

DESIGN, CONSTRUCTION, OPERATION AND MAINTENANCE
OF AVIATION FUELLING FACILITIES

API/IP Recommended Practice 1540

PART 7 OF
IP MODEL CODE OF SAFE PRACTICE IN THE PETROLEUM INDUSTRY

Fourth edition
February 2004



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FOREWORD

This publication supersedes the third edition of the Institute of Petroleum's Model Code of Safe Practice Part 7 *Airports Safety Code*, published in 1998, and the second edition of the American Petroleum Institute's Publication 1500 *Storage and Handling of Aviation Fuels at Airports*, which was withdrawn in 1998.

This publication has been prepared jointly by the API Aviation Technical Services Subcommittee and EI Aviation Committee, with technical feedback from other industry stakeholders, and is intended to provide guidance on the siting, layout, design, construction, operation and maintenance of aircraft fuelling facilities, including the design and construction of fuellers, hydrant servicers and ancillary equipment used in fuelling aircraft.

The guidance contained in this edition has been significantly revised from earlier editions to ensure that the safe practices contained herein are equally applicable in all areas of the world; to include adequate guidance for the large number of non-airline type facilities used by retail and consumer-type operations; to include suitable reference to environmental protection controls and facilities that are receiving increased emphasis and regulation in some regions and to ensure that the guidance reflects current levels of knowledge and industry experience.

As it is difficult for a clear delineation to be made between commercial airport facilities and others such as are found in retail or consumer operations, those using this publication should decide which sections are applicable to their specific operation. However, some guidance is offered in Section 13.

The guidance contained in this publication is primarily intended to apply to civil aviation operations. However, many of the practices and procedures are suitable for military operations, except where they conflict with specific regulations and codes that are designed to fulfil military requirements.

The guidance relating to design of equipment is primarily intended for new facilities, and for existing facilities which are significantly upgraded. It is not therefore intended that the guidance be applied retrospectively where it is not practicable to do so.

Local, national, regional, international or industry standards may be applicable to certain aspects of aviation fuelling facilities and/or equipment, depending on location. A list of the most widely applied of these is provided in Annex B. References to this Annex are made throughout this publication, and such references, and all other similar references, refer to the latest edition of the document in question.

It is recommended that where a local or national standard either does not exist, or is less stringent than a standard with a similar scope listed at Annex B, the standard listed at Annex B should be used. Conversely, where a local or national standard is more stringent than a standard with a similar scope listed in Annex B, then the more stringent standard should be used.

In addition, in some areas local or national fuelling and other statutory regulations also apply. This publication is intended to be complementary to these established controls and practices.

This publication is intended to provide recommendations for safe practice, rather than set rigid requirements. Users of this publication should be aware that due consideration should be given to the effect of any unusual or abnormal circumstance, on which it is not possible to generalize within the scope of this publication.

For the purpose of this publication the definitions given in Annex A apply irrespective of any other meaning the words may have in other connections.

The API and the EI are not undertaking to meet the duties of employers to warn and equip their employees, and others exposed, concerning health and safety risks and precautions, nor undertaking their obligations under local and regional laws and regulations.

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It is hoped and anticipated that this publication will assist those involved in aviation fuel handling at airports. Every effort has been made by the American Petroleum Institute and the Energy Institute to assure the accuracy and reliability of the data contained in this publication; however, API and EI make no representation, warranty, or guarantee in connection with this publication and hereby expressly disclaim any liability or responsibility for loss or damage resulting from its use or for the violation of any local or regional laws or regulations with which this publication may conflict.

Suggested revisions are invited and should be submitted to the director of standards, American Petroleum Institute, 1220 L Street, N.W., Washington, D.C. 20005, or the Technical Department, The Energy Institute, 61 New Cavendish Street, London, W1G 7AR.

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GENERAL

1.1 CLASSES OF AVIATION FUELS

1.1.1 Jet fuels

The two basic types of jet fuels are kerosine-type jet fuel (such as Jet A-I, Jet A) and wide-cut jet fuel (Jet B).

Kerosine-type jet fuels have a minimum flash point of 38 °C and do not give off flammable vapour at normal ambient temperatures. At ambient temperatures above 38 °C they must be treated as flammable liquids and additional precautions should always be taken in handling them at these temperatures.

Wide-cut jet fuels are relatively wide boiling range distillate fuels and are highly flammable under most conditions.

It should be noted that the above fuels do not contain identification colour dyes.

1.1.2 Aviation gasolines

The five grades of aviation gasoline fuels (Avgas) listed below are identified by their Lean Mixture Octane ratings as recognized in commercial and military fuel specifications:

Avgas 80	Dyed Red
Avgas 82UL	Dyed Purple
Avgas 91	Dyed Brown
Avgas 100LL	Dyed Blue
Avgas 100	Dyed Green

Note: Not all of the above grades are available worldwide.

1.1.3 General classification

The classification of aviation fuels, which will divide fuels into classes based on flash point and other considerations, will lead to determining safety separation distance of tanks, the type of tank and its fittings, handling precautions, etc. when designing and operating facilities. The classification of aviation fuels is not a simple matter and in all cases local or national standards should be adhered to. (See Annex B-2 and Annex D.)

When handling petroleum products in hot climates or in circumstances where the products are artificially heated, special consideration of the effect of these circumstances should always be taken as they may change the classification of the product being handled. The requirements of local or national standards should be adhered to.

1.2 ELECTRICAL SAFETY PRECAUTIONS

1.2.1 General

Local or national electrical safety codes, and other publications, set out in detail the special precautions needed to safeguard against the risk of fire or explosion due to the use of electrical current and lightning. (See Annex B-2 for a listing of some national standards.) Due consideration should be given to the requirements/guidance contained therein.

