isolated and vented during the pipework test to avoid excessive pressure being applied to the tank.

12.4.2 **Fill and Vent Lines:** Shall be pressure tested. Fill lines tested from tank connection point up to and including the spill container at 200kpa

12.4.3 **Spill Containers:** Shall be filled with water ensuring there is no change in water level over a one hour period

12.4.4 **Under Pump Sumps:** Shall be filled with water ensuring there is no change in water level over a one-hour period.

12.4.5 **Shear Valves:** Shear valves shall be tested by manually tripping the hold-open linkage.

12.4.6 **Test Records:** the Project engineer or his nominee shall make a record of all test witnessed together with the results of each test.

Test records shall be retained with all other records pertaining to the installation of underground storage equipment for the site.

13. CATHODIC PROTECTION

13.1 General

Before any cathodic protection system is installed, a site investigation shall be carried out to establish soil resistivity levels and the presence or absence of stray currents in the ground.

Where required by this Code, new UPSS that are constructed of steel shall be protected against failure due to corrosion by cathodic protection, supplemented by a suitable coating where practicable, unless site investigation shows that the system will not be subject to corrosive attack.

The UPSS shall be protected from corrosion in its entirety. Tanks, pipework, fill lines, and vent lines are all potential areas for product leakage and/or water ingress and must therefore be protected against corrosion.

13.2 Coatings

The coating shall be:

- of high dielectric resistance;
- resistant to moisture transfer and penetration;
- strongly adherent to metal surfaces;
- applicable with a minimum of defects;
- resistant to mechanical damage;
- resistant to cathodic disbonding;
- easily repairable on-site prior to installation;
- proven by experience in service.

13.3 Corrosion Protection:

A system shall be installed that is suitable for the individual installation, taking into account:

- Number of tanks to be protected.
- The length of pipework requiring protection.
- Soil resistivity.
- Other corrosive characteristics of the soil.
- Presence of stray currents.

13.4 Testing and Monitoring

The owner shall be responsible for having all tests carried out and shall retain the test reports for the life of the system.

Upon completion of the installation, tests shall be carried out to confirm that the system is functioning correctly and that corrosion protection is being given. This situation should again be confirmed 6-12 weeks after installation and again one year later.

If all tests yield satisfactory results, then checks shall be made at intervals of 12 months for sacrificial anode systems.

Should any check reveal the need for remedial work (such as additional anodes), the system shall be upgraded without delay and the cycle of checking and monitoring shall recommence.

For impressed current systems, quarterly checks of the rectifiers must be made to verify that the units are operational. Annual surveys of the

system must also be carried out to ensure continued satisfactory operation.

The cathodic protection system must include permanent test points to facilitate the above checks.

13.5 Isolation

The components being protected by the cathodic protection system must be electrically isolated from components to which they are physically connected and for which cathodic protection is not intended. Isolating connections must be installed at the connection between the product lines and the pumps, and special care taken to maintain isolation where such equipment as submersible pumps or electronic contents gauges are used.

The UPSS shall be isolated from electrical earth. A minimum of 300mm separation must be maintained between all protected UPSS components and other metal conduits on the site. Wherever this 300mm separation cannot be achieved, suitable insulating material must be placed between protected and unprotected items so that the current path between is at least 300mm. Where shielding insulation is used, anode positions should be reviewed and adjusted if necessary.

On existing sites where additional storage facilities are to be installed, the newly installed cathodically protected systems shall be electrically isolated from existing non-protected systems.

13.6 Records

The Owner shall ensure that records are kept and shall include the readings obtained in commissioning tests and the readings that should be expected in later checks so that any need for remedial work may be immediately recognised.

Records must also include the results of periodic checks and details of any remedial works carried out. One copy of these records shall be retained on-site, or by the Owner.

13.7 Practitioners

Site tests, installation works, commissioning and monitoring tests shall be carried out by or under the direct supervision of a competent person qualified to advise on corrosion control for buried metallic structures.