1.2.2 Static electricity

Local or national codes and other publications set out in detail the special precautions needed to safeguard against the risk of the effects of static electricity. (See Annex B-2 for a listing of some codes and standards.) Due consideration should be given to the requirements/guidance therein.

1.2.3 Portable electronic devices

The use of any portable electronic device, such as a mobile phone, radio, radio telephone, or personal stereo

etc., should be prohibited within any hazardous area unless it is designed and approved for use in those areas.

1.3 FIRE SAFETY

Aviation fuels, by their very nature, require safe handling procedures to prevent serious incidents affecting both people and property. Stringent operating standards, meeting local and national requirements, should be adhered to at all times.

2

DEPOT LOCATIONS RELATIVE TO AIRPORT FACILITIES

2.1 METHODS OF FUELLING

Depending on the scale of operation at an airport, the usual fuelling methods used can be mobile fuellers, a hydrant system, a fixed dispensing unit or an underground chamber system.

Where mobile fuellers are employed, the airport depot facilities allow for the fuel required by the aircraft to be pumped from the storage tank into fuellers which then proceed to the aircraft where the fuel is delivered.

In the case of hydrant fuelling, the facilities provide for the fuel to be pumped directly from the airport fuel depot storage tanks to the aircraft parking apron by means of pipelines and then transferred from the hydrant pit(s) installed there into the aircraft via hydrant servicer(s).

In cases where for any reason main airport stocks of fuel are located at such a distance that a direct fuelling service is impracticable, intermediate tankage for this purpose may be provided at a satellite or forward fuel depot conveniently close to the fuelling area. A satellite depot would usually be supplied by pipeline(s) from the main depot.

The use of fixed dispensing units is normally limited to smaller airfields where light aircraft are fuelled. These may be the sole source of fuel or they may supplement mobile fuellers. They may take the form of a cabinet supplied from an underground tank, a remotely positioned above-ground tank, or in the case of a modular unit, from an integrally mounted horizontal tank. It is normal practice for the cabinet or dispensing unit to be fitted with a suitable type of filter, a hose reel, a meter, a bonding cable and a safety

shutoff/deadman device. The aircraft requiring fuel taxis to the fuelling area. Such facilities should be located in an area away from normal taxiing areas in order to minimise the risk of damage.

A further system, to be found extensively on military bases and some commercial airports, is the underground chamber system whereby the equipment normally found on a hydrant servicer is located in a pit adjacent to the aircraft parking/fuelling position.

2.2 DEPOT LOCATION

The selection of the best site for an airport fuel depot is governed firstly by the restrictions which are necessary to ensure the safety of aircraft operations (see 2.3) and secondly by the efficiency in fuelling aircraft.

Depots from which mobile fuelling is carried out preferably should be located so as to give ready and easy access to the fuelling area by mobile fuellers, making as little use as possible of public highways and airport roads open to general traffic. Where practicable, the necessity for mobile fuellers to cross runways or their approaches should be avoided. When a number of fuelling areas exist on an airport a compromise location, or more than one depot, may be necessary.

Hydrant systems are subject to hydraulic shock pressures or surge pressures when supply to the aircraft is shut off. Hydrant system surge pressures are dependent upon product velocity in the pipeline and the hydrant configuration and length in relation to valve closure time. (See Section 5.) The aircraft is protected from these surge pressures by devices on the hydrant

servicer, and surge pressures in hydrant systems, whatever the length, can be catered for within the design of the system. Therefore, although ideally the distance between the airport fuel depot and the fuelling area should be as short as possible this is not an overriding consideration. Where surge pressure generation within the hydrant system could lead to component damage, the use of surge suppressing equipment should be considered.

When it is not possible to locate the airport fuel depot near to the fuelling area then a satellite area, with office and parking space for fuelling equipment, to facilitate supervision of fuelling operations, should be considered.

Supplies of fuel may arrive at the airport by pipeline, road tanker, rail tank car or water-borne transport and these factors should be taken into consideration in locating the airport fuel depot. (See Annex B-2 for relevant sources of information.)

For vehicles supplying the airport fuel depot by road (i.e. bridging) there should be easy access from the public highway without the need to encroach upon areas in regular use by aircraft and or passengers.

In the case of rail and water-borne transport, it may not always be possible to reconcile the location of rail sidings or vessel berths with the requirements for airport fuel depot location in relation to the fuelling area. In such cases, consideration should be given to providing a minimum distance between the airport fuel depot and the fuelling area. In routing pipelines, due regard should be given to the location of other airport services. Where it is preferred for the pipelines to pass under runways, taxiways etc., the shortest possible route across should be selected.

2.3 RESTRICTIONS ON AIRPORTS

2.3.1 General

When selecting airport fuel depot sites, airport authority, local government and national requirements need to be observed. Annex B-2 includes a listing of some sources of information on national aviation authority standards for the siting of airport fuel depots. An example of one national aviation authority standard, the UK Civil Aviation Authority, which applies to commercial airports, is shown in Figure 1.

As most airports operate a system of taking off and landing in both directions on the same runway, the most critical conditions apply to both ends of the runway.

The prohibited zones to be considered are as follows:

— at the ends of runways, known as approach, take-

- off and clearway funnels;
- runway and taxiway side clearances; and
- around aircraft parking aprons.

As a general policy it is advisable to locate all airport fuel depots outside the above zones but, for technical reasons, this may not always be possible.

The recommendations contained in this section apply to all airports. For simplicity no differentiation has been made between various methods of aircraft operation. In all cases the requirements given for locating airport fuel depots meet the most critical condition of aircraft operation.

2.3.2 Approach, take-off and clearway funnels

The extent of each of these zones is illustrated in Figure 1, which also indicate(s) the approach/take-off slope which limits the height of any structures or temporary features within these zones. The potential hazard in approach/take-off zones is greatest on the extended centre line of the runway. When it is essential to site airport fuel depots within the zones, they should be located towards the side boundaries of the funnel and in all cases should conform to the following conditions:

- (a) The first 365 metres (1 200 feet) measured from the runway strip ends should be considered to be prohibited zones within which fuel depots may not be located.
- (b) Airport fuel depots may be located in the zone between 365 metres (1 200 feet) and the end of any declared clearway or 1 370 metres (4 500 feet) from the ends of the runway if greater, provided that all fuel storage tanks and electrical power lines are fully buried. Tank fittings, pipelines, pumps, buildings, etc., may be above ground, but the height of these operational facilities or temporary equipment facilities should be below the approach/take-off slope surfaces.
- (c) Airport fuel depots with buried, mounded or above-ground storage tanks may be installed in the zone extending beyond 1 370 metres (4 500 feet), or the end of the clearway if greater, measured from the ends of the runway. The only restriction in this zone is on the height of structures/temporary features which must not exceed the approach/take-off slope. When considering the areas likely to be affected by approach/take off funnels, account should be taken of any planned extensions to the runway or clearway.

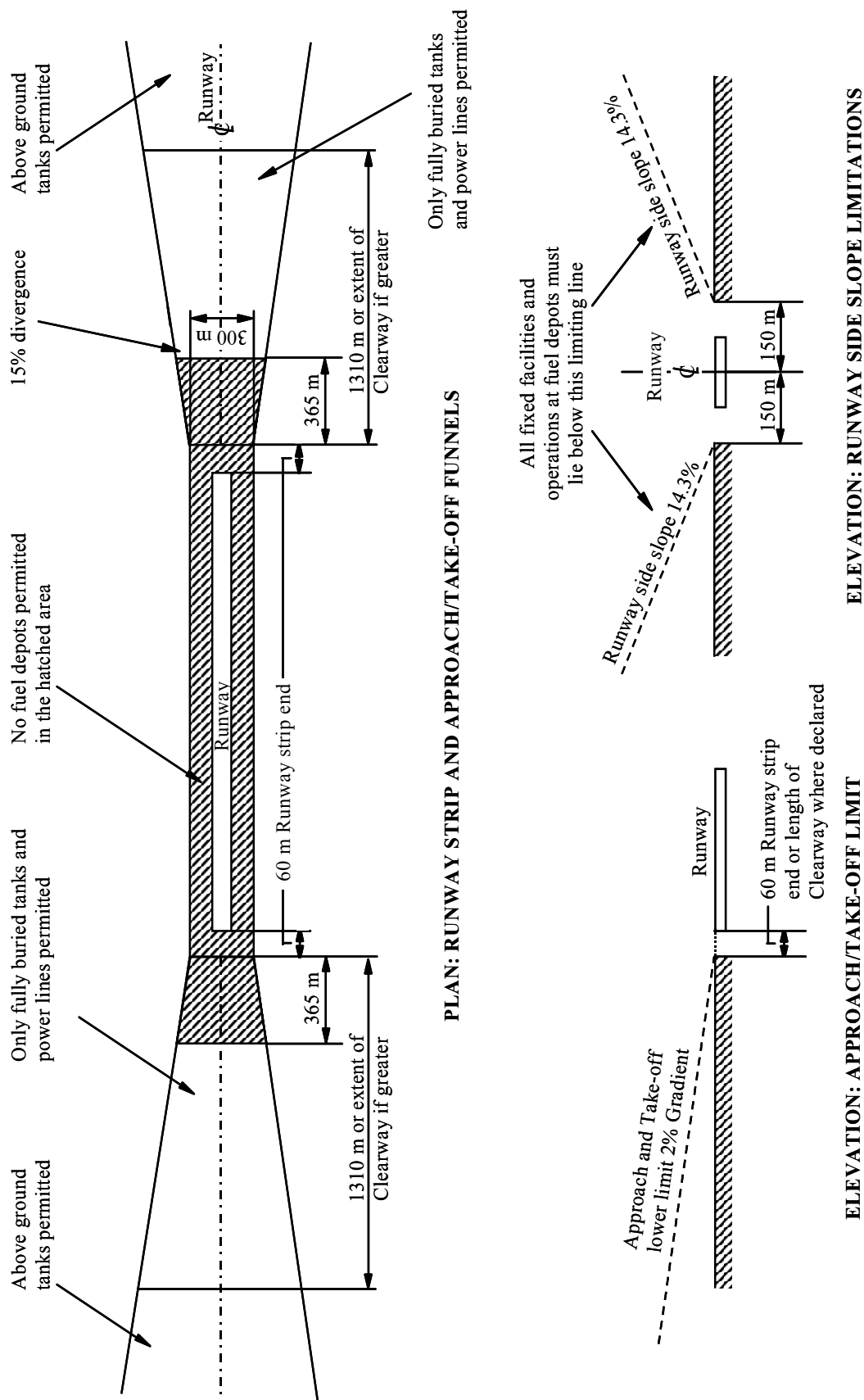


Figure 1 Airport fuel depots-siting restrictions (typical CAA requirements for UK airports).

2.3.3 Runway side clearance areas

These areas are parallel to the runway; a ground level height limitation extends to 150 metres (500 feet) on either side of the runway centre line. The location of airport fuel depots within these areas is prohibited.