14. LEAK MONITORING

Observation wells shall be installed in the tank pit at the time of installation of the storage system. Site monitoring wells may be installed.

These wells will enable prompt confirmation of suspected leakage as they may be readily examined for the presence of fuel or vapours using bailers or a portable gas analyser. This examination may be carried out at any time by a representative of the owner, or by an authorised officer of the Authority if a leak is suspected to have occurred. The System owner or representative is to carry out 6 monthly inspections.

Typical details for the construction of observation and monitoring wells are shown in *Figures 10.9 a, b &c and 14.0*. For both types of well, the well liner must terminate in a locking cap so designed that it is impossible to connect any hose coupling to the well.

The number of wells required depends upon site conditions.

14.1 Observation Wells

Observation wells are normally used to monitor the back-fill area around underground tanks.

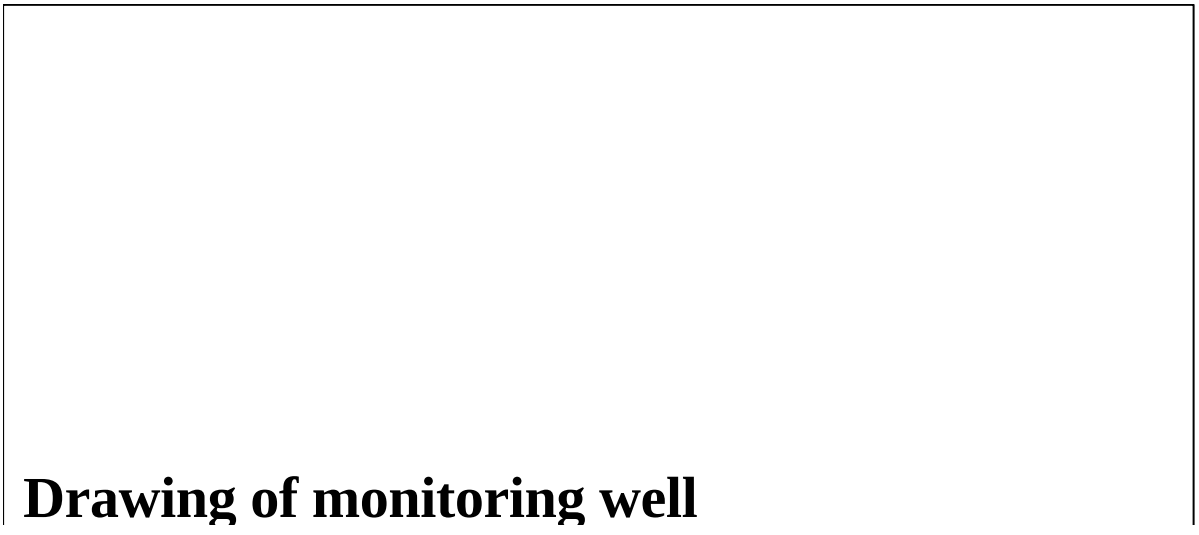
One well is required for a single tank, two for each group of adjacent tanks up to five, and one additional well for each further group of up to four additional tanks.

The first observation well shall always be at the lowest point of the tank excavation.

14.2 Monitoring Wells

Monitoring wells may be used to monitor the ground water table in the general area of the UPSS for any sign of hydrocarbons at the ground water surface on sites where there is no secondary containment.

Fig 14.0 Monitoring Well (Typical)



They provide a leak detection capability equivalent to an observation well, but should only be used where soil permeability is high and the normal water level is below the tank excavation but within 12m of ground level

Where Monitoring wells are installed they should be in accordance with the MFE Guidelines 1999

15. OPERATION

The hazards for the operators, the public, and the environment that may be associated with the storage and handling of petroleum products in underground storage systems arise from:

- Spills
- Leaks
- Fires and explosions.

These can be minimised with good management.

All owners and operators of UPSS must exercise good management, including:

- Sound operating procedures;
- Adequate equipment, properly maintained;
- Supervision to check that good operating procedures are followed and that equipment is maintained;
- Monitoring of product stock to identify any losses that may

occur;

- Risk assessment for each and every UPSS site; and
- System up-grading where appropriate.

15.1 Inventory Control

The operator shall set up and maintain an inventory control system.

The system shall include regular routine reconciliations of quantities of sales, use, receipts and stock-on-hand, with monthly reviews of cumulative variances. Reconciliations should be made daily on a busy site and no less frequently than monthly on any other site.

Any petroleum storage installation that has a properly administered inventory control system will display a regular pattern of stock variation peculiar to that installation. Similar sites in the same region should display similar characteristics.

Any departure from the established pattern for a particular UPSS must be immediately investigated and explained.

15.2 Equipment Checks

In addition to inventory control, the operator should regularly check the components of the UPSS.

Hesitation in the delivery from a pump may indicate a leak in the suction piping.

Tanks should be checked regularly for the presence of water. This may not necessarily be due to leakage but it is nevertheless a most undesirable situation. Water should be removed as soon as practicable and the cause of water ingress investigated.

15.3 Avoiding Spills

15.3.1 Spills During Delivery

Spills are most likely to occur during delivery of product to storage tanks. The person making the delivery must:

- Ensure that there is sufficient space in each receiving tank to hold the amount of product to be delivered;
- Ensure that the delivery hose is connected to the correct fill point, and that hose connections are tight;
- Keep the delivery lines under constant observation during the

whole of the delivery; and

- Stop the delivery immediately if any leaks occur. Do not resume delivery until the defect is remedied and it is safe to proceed.

15.3.2 Spills During Dispensing

The operator must ensure that any spills are minimised, contained and cleaned up.

15.4 Avoiding Leaks

Risks of leakage from the system can be minimised by implementing good management Systems. Such Systems would include site-by-site risk assessment and system upgrading where necessary.

The owner of every UPSS must establish and actively pursue an on-going risk assessment and management system which quantifies the risks of each of the various storage sites, having due regard for each of the release risk and potential impact factors listed in section 7.

High risk sites must be identified and appropriate action taken.

All owners of UPSS must be able to demonstrate to the relevant authorities that they operate soundly-based, on-going risk assessment and management systems. In setting up their systems, owners should refer to the principles set out in documents such as ISO 9000, or to their major supplier of petroleum products.

Whenever circumstances change, the risk assessment for each site must be reviewed to reflect any changes in the original assessment.

15.5 Monitoring for Leakage

Should product leakage occur, it can be identified by following a strict stock reconciliation system (also known as "inventory control").

Every storage site operator must establish and operate a sound system of stock reconciliation that will identify any losses as they occur. It must be updated regularly - at least daily on busy sites, and no less frequently than fill-to-fill or monthly, whichever is the less, on any other site.

The basic elements of a stock reconciliation system are:

- **Measure actual stock in each tank at the beginning of the period (equals opening stock).**
- Record all product received **into** the tank (equals receipts).
- Record all deliveries **from** the tank (equals sales or

throughput).

- Calculate book stock at the end of the period.
- Measure actual stock at the end of the period (equals closing stock).
- Previous period losses/gains shall be considered and carried forward from month to month when assessing trends.

The difference between the book stock at the end of the period and the actual closing stock is the recorded loss or gain. It must be calculated separately for each tank (or pair of coupled tanks). However, petroleum products are volatile, and there will be some vapour losses in handling. Apparent losses can also arise from several factors, including temperature changes and dipping errors. For motor spirits losses of up to 0.5 percent of sales can be expected. Losses of more than 0.5 percent of throughput must be investigated. See also *Appendix A* - Stock Reconciliation.
Monitoring for the presence of product in observation wells and monitoring wells, where fitted, provides prompt confirmation of suspected leakage. They should be examined for the presence of product or vapour using a bailer or a portable gas analyser. This examination may be carried out at any time by a representative of the owner, or by an authorised officer of the authority. The site operator must check each well regularly, at least once every month, for any liquid hydrocarbons, and record his observations. See *Figure 10.9 (C) - Observation Well* and *Figure14.0 -Monitoring Well.*

The operator must notify the owner immediately if there is any cause to suspect product loss.