Depots with fuel storage tanks, buried, mounded or above ground, may be sited beyond these areas provided the maximum permissible structure height is not exceeded. This height is defined by a line drawn from a point at ground level 150 metres (500 feet) from the runway centre line at an upward and outward slope of 14,3 %.

2.3.4 Taxiway clearance areas

These areas are parallel to each taxiway and extend 60 metres (200 feet) from the centre line of the taxiway on either side of it. Airport fuel depots should not be installed within these areas.

2.3.5 Parking apron clearance

The clearance between parked aircraft and any part of the airport fuel depot should be agreed with the authority having jurisdiction over the site taking into account the requirements for operating the facility and the safety of both the depot and aircraft parked near it.
(See Section 9.2.2 – Hazard Zones.)

2.3.6 Other restrictions

Other restrictions may result from line of sight limitations of ground radar equipment. The local aviation authority may not permit a depot to obstruct the line of sight from a control tower (or other observation locations) to runways, taxiways and parking stands, or be located such that spurious radar reflections may occur from the side of tanks or buildings. While it is beneficial to have a depot located for easy access by airport fire services, it should not be so close that a major fire could adversely affect the operation of the fire fighting facilities.

3

DEPOT LAYOUT

3.1 GENERAL

The airport depot is as defined in Annex A. It should be planned and designed in accordance with local or national requirements with regard to safety distances, tank compound capacities etc. Annex B-2 defines the classification of aviation fuels.

Hazardous areas should always be determined in accordance with an applicable classification code. Refer to Annex A for a definition of such an area.

Where such local or national codes are not available, or are less stringent than the codes referenced in Annex B-2, it is recommended that an appropriate code be chosen to best suit the installation under consideration.

3.2 DEPOTS LOCATED OUTSIDE A CONTROLLED AREA

3.2.1 Boundary and enclosures

Airport depots should always be effectively bounded by fencing or walls composed of suitable incombustible materials. Unless local or national regulations are more stringent, the total vertical height should not be less than 2 metres (6 feet) from ground level to the top of the fence or wall including any barbed wire. The boundary may in part be formed by the walls of depot buildings or bund walls. Adequate access for fire-fighting vehicles should be provided. (See also Annex B-2 and 3.3.2.)

3.2.2 Tankage layout - Safety distances, fire walls and tank compounds

3.2.2.1 *Spacing of tanks*

For the spacing of above-ground tanks reference should always be made to an applicable code, local or national codes or a code referenced in Annex B-2.

For smaller airport depots where buried or mounded tanks are installed, the distance between any tank and the outer boundary of the depot depends on constructional and operational convenience only unless there is a more stringent local or national code in place. (See Annex B-2.)

3.2.2.2 *Tank compounds/bunded areas/dikes*

For the requirements for tank compounds/bunded areas/dikes for product containment and fire protection, reference should be made to an applicable code, local or national code, or a code referenced in Annex B-2.

3.2.3 Buildings - Location and spacing

3.2.3.1 *Offices, including crew rooms, canteens, etc.*

These buildings should be located whenever possible in non-hazardous areas and preferably near to the main depot entrance gates. Arrangements should prevent unauthorized entry by visitors into the depot working areas.

When, for operational or other reasons, these buildings cannot be located in non-hazardous areas, they should be constructed of fire-resisting material and should comply with local fire and safety regulations.

3.2.3.2 Operational buildings

These buildings should be constructed of materials complying with local fire and safety regulations and are divided into three groups as follows:

- (a) Group 1 - Housings for boilers, power plants and fire-fighting pumps.

These buildings should always be sited in non-hazardous areas so that the equipment in them does not present a risk of ignition and can be safely operated in the event of a spillage in an operational area.

- (b) Group 2 - Packaged oil stores, pump houses, filling points.

No packaged oil store, pump house or filling point handling Avgas or jet fuels falling into applicable Class I Classification should be situated less than 15 metres (50 feet) from any part of the outer boundary of the depot when it is constructed with open type fencing. When the outer boundary consists of a continuous solid wall at least 2 metres (6 feet) high without openings, this distance may be reduced but should not in any case be less than 6 metres (20 feet). For pumping equipment installed in open premises, the distance to the outer boundary should not be less than 15 metres (50 feet). When packaged oil stores, pump houses and filling points handle only jet fuel that does not fall within Class I the distance to an open type boundary fence may be reduced to 6 metres.

Packaged oil stores, pumping equipment and filling points handling Avgas and/or jet fuels falling within Class I should be located at a minimum distance of 15 metres (50 feet) from any building or compound in which hot work is normally carried out. In the case of jet fuels that do not fall within Class I, this distance may be reduced to 6 metres (20 feet).

Packaged oil stores should be positioned so that there is a minimum separation distance of 6 metres (20 feet) between them irrespective of the classification of oils and quantities stored therein.

Packaged stocks which are held in drums or other receptacles which may be stored in the open air will be subject to the same distances referred to above.

- (c) Group 3 - Maintenance shops, service buildings. These buildings may include sources of ignition and therefore they should be situated in non-hazardous areas.

The walls of any buildings except those for

which safety distances are specified in Group 2 above may form part of the boundary of the airport depot.

Reference for vehicle maintenance provision and associated separation distances should be made to an applicable Code, either local or national, or a code referenced in Annex B-2, whichever is the most stringent.

3.3 DEPOTS LOCATED WITHIN A CONTROLLED AREA

When airport depots are constructed within a controlled area, then the conditions imposed for that area should not be less onerous than the requirements contained in this publication.