The owner must inform each relevant authority immediately if there is good reason to believe that a product release may have occurred.

15.3 Response to Product Release

The UPSS is engineered and operated so that the likelihood of product release is minimised. Notwithstanding this, further precautions by way of preparedness must be in place so that should a product release occur, its effect will be minimised by prompt and appropriate action.

The Owner or operator shall have an appropriate emergency response plan prepared in case product is released. The site operator is required to be aware of the emergency response plan and to manage and coordinate the response plan with the owner.

The immediate essential steps, some of which can be taken concurrently, are:

- Stop the release at source.

- Report the release to the relevant Authorities and to the Owner.
- Respond to any emergencies.
- Contain any release of product where possible.
- Assess the degree of contamination.
- Develop a corrective action plan in conjunction with the Authority and clean up the released product.

16. RECORDS

Site layout drawing, including this section refers particularly to UPSS installed prior to the introduction of the code in 1992.

Where as-builts are not available, general arrangement drawings will be developed.

Information that needs to be readily available on site includes:

- Site layout drawing, including underground tanks, pipework and services.
- Details of secondary containment system, where provided.
- Location of observation wells and monitoring wells.
- Stock reconciliation records.
- Observation and monitoring well, monitoring records.
- History of any product releases at site.
- Records of any tank or pipeline test done.
- Records of tests of any cathodic protection installed.

17. POTENTIAL RISKS

The risk of product leakage from a storage system can be considered

under two broad categories - the likelihood of product release from the system, and the potential impact on the environment should a leak occur.

17.1 Factors which influence the likelihood of product release include:

- Soil Corrosivity - *See Appendix G*. For steel tanks and pipework, corrosivity of the soil is a most important factor in determining how long the system will last in the ground. **Non metallic tanks and pipework appear to be unaffected when buried, even in corrosive soils.**
- Age - Field experience shows that there is no absolute limit to the useful life of a steel underground storage tank. Age of a tank installation is only relevant when considered along with soil corrosivity and any corrosion protection provided. For fibreglass tanks age appears to be a very minor concern as far as potential leakage is concerned.
- Tank coatings and/or jacketing designed to minimise corrosion.
- When a leak occurs, pipework is all too often the source. Under-ground pipework may be damaged by heavy traffic passing over it and must be protected by adequate load bearing capacity above -e.g. by a concrete slab or by extra cover depth. It can be subject to corrosion. It can also be damaged during construction work in the vicinity, but can be protected by first identifying its location and route, and then making sure that all construction work is kept clear of the pipes.
- Cathodic protection systems designed, maintained and monitored to overcome the corrosion problem.
- Double skin tanks and HDPE secondary containment systems designed so that leakage from the primary containment can be detected while still being retained by the outer containment system.
- Spill containers retain spillage at fill points and prevent it from seeping away into the ground. See Fig11.6 (a) - Spill Container.
- Overfill preventers give warning when the tank is full and minimise spills when uncoupling. *See Appendix 11.6 (b)* Overfill Device.
- Site Stability - Pipework and, to a lesser degree, tanks may be damaged by disturbance of the ground due to earthquake or other causes. Soil type, local subsidence and seismic zoning must be considered.
- Dissimilar metals in close proximity or stray currents

underground can create an electric potential capable of causing rapid electrolytic corrosion.

17.2.1 The key factors affecting the impact of a product release are early detection and immediate implementation of the response plan.

Other factors include:

- Effective inventory control which can give early indication of a leak in the system.
- Size of tank - the larger the tank, the larger is the potential release, and the larger impact it can have on the area around the tank.
- Environmental risks near the site.