3.3.1 Tanks, packaged oil stores, pumping equipment and filling points

When the depot is located within a controlled area, the distances between these facilities and the depot boundary should be governed solely by constructional convenience. In all cases, however, the distances between these facilities and the perimeter of the controlled area should not be less than those quoted to the depot boundary in 3.2 above.

3.3.2 Boundary and enclosures

Where security fencing is not necessary by virtue of the depot being located within a controlled area, the boundary may be defined by other suitable means. Adequate access for fire fighting vehicles should be provided.

3.4 DRAINAGE AND OIL/WATER SEPARATORS

3.4.1 Surface water - General

The protection of both surface and ground waters from pollution is essential. Drainage should always be planned in accordance with local or national requirements and practices and in consultation with the regulatory authorities concerned, who may set quality standards for any water discharged from the site. Where possible the drainage system should take full advantage of any natural drainage at the site for the disposal of surface water. It is essential that drains and separators are regularly inspected and maintained. (Refer to Annex B-2.)

3.4.2 Drainage from operational areas

Guidance on drainage from the depot area, the tank compound and filling area can be found in the documents listed in Annex B-2.

3.5 LIGHTING

Airport depots should be provided with adequate levels of lighting consistent with the operations that will be carried out in hours of darkness. Depot lighting should not be such that it is hazardous to aircraft operations. Reference should be made to an applicable code, either a local or national one or a code referenced in Annex B-2, whichever is the most stringent.

4

DEPOT PLANT, FIXED EQUIPMENT AND BUILDINGS

4.1 GENERAL

The information contained in this publication covers the minimum requirements for the design, maintenance and operation of depot facilities.

The observance of sound engineering practices in the design of facilities is considered essential to ensure that product quality is maintained.

All facilities used for handling aviation fuels should be fully grade segregated.

A schematic piping diagram identifying tanks, valves, pumps, pipelines, etc., should be available in each storage depot with instructions for performing the various operations e.g. loading, unloading. These diagrams should be displayed where they are readily available for reference by personnel operating depot equipment and by other interested authorities.

4.2 TANKAGE

4.2.1 Design and construction

All tanks should always be constructed in accordance with a relevant local or national standard, see Annex B-2. Aviation fuels should be stored in horizontal or fixed roof vertical tanks. All tanks should be constructed and installed to allow settling and removal of water, dust and dirt through a low point connection. To achieve this, new horizontal tanks should be installed with a minimum slope of 1:50 and new vertical tanks should be constructed with a coned down bottom having a slope of not less than 1:30 to a low point sump. If

Avgas is stored in a vertical tank, an internal floating roof or blanket may be used to reduce vapour losses. Environmental legislation may require that all new vertical Avgas tanks be fitted with an internal floating roof or blanket providing an adequate seal to reduce vapour emissions to the atmosphere. It is normal practice to free-vent the ullage space of tanks fitted with internal floating roofs. However, the use of such a roof or blanket does not remove the need to install a floating suction unit as required in 4.2.5. Pressure vacuum (P/V) valves provide an alternate, but less efficient, method of reducing vapour losses and should be fitted to all Avgas tanks not equipped with an internal floating roof or blanket. If P/V valves are used, the working pressure of the vent must be taken into account in the structural design of the tank.

4.2.2 Materials

Tanks referred to in this section are typically of steel construction. Tank materials other than carbon steel should be designed to an appropriate standard and in accordance with good engineering practice. If glass reinforced plastic (GRP) tanks, which should only be used for underground storage, are to be used then they should meet local or national standards (see Annex B-2). It is essential to ensure that the tank material will not affect the quality of the product. Also the product and water must not affect the tank material. Specialist advice should be sought in selection and application of protective linings and appropriate documentation supporting the above should be obtained prior to using any epoxy resin.

4.2.3 Tank foundations and supports

Local or national tank standards contain recommendations on the construction of foundations for tanks built to that standard (see Annex B-2). Where local standards are less stringent than those listed, it is recommended that one of the listed standards is used. The foundation design will depend generally on site conditions and consideration should be given to incorporating an impermeable barrier such that continuity of the tank containment system is achieved. The design should provide drainage, should prevent external corrosion of the tank bottom, and should give stability to the tank under test and under all service, wind, seismic, and other climatic conditions likely to be encountered. Where the tank site may be subject to flooding, further protection against erosion and flotation should be provided.

Further advice is given in documents listed in Annex B-2.

4.2.4 Tank inspection and testing

Factory and site inspection of tanks should be carried out in accordance with the selected standard.

4.2.5 Tank fittings

Tanks should always be provided with separate fittings for filling and outlet and for drawing off water and draining, emptying below the depth when the floating suction has landed for maintenance purposes, sampling, venting and, where necessary, for temperature monitoring. The following additional fittings should also be provided:

(a) Product level indicators

High and low level alarms and tank contents instrumentation should be installed on all tanks. Tanks should always be fitted with overfill warning and automatic shut down devices. (See also Section 11.1.7.)

(b) Floating suction units

Tanks in Jet A/A-1 service should always be equipped with floating suction units. Means of carrying out regular checks of the buoyancy of these units must be provided. The use of a floating suction unit should also be considered for tanks in Avgas service.

(c) Status indicator boards

Unless the status of the tank (e.g. filling, settling,

released or in service) is shown on control panels or monitor screens, a board or similar sign to indicate the tank status should be provided adjacent to the outlet valve.

(d) Fire fighting

Fire fighting fittings such as foam injection points/nozzles and water cooling systems should be installed on large vertical tanks. It is recommended that the agreement of the local fire service be obtained for the design.

4.2.6 Tank vents

Tanks should always be adequately vented to prevent the development of pressure or vacuum outside the design limits of the tank. It is recommended that tanks in Jet A/A-1 service be free vented. P/V valves should be used on tanks in Avgas/Jet B service unless they are fitted with an internal floating roof or blanket affording the necessary seal against vapour emissions.

Venting devices should be selected to ensure adequate venting capacity at all times and in all weather conditions, to deal with flow rates associated with receipt into tankage from supply pipelines and, particularly, deliveries from tankage into hydrant systems. Normal and emergency venting requirements for fixed roof tanks should meet local or national standard requirements. (See Annex B-2.)

Screens to prevent the ingress of foreign bodies should have a coarse mesh with minimum 5 mm (0,25 inch) holes.

4.2.7 Earthing of tanks and depot components

Tanks and the depot components should always be effectively earthed in accordance with the detailed recommendations for earthing given in local or national standards. (See Annex B-2.) Electrical continuity should be maintained between the tank shell and gauge floats, floating suction arms and any other floating equipment.

4.2.8 Tank pipe connections

(a) All connections and valves fitted to the tank shell and bottom should be of steel construction.

(b) All tanks should be fitted with a low point sump provided with a drain line and suitable valve for the draining of water and sediment. The use of tankside flushing tanks of at least 200 litres capacity with a facility for taking a running sample,

into which the sump may be flushed, may be considered.

- (c) In the case of above-ground tanks the low point sump may also be provided with a large diameter flushing line and isolating valve suitable for purging water and particulate.
- (d) Tanks should always be fitted with separate product inlet and outlet connections. Vertical tanks should always be filled through a nozzle near to the bottom of the shell and designed to minimise turbulence. Outlet connections should be fitted with floating suction units.
- (e) All tank inlet/outlet valves and piping isolation valves should have thermal relief. (See also 4.3.5).

4.2.9 Tank corrosion protection and painting

4.2.9.1 External protection

Tank shells, roofs, fittings and fixtures should be painted externally with an oil-resistant paint to prevent corrosion. The type, thickness and colour of the protective coating should be selected to suit atmospheric conditions and, where applicable, to minimise evaporation of contents and meet the requirements of API/IP 1542.

4.2.9.2 Cathodic protection

Consideration may be given in special circumstances to protect tank bottoms by the installation of cathodic protection using impressed current or sacrificial anodes. However, it is important that where cathodic protection is employed, the tank should be insulated from all other steel structures or pipelines in its vicinity that are not protected by the same system. See Annex B-2 for a listing of appropriate standards or sources of information that should be applied.

4.2.9.3 Internal protection

All steel vertical or horizontal tanks should be coated on all internal surfaces with a suitable protective lining (see Annex B-2) in the interests of product quality control and to facilitate tank inspection and cleaning. It is essential to ensure that the lining material does not affect the quality of the product nor the product or water affect the lining material. Specialist advice should be sought in selection and application of these linings and appropriate documentation supporting the above should be obtained prior to using them. It is preferable that the lining material be white or a light/pale pastel shade to facilitate inspection. Strict supervision of the

preparation of the tank steel and application of the lining material should be carried out.

4.2.10 Tank bunds/dikes and other methods of containment

All above-ground tanks should be contained within a bund or dike unless other means of containing spillages such as double walled construction or installing a secondary shell are implemented. Where a bund or dike is used, its capacity should comply with local or national standards. A secondary shell system should be capable of containing the spilled contents of the tank or tanks that it is protecting.

Where no such standards exist, or are less stringent, it is recommended that each area should be capable of containing a minimum of 100 % or preferably 110 % of the volume of the largest tank within the containment area. Low permeability materials are recommended for new installations. Where earth bunds or dikes have been used, an assessment of the risk to surface and ground waters should be undertaken and appropriate steps taken to prevent damage to the environment.

Any rainwater drain-down valves in the bund or dike walls should be subject to procedures to ensure that they are kept shut when not in use and that any contaminated water is properly disposed of. (See also Section 10.9.3 and Annex B-2.)

4.2.11 Buried and mounded tanks

4.2.11.1 General

Design and construction details are provided in local or national standards. (See Annex B-2.)

Tanks should always be designed to withstand external loads imposed by the ground and by groundwater when the tank is empty. In certain applications it may be necessary to install a pumped drainage system to dispose of groundwater.

Where high water tables above tank bottoms can be experienced tanks should always be anchored to prevent uplift.

4.2.11.2 Access to tanks

Manholes should be not less than 800 mm (32 inches) diameter, and should be so positioned to enable personnel in protective clothing to enter or leave the tank with ease in case of emergency. A caged ladder may be permanently attached internally to the tank shell extending from the top manhole and fixed to the tank bottom. Means of ensuring dissipation of electrostatic charges should be provided. Refer to Annex B for guidance documents on methods of controlling static electricity charges.

4.2.11.3 Ventilation

In access tunnels, natural ventilation should be used when possible. When forced ventilation is used it should be of the blower type and it should be ducted to a low point adjacent to the tank to ensure maximum dissipation of any vapours.

4.2.11.4 Fire protection

Water drenching and fire foam connections for these types of tanks are not normally required, but local or national requirements should be applied where such exist.

4.2.11.5 Corrosion protection

Tanks should be given an external protective coating to combat corrosion from sub-soil and water table conditions. The following coatings are commonly used for this purpose:

- Bituminous paints applied cold.
- Bituminous coatings applied hot with or without wrapping.
- Polyurethane paint.
- Epoxy resin coatings.