Environmental Zones "A" "B" and "C" as defined in section 10.1 of the code and established in consultation with the Regional Councils and territorial authorities cover several factors that have a bearing on the likely environmental impact of any product release. These include proximity to, and possible contamination of an aquifer which is used or intended to be used for potable water supply, or of environmentally sensitive waterways, including coastal waters and wetlands.

- Land use in the immediate vicinity of the site and proximity to underground services which could allow escaped product to spread.
- Soil type/permeability. Will any product released spread quickly, slowly or not at all?
- Viscosity of product. Will any product released disperse quickly, slowly or not at all?
- Toxicity of product in terms of effects and degree of exposure required to cause those effects.

- Checks for product in observation wells and/or monitoring wells will aid in early leak detection, and can reduce the amount and therefore the impact of any release.

- Pressurised delivery pipework. If pressurised, the amount of product released should a leak occur may be greater than from unpressurised pipework. However, automatic leak detection is mandatory in pressurised systems and should trigger action by the operator to remedy the situation.

- Location of the non-return valve on the suction system immediately under the dispensing pump will minimise the amount of product released should a leak occur in the suction pipe.

18. RISK MITIGATION

Acceptable ways of reducing the risk of product release include.

18.1 Stock Reconciliation

So that any discrepancy in stock quantities that could indicate a leak can be found and investigated promptly, an inventory control system must be used, and stocks reconciled frequently. *See section 15 and 21* of the code, and *section 16.3* above.

Whenever there is a discrepancy greater than 0.5 percent of throughput or a change in the normal pattern in stock reconciliations, it must be investigated quickly and thoroughly.

A standard format should be used for inventory control so that stock movements can be followed day by day. See *Appendix A*, which gives an example of a stock reconciliation system.

Statistical inventory reconciliation systems may also be used in the analysis of stock loss trends.

18.2 Cathodic Protection

See section 13 of the code.

Where steel tanks or pipework are installed, cathodic protection may be fitted to overcome continuing corrosion.

18.3 Observation Wells

See sections 12.9.3 and 16.1 and *Figure10.9(c)*. UPSS may have observation wells installed alongside the tank or tanks.

The first observation well shall always be at the lowest point of the tank excavation.

18.4 Monitoring Wells

See section 14.2 of the code and Figure 14.0

Monitoring wells may be installed down groundwater gradient where there are permeable sands and gravel and the highest recorded ground water level is below the tank excavation but within 12 m of ground level.

Monitoring wells may also be required in some highly sensitive areas where ground water level is outside this range, but still reasonably accessible.

The location of wells will be determined after due consideration of relevant site specific factors.

Care must be taken that monitoring wells do not penetrate any significant impermeable layers and provide a route by which a product release may reach groundwater that would not otherwise be affected.

Note: Observation and monitoring wells are to be secured against unauthorised access, and against entry of contaminants either down the side of the well casing or directly into the well.

18.5 Spill Containers

If practicable, spill containers shall be installed at tank fill points. See Figure 13.6 (a) - Spill Container.

18.6 Under Dispenser/Pump Sumps

If practicable, drip sumps shall be installed under dispensing units.

18.7 Dip Points

Toby boxes at dip points may be sealed to prevent drips from the dipstick getting into the ground.

18.8 Overfill Protectors

Overfill protectors shall be installed at tank fill points.
See Appendix U - Overfill Device.

18.9 Tagging of Fill Points and Toby Boxes

All tank top dip points, direct top and remote fill points, and toby box tops shall be clearly identified by means of permanent markings fixed on or alongside the fitting.

18.10 Monitoring Secondary Containment

All secondary containment systems must be regularly monitored. Observations must be noted and a record kept on site.

18.11 Tank and Pipeline Testing

If there is reason to suspect a leak, the owner shall have the whole tank and pipework system checked by applying an approved test.

"Approved tests" are those tests approved by both:

- The Chief Inspector of Dangerous Goods for use in hazardous areas; and
- The owner, who will only accept tests that have been independently approved by a recognised authority.

Note: Air pressure testing shall not be used in any circumstances.