Consideration may be given in special circumstances to the installation of cathodic protection. (See 4.2.9.2.) The type of treatment will depend upon the severity of the soil conditions applicable in each case and specialist advice should be sought to ensure adequate protection. (See Annex B-2.).

4.3 PIPEWORK

4.3.1 Standards

Section 5 gives guidance on the special requirements for pipework for fuel hydrant systems.

All pipework and pipeline systems should be designed, fabricated and tested in accordance with local and national codes. (See Annex B-2.) In some areas, regulations require periodic testing of pipe systems at proof pressure. Proof pressure is defined as 'the maximum pressure required of the system under test without external leakage after which the tested items will meet all other performance characteristics'. However, experience in other areas is that this can be harmful to the pipe and may shorten its life. Therefore, unless there is a regulatory requirement for periodic proof pressure testing, it should not be carried out.

4.3.2 Segregation of grades

4.3.2.1 General

Each grade of aviation fuel must be handled in a completely segregated system. There should be no inter-connecting lines between pipelines that handle different products. Pipelines that handle tested and untested batches of the same product should be positively separated by the use of any of the following:

- Removable distance piece.
- Spectacle blank flange.
- Double block and bleed valves.
- Twinseal block and bleed valve.
- Any other equivalent system which will offer the same level of positive segregation.

Whichever method is used should be of adequate strength and embody a means of clearly indicating its setting.

4.3.2.2 Segregation during testing

When aviation fuel stocks require to be laboratory tested before release into aircraft fuelling service, complete segregation should always be provided between the tanks/pipelines handling tested and untested stocks.

4.3.2.3 Selective couplings

Grade selective couplings should always be fitted, wherever possible, to fueller bottom loading connections, to hydrant pit valves and to road bridger and rail tank car receipt connections where more than one fuel grade is handled.

4.3.3 Materials

It is considered preferable to use stainless steel or internally lined carbon steel piping to prevent the introduction of particulate in aviation fuel. No copper or cadmium alloys, cadmium plating or galvanized steel or other zinc material coatings should be permitted in product pipework. Small bore tubing used for instrument air may, however, be of copper or other suitable material, but only where it will not be vulnerable in the event of fire. Gasket material used should be impervious to water and fuel.

4.3.4 Flexible or articulated pipe connections

The use of flexible type and/or articulated connections,

unless required by local regulations or topographical requirements (such as earthquake zones, filled land etc.) is not recommended, but when used they should always be fire-resistant.

4.3.5 Thermal relief

Adequate thermal pressure relief should always be provided around any valve in such a connection although product that has not been released for use should never be relieved into product that has been released. Where absolute segregation to prevent this occurring cannot be guaranteed under all operating conditions, consideration should be given to piping all thermal relief systems to an enclosed system or recovery tank.

4.3.6 Corrosion protection and painting

Above-ground pipework should be protected from corrosion. The type and colour of protective coating should be carefully selected to suit climatic conditions in order to minimize product heat gains.

When pipes are installed below ground they should always be appropriately protected against corrosion. The following are the preferred methods:

- Bituminous coating applied hot with a reinforcing rot proof wrapping.
- Factory applied epoxy resin coating.
- Bituminous primer paint and self-adhesive plastic wrapping.
- Factory applied polyethylene coating.

Joints made during installation should always be protected by an appropriate proprietary wrapping system.

The integrity of the external coating and wrapping of buried pipes should be verified, and any defects corrected before the trenches are back filled; great care should be taken to protect the wrapping during back filling.

Consideration should be given to cathodic protection where soil conditions are such that corrosion of the metal may result. (See 4.2.9.2.)

4.3.7 Pipeline identification

Means of identification should be applied to pipelines and valves to show the product or service for which they are used. The product identification should be in accordance with API/IP 1542.

4.4 PUMPS

4.4.1 General

Local or national standards on pump design, installation and operation should be applied. (See Annex B-2.)

4.4.2 Location

Pumps should preferably be situated in the open air, unless severe climatic conditions may be experienced. They should preferably not be installed below ground level. Pumps and pump manifolds should not be located within tank compounds. Pumps should be used to transfer one grade of product only.

4.4.3 Type

The type of pump to be used will be determined by product characteristics and pumping duties, in particular the suction conditions. Centrifugal pumps of single or multi-stage design are generally preferred for all aviation fuels.

4.4.4 Pump installation

Check valves should be fitted on the discharge side of the pumps in all cases where two or more pumps operate in parallel or where gravity flow back from the discharge line through the pump could take place when the pump is not operating.

Positive displacement pumps should have a by-pass circuit or other suitable protection against over-pressure or overloading.

Pumps should be protected from damage by a strainer mounted on the inlet side of the pump.

Guards should be installed over all moving parts to protect personnel.

4.4.5 Driving units for pumps

- (a) Where pumps are driven mechanically, the driving units should be sized for continuous duty at maximum pump requirements, and in the climatic conditions prevailing. Motors and any associated equipment should be entirely suitable for operation in the classified area in which they are located. An applicable code should be consulted.
- (b) Gasoline engine driven pump sets should not be used in aviation fuel depots. Where they have to be

used they should only be operated in non-hazardous areas. Diesel engine driven pump sets when operated in an area in which there is any risk of flammable vapour should conform with local or national standards. (See Annex B-2.)

Turbo-charged diesel engines present particular problems of high temperature exhaust surfaces that should be taken into account if they are used.

- (c) Diesel engines should be installed above ground level to reduce the risk of operation in an accumulation of flammable vapour.
- (d) Driving units should be fitted with guards for all moving parts.
- (e) There should be a means for rapid shut-down of the unit in an emergency.