18.12 Tank or Pipework Removal or Replacement

If found to be leaking, the tank and pipework system shall be removed, repaired or replaced.

19. RESPONSE TO PRODUCT RELEASE

19.1 Emergency Planning

Both the owner and the operator must ensure that an appropriate response plan is in place to deal with any emergency that may arise, including possible spills, leaks, fire and explosion. It is the operator's responsibility to keep a copy on site and to ensure that all staff are familiar with the plan and can implement it promptly in an emergency.

19.2 Response Plans for Product Releases

The response plan for any product release must include the following essential steps, some of which can be taken concurrently:

- Assess the situation.
- Stop the release at source (if possible).
- If there is a fire or spillage that cannot be controlled on site, call the Fire Service.

- Close the interceptor shut off valve.
- Contain the release if possible.
- Put out the fire if possible with extinguishers on site. Do not use water jets as these will spread the fire.
- If product is flammable, but not burning, remove any potential source of ignition.
- Keep the public away.
- Respond to any emergencies.
- Report the release to the relevant authorities and the owner.
- Re-assess the situation.
- Decide on corrective action in conjunction with the authority and the owner, and clean up the released product.
- Do not re-open the site until it is safe to do so.
- Conduct a review of the incident so that lessons may be learnt and a recurrence prevented.

19.3 Additional Information and Guidance

The response plan should also include essential items of guidance and information for easy reference in an emergency.

These should include:

- Agencies/authorities (including phone numbers) to be advised.
- List of spill containment and clean-up equipment available on site, and also from other local and regional sources.
- Assessment of size and extent of the product release, for example:
  - Able to be contained and cleaned up on site by operator and / or owner.
  - Affects off-site areas but can be cleaned up by operator and / or owner
  - Affects off-site environment and requires other agencies to assist clean up.
- Requirements for disposal of contaminated material.
- Refer to safe handling of petroleum products See *Appendix C*.

20. PRODUCT LOSS INVESTIGATION

20.1 General

Product loss will usually become apparent due to inventory shortage. Rather than immediately concluding that the UPSS is leaking, a series of steps should be undertaken promptly in the order listed to find the reason for the shortage.

20.2 Inventory Investigation

- Check observation wells for any signs of product.
- Check all inventory data to ensure it is correct.
- Ensure correct product quantities have been delivered.
- If all information is correct assess potential loss and ascertain when change from normal trends occurred.
- Check that dispensing meters are measuring accurately.
- Ensure there are no leaks from dispensers or pumps.
- Lock out all points of interference and check for product loses.
- Test all lines for integrity.
- Test tanks for integrity.

- At any point when the reason for apparent or real lose is found actions must be taken to
  - To confirm an actual product loss or identify and reconcile the apparent loss.
  - To prescribe improvements to inventory control procedures appropriate to the site in question.
  - To prescribe appropriate improvements to product security measures at the site.
  - To prescribe what replacement or decommissioning actions are required.

21. LEAK TESTING

21.1 General

Leak testing of the tank and pipework shall be carried out upon completion of the installation.

After the UPSS has been commissioned, a leak test should only be carried out when there is reason to believe that there has been a release of product form the system and all other possible explanations have been tested. Experience with product loss investigations has shown system leakage to be the least likely cause.

Free product suddenly appearing in trenches, drains etc., near a UPSS does not necessarily indicate tank leakage. Such incidents may be the result of accidental spillage during delivery. An immediate check of deliveries should be made and quantities reconciled. These checks should be carried out within four hours of the product being detected, by which time all free product should have been recovered and determination made of whether further product is continuing to appear. When the foregoing fails to suggest an explanation for the product release, a leak test should be arranged.

21.2 Method

A proven hydrostatic or other approved test method shall be used by a competent exponent of that method to test tank system. Air press testing shall not be used in any circumstances.

The whole tank and pipework system shall be tested and repaired if found to be leaking.

A tank that is found to be leaking shall be immediately emptied and removed form service.