4.4.6 Electrical equipment for pumps

All electrical equipment for pumps should always be installed in accordance with an appropriate electrical safety code or similar document. (See also Section 1.2.)

4.5 FILTRATION

At appropriate stages in the transfer of product from water-borne craft, rail or road tank cars, or pipeline to airport depot storage tanks and from these tanks to hydrant systems and/or mobile fuelling equipment, provision should always be made for improvement and maintenance of product quality by the use of filtration, and monitoring equipment as required by adopted quality control procedures.

- (a) All filter vessels should comply with the requirements of API/IP 1581, API/IP 1583 or API/IP 1590.
- (b) The pumping of jet fuel through filter elements can induce a high static charge in the product. These generated charges can best be prevented from accumulating to a dangerously high level by the addition of a static dissipator additive to the fuel. Where such an additive is not used alternative means, such as static relaxation tanks, should be used to dissipate static charges generated. The provision of product residence time should also be considered. See Annex B-2 for relevant publications giving guidance in controlling static

electrical charges. It is recommended that one of these publications be used.

- (c) Filter/separator, filter monitor and microfilter installations and their associated pipework should be designed to prevent the vessels draining either partially or completely during normal operation. It is especially important that fuel filters are never operated unless the vessel is full of fuel. If air is present in a filter housing, the atmosphere above the jet fuel could be flammable in hot climates. The taking of routine samples may result in air being introduced into the filter vessel. Whenever a filter vessel is less than full, it should be refilled slowly before being operated.
- (d) The following filtration requirements should be provided at the inlet to airport storage tanks:
 - Jet fuels – Filter/separators, or in clean and dry systems, a filter monitor.
 - Avgas – A five micron or finer microfilter, filter/separator or filter monitor.
- (e) The following filtration should be provided at fueller loading racks and into-hydrant delivery lines:
 - Jet fuel – Filter/separators or, in clean and dry systems, a filter monitor.
 - Avgas – A five micron or finer microfilter, filter/separator or a filter monitor.

4.6 FUELLER LOADING

4.6.1 Requirements for loading of fuellers

The requirements for loading of fuellers are as follows:

- (a) A pump emergency shut-off button should be easily accessible from each loading point.
- (b) A quick acting shut-off (deadman) valve or pump emergency stop should be fitted at each loading point, in addition to the normal isolating valve.
- (c) Each loading point should be fitted with a system that ensures complete grade segregation where more than one grade of fuel is handled.
- (d) All loading systems should be designed for bottom loading only and the connection between the fueller and loading arm or hose should be by a self-sealing dry-break coupler.

- (e) The loading hose should conform to the requirements of Section 7.
- (f) An effective electrical bonding facility should always exist between the fueller and the loading point throughout the loading procedure. A bonding cable should be attached to the vehicle bonding point before the loading hoses are connected. The reverse procedure should be used on completion of loading. An effective bonding facility may be incorporated in the loading pump control circuit to ensure that loading cannot take place without the fueller first being bonded to the loading point.
- (g) Control of the filling of the fueller tank will normally be by the automatic bottom loading system on the fueller or by a sensor in the fueller that will shut down the loading pump. Fueller filling should be carried out at a steady maximum rate to minimise the generation of static electricity and to avoid over-pressurization of the fueller tank. (See 4.5 (b).)
- (h) Splash deflectors should be fitted within the tank to minimise spray, jet or mist formation when pumping into an empty tank.
- (i) Dip tubes should have contact with the tank bottom to ensure electrical continuity.
- (j) Metallic or conductive objects should never be lowered into the vehicle tank during loading or for a five minute period after loading has finished. However, this restriction is not applicable where dipsticks are used in dip tubes which have their bottom ends submerged in the product.
- (k) Fueller or fueller/trailer combinations should be dedicated to one grade of product only.
- (l) An operator should always be in attendance throughout the loading operation.
- (m) Adequate supplies of fuel-absorbing material should be available to assist in retention and clean-up of spilled fuel.
- (n) The loading area should have a low permeability surface with adequate drainage facilities and oil/water separators to accept spillage and prevent fuel entering the main drainage system and any water course.

4.6.2 Loading from a hydrant pit valve

Fuellers may be loaded direct from a hydrant pit valve if they are equipped to do so and the local authority approves such an operation. The fueller should never be bonded to the hydrant pit valve internals. Adequate overspill devices should always be fitted and a means to close the pit valve provided and ready for use. (See 4.5 (b) and 5.5.)

4.6.3 Loading facilities receiving supply from a hydrant system

There are situations where the fueller loading facility receives its supply through a spur of a hydrant system. In addition to the safety requirements in 4.6.1, an Emergency Shut Down (ESD) Control as in Section 5.7 should be located in a readily accessible position adjacent to the loading facility. If fuel flow cannot be stopped in an emergency by using the loading controls, the ESD may be used.

4.7 CONTAINER FILLING

In can and drum filling plants product residence time should be provided in the pipework after the filtration equipment to permit the dissipation of static charges generated. Containers should be bonded before the filling nozzle is inserted.

4.8 PUMPING OPERATIONS - PRECAUTIONS AGAINST STATIC ELECTRICITY

This clause applies to all depot pumping operations and fueller loading. For precautions against the generation of static electricity refer to the applicable documents listed in Annex B-2.

Limitation should be applied to pumping velocities in accordance with the applicable document in Annex B-2.

Where possible, the practice of displacing product receipt line contents with water should be avoided. Similarly, the pumping of product/water mixtures or product with entrained air should not be permitted.

Extreme caution should be exercised during the likelihood of lightning and electrical storms. Operations should be suspended during lightning activity within the immediate vicinity of the location.