A suitable Leak Testing Procedure is attached as *Appendix A.*

22. SITE RECORDS

The owner shall maintain records as specified in this section.

22.1 As-built Drawings

As–built drawings as specified in *Section 7.3* shall be kept by the Owner and site operator, and key plans provided as described in *Section 7.4*

The as-built drawings shall include details of initial installation and any subsequent additions and alterations.
In addition, the Owner shall maintain on file any photographs taken during construction, additions and alterations.

22.2 Environmental Risk Evaluation

The owner shall retain on file the results of the environmental sensitivity analysis together with the hydrogeological survey where one was carried out.

22.3 Records of Tests

22.3.1 Tank Manufacture Test

The record of the tank tests carried out at the manufacturer's premises shall be retained by the owner of the installation.

22.3.2 Backfill

The certificate that the material used for backfilling around the tank and pipework meets this Code shall be retained by the owner of the installation.

22.3.3 Leak Tests

The records of all tank and pipework tests carried out at the time of installation, together with the record of any tank and/or pipework leak tests carried out during the operational life of the site, shall be retained by the owner. These records shall also include details of any repair work that had to be carried out to the tanks and associated pipework.

22.3.4 Cathodic Protection Tests

The results of the commissioning tests and ongoing routine tests of the cathodic protection system shall be retained on-site and also by the owner. *(See Section 15.6)*

Appendix A

STOCK RECONCILIATIONS

On site daily inventory control by the site operator is one of the best methods of early detection of any problems that may be occurring in the storage and dispensing system.

Inventory control process.

1. Data collection

Collect the information required each day preferably at the same time each day and during a quiet period of site operation.

- Carefully dip each tank with the dipstick calibrated for that particular tank.
- Collect readings from pump/dispenser meters.
- Check for water in the tanks
- Check product delivery information. Optimally tanks should be dipped before and after product delivery to verify delivered quantities.
- Collect information about any other tank product removals or additions, such as for testing or meter calibration.

2. Reconciliation

The information collected above should then be immediately entered into a reconciliation sheet, either (paper or electronic), following the instructions on the form.

- Calculate the tank throughput by dip.
- Calculate the tank throughput by meter readings
- Calculate the difference between dip and meter throughputs as a loss or gain
- Calculate cumulative daily throughput losses.
- Weekly and or monthly summary sheets should also be kept to monitor trends

3. Anomalies

- Any major daily discrepancies
- Trends indicate that losses are consistently in excess of 0.5 percent, (5 litres in 1000litres)
- Large quantity of water in the tank
- Sudden large one off volume discrepancy.

4. Actions

- In each case of an anomaly all data and calculations should be checked.
- If after checking all data the discrepancy is confirmed checks need to be carried out to eliminate all possible problems. A systematic approach to this should be followed to narrow down the source of the problem. In many cases the discrepancy can be explained and is not a real lose or gain.
- Items to check include
  - Meters are working properly
  - Meters have not been changed.
  - Dip stick is correct
  - All openings and fittings are secure.
  - All openings may need to be locked or sealed if theft is suspected.
  - No obvious leaks from pumps /dispensers
  - Has any work occurred on site.
  - Check observation wells.
  - Have any water in tanks removed and monitor for further water ingress.
  - Inform the tank owner or product supplier and seek guidance from them.

APPENDIX B

SAFE HANDLING OF PETROLEUM PRODUCTS

General

All petroleum products are hazardous. They can cause EXPLOSION or FIRE.

Most petroleum products are TOXIC when not used with due care.

Fire and Explosion

All petroleum products must be treated as being potentially explosive, even in small quantities.

Petrol, aviation gasoline and most solvents evaporate readily, producing an explosive mixture with air. Kerosine, aviation turbine fuel and the less volatile solvents can also produce explosive vapours, particularly in poorly ventilated areas. All products can accumulate static electricity which may trigger an explosion - kerosine type products are particularly susceptible.

Automotive diesel, fuel oils and lubricating oils can produce explosive conditions if sprayed or heated, even over small areas.

Precautions Against Fire and Explosion

Keep all SOURCES OF IGNITION away from petroleum products and their vapours. Sources of ignition include:

- Matches, lighters and cigarettes, etc.
- Any flame or spark.
- Any non-flameproof electrical equipment, including switches, hand torches, electric radiators, vacuum cleaners, power tools, radios and mobile phones.
- Welding sets, power leads, electrical connections and hand-pieces.
- Gas welding torches.
- Motor vehicles and all internal combustion engines.
- Tools which can cause a spark if dropped, etc.
- Grinders.

Petroleum vapours are heavier than air and will readily collect in pits, drainage sumps, cellars, and any low areas. Small quantities of vapour can be quickly and safely dispersed by good and rapid ventilation.

- The presence or absence of petroleum vapours can be checked by a competent operator using an explosimeter.
- **Do not enter any tank or pit** that has contained or does contain petroleum products unless it has first been tested and a work permit is issued by a competent person.
- **Do not do any hot work** (e.g. welding, gas cutting, grinding, drilling or power wire-brushing) on any tank or container that still contains any product or vapour or that has not been tested and certified gas free by a competent person.
- **Do not transfer or pour petroleum** products from one container to another without ensuring that both containers are fully earthed, and that an effective earthing connection is made between hose nozzle and receiving container before any transfer is started, and is maintained as long as the transfer continues. Approved containers only to be used.

TOXIC HAZARDS

Petroleum vapours can quickly asphyxiate. At lower concentrations, they irritate the eyes and lungs, and may cause nausea, headache and depression.

Petroleum products will irritate the eyes and skin and may cause dermatitis on prolonged or repeated contact.

In addition, high octane petrol and aviation gasolines contain toxic lead compounds. Internal surfaces of tanks which have contained these products will be contaminated and must be treated as highly toxic, even after all product has been removed.

PRECAUTIONS AGAINST TOXIC HAZARDS

- Avoid splashing, or any contact with the eyes or skin.
- Wear PVC gloves and boots, and cotton overalls. Wear goggles or face shield if splashing is possible. Wear respirator to avoid vapour inhalation.
- If clothing gets contaminated with product, remove under a running shower.
- If eyes or skin contact occurs, treat as under First Aid Treatment below.

EMERGENCY ACTION

In Case of Spillage

- If a spill occurs, extinguish all naked flames.
- Isolate source of spill.
- Shut down any other potential sources of ignition.
- Close outlet valve on interceptor.
- Ensure area is well ventilated.

Small Spill: Absorb spills in enclosed areas. Spills outside can be absorbed, using sand, earth, or a proprietary absorbent.

Large Spill: Contain and pump into storage.

Petroleum Fire

- Use dry powder, foam, B.C.F., or Carbon Dioxide extinguishers if it is safe to do so.
- Do not use water jets - these will spread the fire.

Appendix C

TANK CONSTRUCTION SPECIFICATION APPROVED BY THE CHIEF INSPECTOR OF DANGEROUS GOODS

Steel Tanks

AS 1692

Tanks for flammable and combustible liquids

Category 4- Horizontal cylindrical tanks up to 150 cubic meters capacity, for underground or above ground use, intended principally for industrial or service station use.

NZS 7521

Specification for underground steel storage tanks and their fittings, for the petroleum industry. Non- pressurised, horizontal, cylindrical, flat ended.

BS 2594

Carbon steel welded horizontal cylindrical storage tanks

Maximum working pressure 40 kpa

Maximum internal vacuum 10 kpa

Temperature range - 10^{o} C to 150^{o} C

Above-ground with saddle supports and underground tanks, dished ends.

Fibreglass Tanks

ASTM D4021 –81

Glass fibre reinforced polyester underground petroleum storage tanks.

NS1545- (Norwegian standard under NVS)

Horizontal cylindrical glass fibre reinforced polyester (GRP) petroleum storage tanks 1.2 to 5.00cubic

metres.